Weekend Surgical Admissions of Pediatric IBD Patients Have a Higher Risk of Complication in Hospitals Across the US

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Background: Weekend surgical admissions to the hospital are associated with worse clinical outcomes when compared with weekday admissions. We aimed to evaluate the association of weekend admission and in-hospital complications for pediatric inflammatory bowel disease (IBD) hospitalizations requiring urgent abdominal surgery.

Methods: We performed a cross-sectional analysis of pediatric (18 years old and younger) IBD hospitalizations between 1997 and 2016 using the Kids' Inpatient Database (KID), a nationally representative database of pediatric hospitalizations. We included discharges with a diagnosis code for Crohn's disease (CD) or ulcerative colitis (UC) undergoing a surgical procedure within 48 hours of admission. We used logistic regression to evaluate the association of weekend admission and complications, controlling for confounding factors.

Results: Our study included a total of 3255 urgent surgical hospitalizations, representing 4950 hospitalizations nationwide. The risk difference for weekend CD surgical hospitalizations involving a complication vs weekday hospitalizations was 4%. Adjusted analysis demonstrated a 30% increased risk for complications associated with weekend CD hospitalizations compared with weekday hospitalizations (OR 1.3, 95% CI, 1.0–1.7). The risk difference for weekend UC hospitalizations involving a complication compared with the weekday hospitalizations was 7%. Adjusted analysis demonstrated a 70% increased risk of complication for UC weekend surgical hospitalizations compared with weekday hospitalizations (OR 1.7, 95% CI, 1.2–2.3).

Conclusion: Pediatric IBD hospitalizations involving urgent surgical procedures have higher rates of complications when admitted on the weekend vs the weekday. The outcome disparity requires further health services research and quality improvement initiatives to identify contributing factors and improve surgical outcomes.

Key Words: outcomes; weekend; surgery; pediatric

INTRODUCTION

For a broad range of adult and pediatric diagnoses, clinical and surgical outcomes are worse when patients are admitted to the hospital on the weekend as compared with a weekday.[1–6] This phenomenon, known as the "weekend effect," is demonstrated in environments such as the intensive care unit (ICU)[3] and for interventions including management of upper gastrointestinal (GI) bleeding[7] and emergency general surgeries.[8] The weekend effect also impacts gastrointestinal (GI) surgeries with increased perioperative complications, longer admissions, and higher total hospital charges for admissions occurring on a weekend compared with a weekday.[1, 6]

Presence of the weekend effect in the inflammatory bowel diseases (IBD) population is poorly studied. One study demonstrated a weekend effect for surgical admissions involving adult patients with ulcerative colitis (UC) but not Crohn's disease (CD).[1] However, it remains unknown whether the outcomes of pediatric IBD surgeries are affected by the timing of admission. To that end, we used a nationally representative database of pediatric hospitalizations in the United States to evaluate the independent effect of weekend admission on the occurrence of in-hospital complications for pediatric IBD hospitalizations requiring urgent intestinal surgery. We hypothesized that pediatric IBD patients requiring urgent abdominal surgery who are admitted on the weekend are at higher risk for in-hospital complications than those admitted during the week.

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MATERIALS AND METHODS

Data Source

We performed a cross-sectional analysis of data from 1997 to 2016from the Kids' Inpatient Database (KID). KID is a nationally representative sample of pediatric hospitalizations created by the Agency for Healthcare Research and Quality

(AHRQ) for the Healthcare Cost and Utilization Project (HCUP). KID is the largest, publicly available, all-payer pediatric inpatient database and includes data from up to 7 million estimated annual pediatric discharges when using weighting techniques.[9] Published on a triennial interval, KID includes up to 4200 hospitals contributing discharge-level data designed to be representative of pediatric hospital care in the United States. The database contains over 75 clinical and nonclinical variables, 25 international classification of diseases, a ninth revision, clinical modification (ICD-9-CM) diagnostic and procedure codes, and up to 30 ICD-10 diagnosis codes per discharge. KID also includes hospital characteristics and outcomes.[9] The KID database has been used in previously published studies of pediatric IBD and IBD-related surgical procedures.[10–12]

