

Weekend Admissions Associated with Increased Length of Stay for Children Undergoing Cholecystectomy

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ABSTRACT

Background and Objectives: Prior research shows an association between increased length of stay (LOS) and weekend surgical admissions, but none have looked at this relationship in children undergoing nonelective cholecystectomy for benign noncongenital biliary disease. We investigated whether weekend admissions lead to a longer LOS in this patient population.

Methods: The Statewide Planning and Research Cooperative System database was queried for children ≤ 17 years undergoing cholecystectomy in New York State between January 1, 2009 and December 31, 2012. Parametric and nonparametric statistical testing was used for univariate analysis; multivariable binary logistic regression and linear regression models were used for multivariable analysis. Statistical significance was < 0.05 .

Results: A total of 1066 pediatric patients underwent nonelective cholecystectomy for gallstone pancreatitis (9.7%) and other benign biliary noncongenital diseases (90.3%), of which 22.1% of all patients were admitted over the weekend. Most cases (97.2%) were treated laparoscopically with an overall 3-day median LOS. Weekend admission was associated with an increased LOS of 4 days as opposed to 3 days during the weekday ($p < 0.001$). On a multivariable binary logistic regression model controlling for hospital factors, indication for surgery, and comorbidities, weekend

admission was associated with 1.92 odds of increased length of stay (adjusted odds ratio of 1.924, 95% confidence interval: 1.386–2.673).

Conclusion: Weekend admissions were associated with increased LOS and charges for children requiring nonelective cholecystectomy, despite the wide use of laparoscopic surgery.

Key Words: Weekend admission, Cholecystitis, Cholecystectomy, Hospital stay length.

INTRODUCTION

Weekend admissions for surgical and nonsurgical admissions have been associated with unfavorable outcomes such as increased morbidity, mortality, hospitalization duration, and expenditures when compared to patients admitted during the week in admissions requiring urgent surgical intervention such as cases of diverticulitis, Crohn's disease, and ulcerative colitis in adults and children.^{1,2} Little has been investigated in terms of the weekend effect in children with benign noncongenital biliary disease such as gallbladder disease from gallstones—a disease increasing in incidence in children and often requiring urgent procedures for treatment on the same admission.

Pediatric cases of benign noncongenital gallbladder disease, namely cholelithiasis, cholecystitis, cholangitis, choledocholithiasis, and gallstone pancreatitis have been increasing in incidence and prevalence in children mainly due to the obesity epidemic, early-onset puberty, and increased oral contraceptive prescriptions in female adolescents.^{3,4} Currently, few resources exist on the standardization of care for pediatric benign noncongenital gallbladder disease with variation in the modality of diagnosis, laboratory follow-up, procedural/operative interventions, and timing of treatment strategies, leading to significant variation among hospitals.^{5–7} While adult cases have been studied to determine optimal timing for surgical intervention and develop systematic methods for efficient medical decision-making, there is less evidence of this in children.⁸ This leads to significant variation in who admits these children—a surgical or medical

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service—, how urgent they should be treated, and what follow-up they receive.

To date, no reports have evaluated the cross-section of the weekend effect on nonelective pediatric cholecystectomy for children requiring urgent surgical intervention on their admission. Weekend admissions are common for benign noncongenital biliary disease requiring nonelective cholecystectomy. The differences in the weekend versus weekday admission for these children may impact the timing of treatment, the speed at arriving on the diagnosis, and subsequent planned interventions before surgery. Our study investigated whether weekend admissions were associated with longer length of stay (LOS) and greater charges using an administrative database for children with benign noncongenital biliary disease who underwent nonelective cholecystectomy in all hospitals admitting children in New York State. We hypothesized that weekend admissions would lead to increased charges and increased LOS after controlling for geography, race, ethnicity, gender, insurance status, hospital type, admission day, risk of mortality, and severity of the disease.