Study Sample and Procedural Definitions

We examined discharge data for all pediatric (18 years old and younger) hospitalizations in the KID database reported between 1997 and 2016. We included hospitalizations with a diagnosis of either CD or UC using ICD-9 (555.x and 556.x, respectively) and ICD-10 (K50.x and K51.x, respectively) codes. Inflammatory bowel disease hospitalizations must have also included an intestinal surgical procedure identified by ICD-9 and ICD-10 procedural codes (Supplemental Tables 1 and 2). The ICD procedural definitions have been used in prior studies, including HCUP administrative database studies.[8, 13–16] We defined "urgent procedures" as those occurring on the day of admission (day 0) or the day immediately following admission (day 1).

We excluded "elective" hospitalizations and those in which the first surgical procedure occurred 2 or more days following admission. We then classified these urgent, nonelective surgical hospitalizations as either a "weekday" (Monday through Friday) or "weekend" (Saturday or Sunday) admission according to the KID-defined variable. Hospitalizations requiring urgent surgical intervention cannot optimize all factors involved in care provision given their acuity. As a result, these admissions amplify the limitations of consistent 24/7 health care in hospitals, making them ideal targets for quality improvement (QI) efforts and health services research. Figure 1 demonstrates the derivation of the study sample. Consistent with prior published HCUP studies,[10, 13, 17, 18] we excluded hospitalizations with discharge diagnosis lists containing *both* UC and CD diagnoses to minimize misclassification.

Variables

Data collected from each pediatric IBD hospitalization included patient age (categorized as 6 years old or younger, 7 to 12 years, 13 to 18 years), sex, race (white, African American, Hispanic, other; other defined as Asian Pacific, Native American, or unknown), emergency department (ED) admission (yes or no), and payer type (Medicaid, HMO/private, other; other defined as self-pay, Medicare, or unknown).

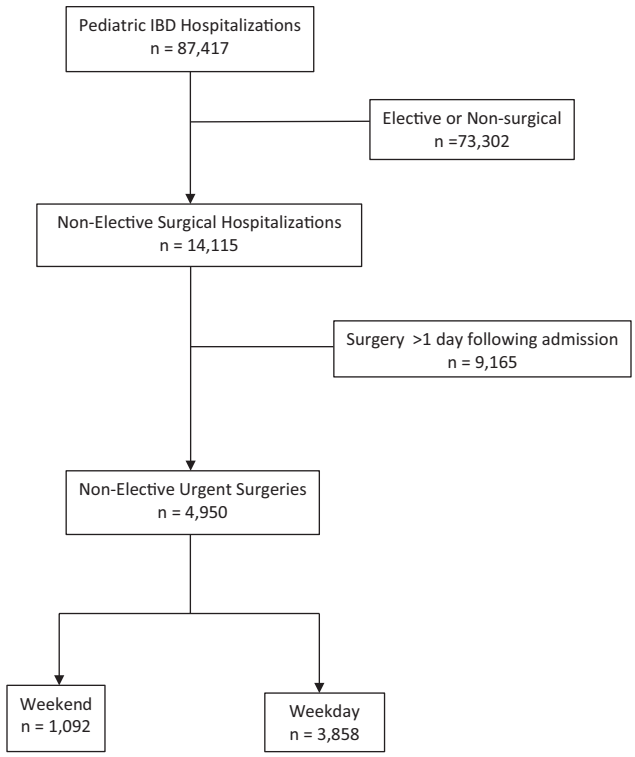

FIGURE 1. Flow diagram representing the derivation of the study's sample population of nonelective pediatric IBD admissions undergoing urgent intestinal surgery. The final study sample is stratified by admission date.

Hospital-level variables included location and teaching status (rural, urban/nonteaching, and urban/teaching).

Outcome Definition

Our primary outcome was a composite measure of in-hospital complication. We used a modified definition of complication used by Ananthakrishnan et al,[1] Kaplan et al,[13] Soon et al,[15] and Berry et al.[19] Our complication definition used ICD-9 and ICD-10 diagnosis and procedural codes. Complications were broadly classified as procedural, cardiovascular, respiratory, gastrointestinal, urinary, and/or infectious (Supplemental Tables 3 and 4).

Statistical Analysis

We used SAS version 9.4 (Cary, NC) for all analyses and followed AHRQ and HCUP guidelines for statistical weighting techniques to generate national estimates from the raw data.[9] Descriptive statistics of the weighted estimates included frequency count and 95% confidence interval (95% CI). We used χ^2 test for bivariate analyses of association between categorical variables.

For both the pediatric CD and UC populations, we calculated the absolute risk of in-hospital complications for both weekend and weekday surgical admissions and the risk difference. We reported the highest frequency complications for both weekend

and weekday procedures. We evaluated the association of weekend admission and in-hospital complications using multivariable logistic regression. We controlled for patient demographics (age, sex, race, disease type, payer type) and for ED admission status, hospital location, and teaching category. We reported the odds ratios (OR) and 95% CI for the primary predictor and covariates.

We used a 2-tailed *P* value of 0.05 as the threshold for statistical significance in all analyses. We selected covariates a priori based on clinical relevance and previously published literature.[11, 13–16, 20]

Ethical Considerations

Due to the de-identified nature of the data, the University of North Carolina Institutional Review Board (IRB) determined this study exempt from review.

RESULTS

Crohn's Disease and the Weekend Effect

Our study included a total of 3255 pediatric IBD hospitalizations associated with an urgent intestinal surgical procedure between 1997 and 2016. This represented an estimated 4950 urgent pediatric IBD surgical admissions nationwide, of which 2984 involved pediatric CD patients. Twenty percent of CD admissions occurred on the weekend. Pediatric CD hospitalizations were predominately 13 to 18 years in age (76%) and 42% female. White patients constituted 63% of the CD hospitalizations, and the majority (71%) were private/HMO payers. The majority (70%) of CD admissions received care in the ED. Table 1 summarizes the characteristics of the pediatric CD surgical hospitalizations.

TABLE 1. Patient and Hospital Characteristics for Non-Elective Pediatric Crohn's Disease Hospitalizations Undergoing Urgent Abdominal Surgery in the KID Database Between 1997 and 2016

	Admission Day						
	All Admissions		[a]Weekend		[a]Weekday		
	n	(%)	n	(%)	n	(%)	
[b]No. nonelective, urgent surgeries in KID database	1941	(100)	387	(20)	1554	(80)	
[b]National est. of nonelective, urgent surgeries in KID database	2984	(100)	607	(20)	2377	(80)	
	%	**(95% CI)**	**%**	**(95% CI)**	**%**	**(95% CI)**	***P*-**
Age (years)							
≤6	2.9	(2.1–3.7)	3.6	(1.6–5.5)	2.7	(1.9–3.6)	
7–12	20.8	(18.8–22.8)	19.0	(14.5–23.6)	21.3	(19.1–23.5)	0.34
13–18	76.3	(74.2–78.4)	77.4	(72.6–82.2)	76.0	(73.7–78.3)	
Sex							
Female	41.6	(39.3–43.9)	44.5	(39.3–49.7)	40.8	(38.2–43.4)	0.10
Race							
Black	13.7	(12.0–15.3)	14.2	(10.3–18.3)	13.5	(11.7–15.3)	
Hispanic	6.8	(5.7–7.9)	5.9	(3.5–8.2)	6.9	(5.7–8.2)	0.69
Other	16.8	(15.1–18.5)	16.1	(12.2–19.9)	17.0	(15.1–18.9)	
White	62.7	(60.5–64.9)	63.8	(58.7–68.9)	62.6	(59.9–64.9)	
Payer Type							
Medicaid	22.8	(20.9–24.6)	22.2	(18.1–26.4)	22.9	(20.8–24.9)	
Other	6.7	(5.5–7.8)	8.9	(5.8–12.1)	6.1	(4.9–7.3)	0.04
Private/HMO	70.5	(68.5–72.6)	68.9	(64.0–73.6)	71.0	(68.7–73.3)	
ED Admission							
Yes	69.8	(67.5–71.9)	67.1	(62.1–72.2)	70.4	(67.9–72.9)	0.11
Hospital Type							
Rural	6.4	(5.2–7.6)	8.2	(4.9–11.3)	5.9	(4.6–7.2)	
Urban/nonteaching	16.6	(14.8–18.4)	17.5	(13.5–21.5)	16.4	(14.3–18.4)	0.09
Urban/teaching	77.0	(74.9–79.1)	74.3	(69.7–79.0)	77.7	(75.5–79.9)	