METHODOLOGY

Through the New York State Department of Health Statewide Planning and Research Cooperative System (SPARCS) database, we queried all hospital admissions for the pediatric population who underwent cholecystectomy in New York State between January 1, 2009 and December 31, 2012 in patients ≤ 17 years old. These dates were chosen given that these were the only dates days of admission and day of discharge were recorded in the database. The SPARCS database is an administrative database of both government and private sector patient claim information for all payers in New York State. The unit record of the database is a patient's visit or stay. The data include demographic information, claims information, and clinical data for every hospital discharge, ambulatory surgery, and emergency department visit. The database consists of race and ethnicity, International Classification of Diseases (ninth Revision) codes with the primary diagnosis, LOS, procedure(s), and charges. For disease and mortality risk assessment, the database uses All Patient Refined Diagnosis Related Group (APR-DRG) risk of mortality and disease severity, which is commonly used by hospitals and insurance companies determine the value of care for higher acuity patients for a given disease and incorporates procedures performed as well as utilization of health care resources.⁹ The APR-DRG system is divided into four categories for each factor (risk of mortality and

disease severity) consisting of minor, moderate, major, and extreme, with higher levels of APR-DRG codes meaning increased use of medical resources and increased severity of primary disease or secondary comorbidities. Higher APR-DRG levels in the risk of mortality and disease severity categories are associated with higher readmission rates and other adverse outcomes.^{10,11}

The database is deidentified and publicly available, and the Institutional Review Board at New York Medical College granted exemption according to 45 Code of Federal Regulations 46.101(b)(4) for existing data, documents, records, and specimens. Hospital charges in this database are defined as the amount the hospital charged the insurance company or government for the total services rendered while hospital cost is the total dollar charges reported by the hospital as previously described.^{12,13}

The database was queried for information between January 1, 2009 and December 31, 2012. It included children not born on the index admission and ≤ 17 years with a primary or secondary diagnosis of acute or chronic gallbladder disease who underwent cholecystectomy and were admitted nonelectively. Diagnosis and surgical procedure definitions were used as abstracted from the billing information through International Classification of Diseases Clinical Modification Version 9 (ICD-CM 9) codes and recorded into the database as clinical classification software diagnosis codes as previously described.^{12,13} We used Clinical Classification Software procedure code 84 for cholecystectomy and linked it to Clinical Classifications Software diagnosis code 149 for noncongenital biliary tract disease, which includes the following: 90.70.1 Cholelithiasis with acute cholecystitis, 90.70.2 Cholelithiasis with other cholecystitis, 90.70.3 Cholelithiasis without mention of cholecystitis, 90.70.4 Calculus of bile duct, 90.70.5 Cholecystitis without cholelithiasis, and 90.70.6 Other biliary tract disease. We also linked procedure code 84 for cholecystectomy and linked it to diagnosis code 152 for pancreas disorders not diabetes, which includes: 9.90.1 Acute pancreatitis and 9.90.2 Chronic pancreatitis, 9.90.3 Other pancreatic disorders.

Any elective admissions for cholecystectomy were excluded. Any instances of cholecystectomy in which the operative procedure did not match the diagnosis of biliary tract disease or pancreatic disorders were excluded from the analysis. Patients with a significant concomitant procedure not related to the primary surgery and excluding endoscopic procedures were not included. Any patient who had an unclear clinical indication, missing data, or who had upon further investigation of comorbidities a pathology that was congenital biliary disease and not gallstone

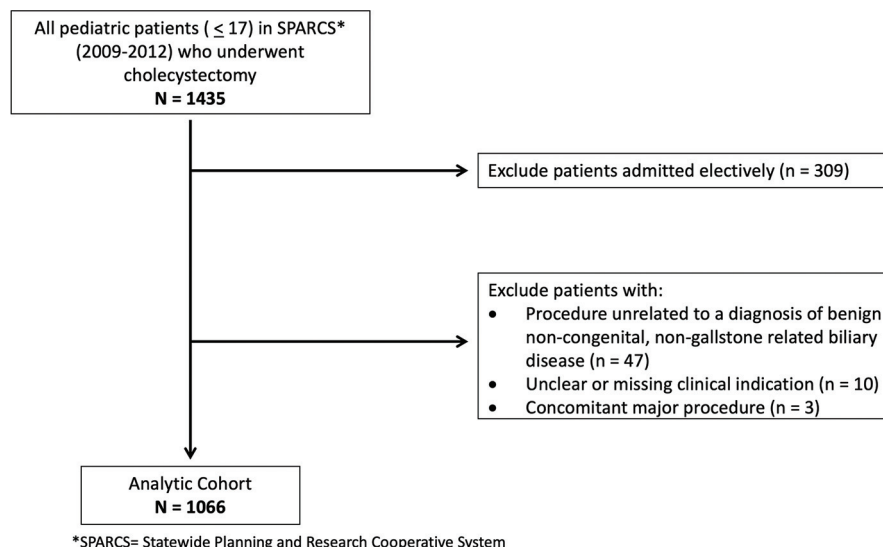


Figure 1. The New York state department of health’s statewide planning and research cooperative system database query protocol.

related were subsequently excluded from analysis (**Figure 1**). Patients who had a pre-operative or postoperative endoscopic retrograde cholangiopancreatography on the same admission were included.