[a]Weekend: Saturday or Sunday; Weekday: Monday through Friday.
[b]*Raw* data is taken from actual database. *National Estimate* reflects KID weighting of raw data to produce national estimate.

In this pediatric CD surgical population, 383 hospitalizations involved at least 1 complication (absolute risk 13%). There were 607 (20% of all CD hospitalizations) weekend surgical hospitalizations, 99 of which involved at least 1 in-hospital complication yielding an absolute risk of complication of 16% for weekend procedures. The most frequent complications for the weekend pediatric CD surgical admissions were postoperative intestinal and hepatic complications (28%), paralytic ileus (16%), and postoperative sepsis (12%) (Supplemental Table 5).

In contrast, of the 2377 weekday urgent surgical hospitalizations, 285 involved at least 1 in-hospital complication (absolute risk of 12%). The most frequent complications associated with weekday CD procedures were the same as those observed on weekends: postoperative intestinal and hepatic complications (23%), postoperative sepsis (13%), and paralytic ileus (11%) (Supplemental Table 6). The complication risk difference between weekend admissions and weekday admissions for the CD population was 4% ($P = 0.004$) (Fig. 2).

Our adjusted analysis of the independent effect of weekend admission on the complication risk in CD surgical hospitalizations demonstrated a 30% increased risk as compared with weekday admissions (OR 1.3; 95% CI, 1.0–1.7). Adjusted analysis also showed an increased risk of complication at urban nonteaching hospitals compared with urban teaching hospitals (OR, 2.2; 95% CI, 1.6–2.8) (Table 2).

Ulcerative Colitis and the Weekend Effect

Ulcerative colitis hospitalizations constituted an estimated 40% (1966) of the total pediatric IBD surgical admissions, 25% of which were weekend admissions. Pediatric UC hospitalizations were predominately of the adolescent age group (69%) and 48% female. White patients constituted 62% of the UC surgical hospitalizations, and 70% were private/HMO payers. Nearly 70% of pediatric UC surgical admissions received care in the ED (Table 3).

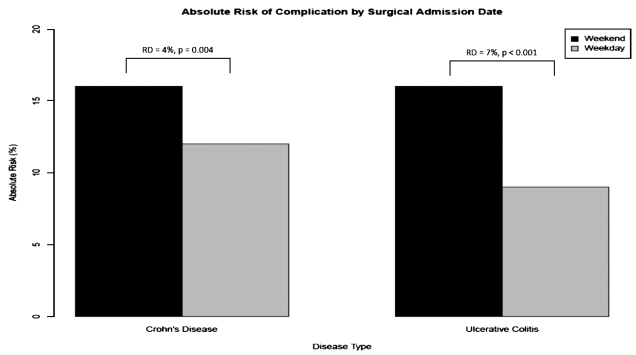

FIGURE 2. Comparison of the absolute risk of in-hospital complication by admission date for pediatric inflammatory disease hospitalizations requiring urgent abdominal surgery in KID database between 1997 and 2016. Abbreviations: RD, risk difference.

In this UC surgical group, 210 hospitalizations involved at least 1 in-hospital complication for an absolute risk of 11%. Four hundred eighty-five UC surgical admissions occurred on the weekend, 76 of which experienced at least 1 complication (16% absolute risk). The most frequent weekend complications experienced in UC hospitalizations were postoperative intestinal and hepatic complications (20%), paralytic ileus (12%), and postoperative infection (11%) (Supplemental Table 7). In contrast to the weekend procedures, there was a 9% (134 of 1481) absolute risk of complication for weekday procedures (risk difference of 7%; $P < 0.001$) (Fig. 2). The most frequent weekday complications were postoperative intestinal and hepatic complications (21%), unspecified septicemia (14%), and postoperative sepsis (11%) (Supplemental Table 8).

Adjusted analysis demonstrated a 70% increase in the risk of in-hospital complication for weekend UC surgeries as

TABLE 2. Multivariable Analysis, OR, and 95% Confidence Interval (95% CI) of an In-hospital Complication Among Urgent Pediatric Crohn's Disease Hospitalizations Undergoing Intestinal Surgery in the 1997–2016 KID Database.

	OR	95% CI
Admission Date		
Weekend	1.3	(1.0–1.7)
Weekday	Ref	
Age (years)		
≤6	1.3	(0.7–2.5)
7–12	0.9	(0.6–1.2)
13–18	Ref	
Sex		
Female	0.9	(0.7–1.1)
Male	Ref	
Race		
Black	0.9	(0.6–1.3)
Hispanic	0.7	(0.4–1.1)
Other	0.7	(0.5–1.0)
White	Ref	
Payer Type		
Medicaid	1.3	(0.9–1.7)
Other	0.6	(0.4–1.1)
Private/HMO	Ref	
ED Admission		
Yes	0.8	(0.6–1.0)
No	Ref	
Hospital Type		
Rural	0.9	(0.6–1.5)
Urban/nonteaching	2.2	(1.6–2.8)
Urban/teaching	Ref	

TABLE 3. Patient and Hospital Characteristics for Nonelective Pediatric Ulcerative Colitis Hospitalizations Undergoing Urgent Abdominal Surgery in the KID Database Between 1997 and 2016

	Admission Day						
	All Admissions		[a]Weekend		[a]Weekday		
	n	(%)	n	(%)	n	(%)	
[b]Number of Nonelective, urgent surgeries in KID database	1314	(100)	306	(23)	1008	(77)	
[b]National est. of Nonelective, urgent surgeries in KID database	1966	(100)	485	(25)	1481	(75)	
	%	**(95% CI)**	**%**	**(95% CI)**	**%**	**(95% CI)**	***P***
Age (years)							
≤6	7.0	(5.4–8.7)	5.3	(2.4–8.3)	7.6	(5.6–9.6)	
7–12	24.1	(21.5–26.7)	26.1	(20.5–31.7)	23.5	(20.5–26.4)	0.20
13–18	68.9	(65.9–71.7)	68.6	(62.6–74.5)	68.9	(65.7–72.2)	
Sex							
Female	47.9	(45.1–50.7)	51.7	(45.7–57.7)	46.7	(43.5–49.8)	0.06
Race							
Black	8.1	(6.6–9.6)	5.9	(2.9–8.9)	8.8	(7.0–10.5)	
Hispanic	13.8	(11.9–15.7)	10.8	(7.3–14.3)	14.8	(12.6–16.9)	
Other	16.4	(14.4–18.5)	19.5	(14.9–24.1)	15.4	(13.1–17.7)	0.01
White	61.7	(58.9–64.4)	63.8	(58.0–69.4)	61.0	(57.9–64.1)	
Payer Type							
Medicaid	24.5	(22.1–26.9)	19.7	(15.0–24.3)	26.1	(23.3–28.8)	
Other	6.3	(4.9–7.6)	6.8	(3.8–9.9)	6.1	(4.6–7.6)	0.02
Private/HMO	69.2	(66.7–71.8)	73.5	(68.3–78.7)	67.8	(64.9–70.8)	
ED Admission							
Yes	68.4	(65.7–71.2)	54.3	(48.2–60.3)	73.1	(70.1–76.0)	<0.01
Hospital Type							
Rural	3.7	(2.7–4.8)	4.8	(2.3–7.3)	3.4	(2.2–4.5)	
Urban/nonteaching	12.7	(10.9–14.6)	11.8	(8.3–15.4)	13.0	(10.9–15.1)	0.30
Urban/teaching	83.6	(81.5–85.5)	83.4	(79.1–87.5)	83.6	(81.3–85.9)	