Variables collected directly from the data set included race, ethnicity, gender, insurance status, admission day, discharge day, disposition, risk of mortality, the severity of disease, LOS, elective versus nonelective admission, transfer status, location of where the patient was admitted from, hospital identity, and cost/charges of the hospitalization for a given child admitted and operated on for the diagnosis. The weekend was defined as an admission on either Saturday or Sunday. Publicly available data was then linked to the SPARCS dataset, such as pediatric surgery fellowships, pediatric residency affiliation of the admitting hospital, and state census data to define urban versus rural were obtained from a prior study using this database and publicly available resources as previously described.^{12,13} Variables collected directly from the publicly available dataset set included geography, race, ethnicity, gender, insurance status, hospital type, admission day, risk of mortality, and disease severity.

IBM SPSS Version 200.0 and 260.0 (IBM; Armonk, NY, USA) was used for data analysis. Nonparametric and parametric statistical testing was used for univariate analysis if the data was non-normally or normally distributed, respectively. A multivariate binary logistic regression model was used for multivariate analysis with the LOS greater than three days used as the binary outcome.

Statistical significance is defined as $P < .05$. Increased LOS was analyzed both as a continuous variable and transformed into a binary category, which was defined as any LOS greater than the overall cohort’s median LOS. Using this database and our selection criteria, the median LOS was three days in children admitted and operated for benign gallbladder disease requiring cholecystectomy either in patients requiring or not requiring endoscopic retrograde cholangiopancreatography beforehand. Anything above three days was defined as an increased LOS. This was used in our multivariable regression models. Others have done the transformation of continuous to binary for identifying patients who have a prolonged LOS in the literature as an accurate way to assess for quality of care by identifying those with longer LOS for a given procedure.¹⁴ Moreover, the median is a more accurate description than other measures when describing LOS.¹⁵

RESULTS

A total of 1066 children ≤ 17 years old underwent cholecystectomy in New York State in the study period (**Figure 1**). Seven hundred ninety children (74.1%) of the overall cohort were identified as female, while 819 children (76.8%) of the overall cohort had private insurance. Just over half of the children in the study (552, 51.8%) were identified as White/Caucasian, while 348 children (32.6%) were identified as Hispanic. Regarding hospital characteristics, approximately 1011 children (94.8%) of the overall

cohort were treated at urban hospitals, and the remaining children were treated at a rural hospital. Five hundred seventy-five children (53.9%) of the overall cohort were seen at hospitals affiliated with a pediatrics residency program, and 475 children (44.6%) of the overall cohort of children were treated in hospitals affiliated with a children's hospital. Eight hundred twenty-one children of the overall cohort (77%) were admitted from the emergency department. Two hundred forty-five children (23%) of the overall cohort in the study were transferred from an outside hospital or directly admitted to the hospital from home, an institution, or an outside hospital. Most children in our overall cohort had their admission and surgery done at a facility not affiliated with any pediatric surgery fellowships (888, 83.3%).

Regarding clinical features, 963 children (90.3%) of the overall cohort had a diagnosis of biliary diseases such as symptomatic cholelithiasis, cholecystitis, or choledocholithiasis. Of the overall cohort, 103 children (9.7%) had a diagnosis of gallstone pancreatitis. A total of 1,036 children (97.2%) of our overall cohort had a laparoscopic cholecystectomy performed while the rest were open procedures. Most of these children were discharged home under parental supervision (1048, 98.3%) and on the weekday (750, 700.8%).