[a]Weekend: Saturday or Sunday; Weekday: Monday through Friday.
[b]Raw data is taken from actual database. *National Estimate* reflects KID weighting of raw data to produce national estimate.

compared with weekday surgeries (OR 1.7; 95% CI, 1.2–2.3). Ulcerative colitis hospitalizations requiring urgent surgery benefitted from initial ED care with a 60% reduction in the risk of complication compared with non-ED admissions (OR 0.4; 95% CI, 0.3–0.5). Hospital teaching status did not influence surgical outcomes in UC hospitalizations (Table 4).

DISCUSSION

Using a nationally representative sample of nonelective pediatric IBD hospitalizations undergoing urgent abdominal surgery, we demonstrated the existence of a weekend effect, with a relative risk of in-hospital surgical complications that is 30%–70% higher for weekend admissions compared with weekday admissions for CD and UC, respectively. These findings support our hypothesis that the weekend effect is present in urgent pediatric IBD surgical hospitalizations.

To our knowledge, this is the first study to demonstrate the presence of a weekend effect in pediatric IBD hospitalizations involving urgent surgical procedures. Hence, we are unable to put our findings in the context of similar studies involving pediatric IBD. There is a paucity of literature in the adult IBD population, as well. One adult study from 2013 used data from the National Inpatient Sample (NIS) and demonstrated a weekend effect for UC surgical admissions, with a 71% adjusted risk elevation for in-hospital complications associated with weekend surgical admissions compared with weekday admissions.[1] In contrast to our findings, this prior adult study did not identify a weekend effect for CD surgical admissions. Reasons for the contrasting results between CD and UC in the adult study are unclear.

The breadth of hospital interventions and interactions involved with urgent pediatric IBD surgical admissions is

TABLE 4. Multivariable Analysis, OR, and 95% Confidence Interval (95% CI) of an In-hospital Complication Among Urgent Pediatric Ulcerative Colitis Hospitalizations Undergoing Intestinal Surgery in the 1997–2016 KID Database.

	OR	95% CI
Admission Date		
Weekend	1.7	(1.2–2.3)
Weekday	Ref	
Age (years)		
≤6	0.9	(0.5–1.6)
7–12	0.7	(0.5–1.0)
13–18	Ref	
Sex		
Female	0.7	(0.5–1.0)
Male	Ref	
Race		
Black	0.7	(0.3–1.4)
Hispanic	0.5	(0.3–1.0)
Other	1.8	(1.2–2.6)
White	Ref	
Payer Type		
Medicaid	1.5	(0.9–2.1)
Other	1.7	(0.9–3.2)
Private/HMO	Ref	
ED Admission		
Yes	0.4	(0.3–0.5)
No	Ref	
Hospital Type		
Rural	1.0	(0.5–2.1)
Urban/nonteaching	0.8	(0.5–1.4)
Urban/teaching	Ref	

extremely diverse. As a result, the weekend effect phenomenon likely involves many influencing factors. Prior studies of the weekend effect have suggested contributors including reduced weekend hospital staffing,[21, 22] delayed seeking of care by patients, which increases illness severity,[23, 24] and reduced access to diagnostic resources and/or lack of access to specialist care or care teams on the weekends.[25, 26] The complexity of surgical procedure has been shown to contribute to the weekend effect, as well.[5, 27] There are likely to be many more influencing factors, in addition to those previously mentnioned, contributing to the variation seen in surgical outcomes. Therefore, targeted research from multiple disciplines (QI, health services research, etc.) is needed if the disparities in patient outcomes are to be eliminated.