Of the overall 1,066 patients, 236 children (22.1%) were admitted over the weekend. Univariate analysis comparing weekend versus weekday admissions in this cohort showed that children hospitalized on the weekend had an increased median LOS of 4 days (interquartile range, 3–6 days) as opposed to 3 days (interquartile range, 2–5 days; Kruskal-Wallis test, $P < .001$) (**Table 1**). More patients were admitted from the emergency department, and fewer patients were admitted as transfer or direct admissions on the weekend versus the weekday (ANOVA, $P = .004$) (**Table 1**). A multivariate binary logistic regression model controlling for demographics, insurance status, and clinical severity as well as surgical approach for patients with a benign biliary disease requiring cholecystectomy demonstrated that there was an association with increased odds of an increased LOS > 3 days for children admitted over the weekend versus the weekday (adjusted odds ratio of 1.924, 95% confidence interval [CI]: 1.386–2.673) (**Table 2**). This analysis remained unchanged with weekend versus weekday associated with longer length of stay in multivariate linear regression ($\beta = 0.038$, 95% CI [0.004–0.893], **Supplemental Table 1**). Moreover, on sensitivity analysis, when we excluded those patients who had a diagnosis of pancreatitis that required admission, prior procedures such as endoscopy,

and a concomitant cholecystectomy on the same admission in a multivariate linear regression model, the result held with weekend admission having increased LOS ($\beta = 0.046$, 95% CI [0.057–0.974], **Supplemental table 2**).

The median total charges were compared for this cohort of patients to compare charges on the weekend versus the weekday. This comparison of weekday versus weekend admission showed statistically different total charges, with children admitted on weekends having an increased median charge of \$26,621 (interquartile range \$16,728–\$197,068) compared to the weekday median charge of \$23,393 (interquartile range \$14,479–\$35,531) per child (Kruskal-Wallis test, $P = .03$; **Figure 2**). The median cost per child was higher on the weekend as well at \$10,967 (interquartile range \$7,232–\$15,656) compared to the median cost of \$9,857 (interquartile range \$6,301–\$16,241) on the weekday, but this was not statistically significant (Kruskal-Wallis test, $P = .103$). On multivariate linear regression however these charges nor costs were statistically significant when accounting for multiple variables ($P > .05$, Data not shown).

DISCUSSION

Using the SPARCS database, we found a statistically significant association between day of admission and LOS in patients ≤ 17 years old in New York State, who had a nonelective cholecystectomy performed on the same hospital admission from January 1, 2009 to December 31, 2012 for benign gallbladder disease requiring urgent surgery after admission. LOS increased by one day for patients admitted during the weekend, in comparison to the weekday, on univariate analysis with increased odds of LOS of > 3 days for those admitted on the weekend versus the weekday, on multivariate analysis after adjusting for demographics, geographics, disease etiology, and disease severity, among other factors. Our secondary outcome showed a statistically significant association between weekend admissions and increased charges of more than \$3,000 associated with weekend admissions for patients requiring an urgent cholecystectomy, but this was not significant in multivariable linear regression analysis. Finally, most pediatric cholecystectomy cases were performed at an institution without an affiliated pediatric surgery fellowship.

These findings support other reported research regarding weekend admission and worse healthcare delivery. Goldstein et al. found that weekend pediatric patients who were admitted and underwent common surgical

Table 1.
Demographics, Hospital, and Clinical Variables of Patients

Demographics, Hospital and Clinical Characteristics	Admission Day		p-Value
	Weekday N = 830 (%)	Weekend N = 236 (%)	
Sex Female	615 (74.1)	175 (74.2)	0.986
Race			0.601
White	424 (51.1)	128 (54.2)	
African American	150 (18.1)	43 (18.2)	
Other	256 (30.8)	65 (27.5)	
Ethnicity			0.239
Non-Hispanic or Latino	507 (61.1)	152 (64.4)	
Hispanic or Latino	272 (32.8)	76 (32.2)	
Unknown	51 (6.1)	8 (3.4)	
Insurance			0.423
Private	636 (76.6)	183 (77.5)	
Public	153 (18.4)	46 (19.5)	
Other	41 (4.9)	7 (3)	
Pediatric residency program in hospital	560 (67.5)	154 (65.3)	0.523
Children's Hospital Association-accredited hospital	366 (44.1)	109 (46.2)	0.569
Hospital with pediatric surgery fellowship	131 (15.8)	47 (19.9)	0.133
Hospital region			0.543
Urban	789 (95.1)	222 (94.1)	
Rural	41 (4.9)	14 (5.9)	
Type of admission			0.004
Emergency department	623 (75.1)	198 (83.9)	
Transfer/direct admission	207 (24.9)	38 (16.1)	
Indication			0.425
Any biliary disease	753 (90.7)	210 (89.0)	
Gallstone pancreatitis	77 (9.3)	26 (11.0)	
Approach			0.873
Laparoscopic	807 (97.2)	229 (97.0)	
Open	23 (2.8)	7 (3)	
APR-DRG severity of illness			0.274
Groups I and II	693 (83.5)	204 (86.4)	
Groups III and IV	137 (16.5)	32 (13.6)	
APR-DRG mortality risk			0.353
Groups I and II	821 (98.9)	235 (99.6)	
Groups III and IV	9 (1.1)	1 (0.4)	
Length of stay (median, interquartile range)	3 days (2 – 5)	4 days (3 – 6)	<0.001

APR-DRG, All Patient Refined Diagnosis Related Group.

Table 2.
Increased Odds of Greater than Three-Day Length of Stay

Multivariate Regression	Odds Ratio	p-Value	Lower 95% CI	Upper 95% CI
Gender				
Male	Ref.	—	—	—
Female	0.603	0.002	0.441	0.825
Race				
Caucasian	Ref.	—	—	—
African American	2.401	< 0.005	1.633	3.531
Other	1.490	0.024	1.053	2.108
Insurance Status				
Private	Ref.	—	—	—
Federal/state insurance	1.455	0.042	1.013	2.090
Self-pay/uninsured	0.931	0.841	0.460	1.883
Ethnicity				
Non-Hispanic	Ref.	—	—	—
Hispanic	1.256	0.183	0.898	1.756
Other	1.215	0.557	0.632	2.339
APR-DRG severity of illness				
Minor and moderate	Ref.	—	—	—
Major and extreme	4.424	< 0.005	2.794	7.006
Hospital Region				
Urban	Ref.	—	—	—
Rural	1.116	0.756	0.560	2.222
Admission				
Emergency department	Ref.	—	—	—
Transfer/direct admission	0.569	0.004	0.386	0.838
Residency type				
No pediatrics residency	Ref.	—	—	—
Pediatrics residency	2.256	< 0.005	1.630	3.123
Admission type				
Urgent	Ref.	—	—	—
Emergent	1.267	0.412	0.719	2.233
Indication				
Any biliary disease	Ref.	—	—	—
Gallstone pancreatitis	6.810	< 0.005	3.450	13.442
Approach				
Laparoscopic	Ref.	—	—	—
Open	8.129	< 0.005	2.500	26.439
Day of admission				
Weekday	Ref.	—	—	—
Weekend	1.924	< 0.005	1.386	2.673

CI, confidence interval.

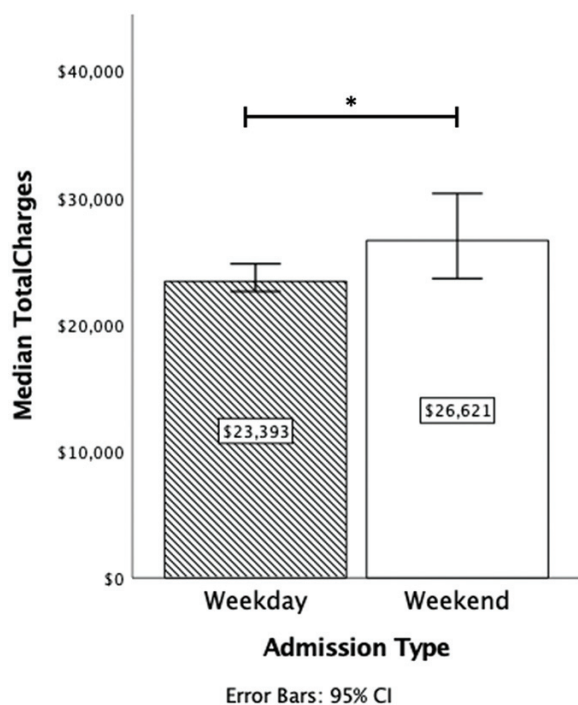


Figure 2. Comparison of total median charges for weekday and weekend admissions.

intervention on the same day on the weekend experienced worse outcomes than those undergoing an admission and procedure on the weekday with higher risk of death, wound infection, LOS, and increased hospital charges among other outcomes.¹⁶ Likewise, our study showed that in addition to the common urgent pediatric surgeries, pediatric cholecystectomy procedures—which were not included in the Goldstein, et al. study—were negatively impacted by weekend hospital admissions with an increased LOS and hospital charges compared to those children admitted on the weekday.