Our study has several implications. First, the presence of a weekend effect for urgent pediatric IBD surgical hospitalizations suggests that consistent care is not provided 7 days per week in hospitals across the United States. The difference in surgical outcomes associated with the day of admission is likely multifactorial and may involve several aspects of health care from systems-level to patient-level factors. The variation seen in surgical outcomes undermines the quality and reliability of care and may lead to unnecessary increases in hospital cost,[28] further emphasizing the importance of identifying contributing factors. Second, drivers for the weekend effect likely influence both pediatric and adult hospital care, an observation supported by previous literature.[1, 5, 6, 8, 29] Therefore, moving forward, pediatric IBD research that provides insight into causes for the weekend effect will benefit a wide array of patients and health care settings. Additionally, insights may allow hospitals to better identify high-risk admissions and develop care strategies to manage that risk and ultimately improve outcomes.

We found that pediatric UC surgical admissions were presented to the ED much more frequently during the week compared with the weekend. It is not entirely clear what factors may be influencing the higher weekday ED use by pediatric UC patients, but the disparity further underscores the need for additional research into drivers for quality and consistency of care. Our results also demonstrate a reduced risk of complications for both pediatric CD and UC surgical hospitalizations when admitted through the ED vs direct admission. Although not the primary purpose of this study, these findings suggest that rapid assessment and stabilization of acutely ill patients in the ED is an important component of care and that physicians should use discretion regarding decisions to directly admit such patients.

Our study has several strengths, beginning with our use of a nationally representative sample of nonelective pediatric IBD hospitalizations undergoing an urgent intestinal procedure. The HCUP KID database is nationally representative of geographic regions, hospital characteristics, and health insurance payers and thus represents a broad range of hospital-level care provided to pediatric IBD patients. Second, KID provides an adequate sample size for analyses improving the precision of effect measure estimates and confidence intervals. Third, our multivariable models allow for more accurate analyses through adjustment for potential confounding factors including age, sex, race, payer type, admission type, region, hospital location, and teaching status.

We acknowledge that our study is subject to limitations, as well. First, as with most epidemiologic studies using administrative data, misclassification of exposure and/or outcomes identified by diagnosis or procedural code are possible. As a de-identified database, validation of diagnosis and procedural codes is not possible. However, KID has been used in previously published studies involving pediatric IBD hospitalizations,[10, 12, 15] and the HCUP-defined weighting techniques provide valid nationwide estimates. Additionally, administrative databases have been used previously to examine postoperative

complications with high positive predictive values.[14, 30, 31] Second, administrative databases such as KID lack clinical data including metrics of disease severity, laboratory markers, identification of provider type, admitting service, presence of a trainee in the provision of care, and patient-level information regarding pre- and postsurgical care. Absence of such clinical information may introduce unmeasured confounding in analyses. Third, weekend admissions cannot be further classified by specific weekend day. Hence, by definition, Sunday admissions going to the OR on Monday remain categorized as a weekend admission, and Friday evening admissions are classified as weekday events. This imprecision biases our results toward the null; hence, our results are conservative.

CONCLUSION

In summary, our data show that pediatric CD and UC hospitalizations requiring urgent intestinal surgery are subject to a higher risk of in-hospital complication when procedures occur on the weekend vs weekday. Additional health services research and quality improvement initiatives may identify specific contributing factors and reduce the disparity between weekend and weekday surgical outcomes.

SUPPLEMENTARY DATA

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

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