Egberg et al. also showed a similar adverse outcome for children with inflammatory bowel disease requiring urgent abdominal surgery who had a 4% and 7% absolute risk increase of in-hospital complications for children admitted with Crohn’s disease and ulcerative colitis, respectively.² Moreover, children not undergoing any surgical or procedural intervention also experience this adverse care when admitted with a diagnosis of failure to thrive; increased LOS and expenditures highlighting that weekend admission may adversely affect patients in a manner that extends beyond whether a procedure is involved but rather involves the whole continuum of care.¹⁷ Furthermore, children admitted on the weekend for hemorrhagic stroke had higher mortality and higher

rates of being transferred to a nursing facility after hospital discharge in comparison with weekday admissions.¹⁸

The adverse outcomes in weekend admissions are likely multifaceted, involving the healthcare delivery system and workload to workforce ratio. Regarding the reasons for the adverse outcomes, it is hypothesized that decreased physician and nursing staff leads to adverse outcomes for weekend admissions. The reduced staffing, evidenced by the higher patient-to-nurse ratios and decreased physician presence over the weekend, is associated with increased mortality and morbidity as measured by the prolonged LOS, missed diagnoses, and missed care opportunities.^{19–21} Moreover, night and weekends are also associated with increased medication error rates in the inpatient setting with up to 10.9 errors per 1000-weekday doses versus 2.55 errors per 1000-weekend doses, with errors involving mostly medication administration, dispensing, preparation, or ordering by pharmacists, nursing, and physicians²². These may contribute to the adverse outcomes of children who are admitted on the weekend as opposed to the weekday.

As pediatric cholecystectomy rises in incidence, optimal timing for surgical intervention and algorithms to standardize treatments is necessary to reduce provider and resource variability that may impact the LOS as we found was the case in New York State hospitals in this paper. Prior work and other work looking at weekend admissions in nonelective appendectomy for children and comparing it to weekday admissions showed no difference in length of stay, cost, or charges in New York State.^{23,24} We hypothesize this may occur because of how appendicitis is treated as opposed to noncongenital benign biliary disease, the latter of which may require a more extensive work-up and are usually admitted to a pediatrics service at least in our institution. Implementing treatment algorithms that standardize the quality of care and the treatment of children at high-volume children’s hospitals may improve the quality of care by reducing this variability. In the United Kingdom, Bray et al. looked at how the variation of care in adults with acute stroke differed across the entire week.²⁵ They concluded that it was the deviation of standard of care and treatment algorithms that contributed to adverse outcomes, implying that variations of care, as well as patient-specific factors, drive worse results; the health care resources, or health team availability did not drive outcomes as much as expected.²⁵ Hence, trying to optimize treatment algorithms by standardizing different steps of diagnosis and treatment may help improve the delivery of care to improve outcomes, as this may reduce the temporal variabilities in the delivery of care that may be more pronounced in the weekend. These variabilities

may explain the worse clinical results seen during this setting in our data.

The use of minimally invasive procedures such as laparoscopy is thought to help overcome the so-called weekend effect although we show that in our study, this made no difference overall as there still was a weekend effect despite approximately 97% of cases being done laparoscopically. In a national administrative sampled data set, Lane et al. show that in cases of appendicitis, open procedures carried out over the weekend had higher rates of pneumonia and increased LOS, implying the value of laparoscopic procedures in overcoming the weekend effect as those done laparoscopically did not have this increased LOS.²³ This alludes to the value of laparoscopic surgery in reducing LOS and possibly the implantation of algorithms to facilitate the rapid treatment and discharge of children with appendicitis in this case, which is not reflected in children with benign gallbladder disease where there is high variability in the LOS by day of admission.

Finally, having children seen and treated at high volume centers where children are exclusively seen may also reduce healthcare delivery variability and decrease the adverse outcomes on weekend admissions. Markham et al. looked at a national children's hospital database and the association between LOS, patient acuity, and readmission for those admitted on the weekend versus the weekday.²⁶ They showed no difference on the weekend admission for any diagnosis in children and their subsequent LOS when adjusted for demographics, clinical features, and other factors. They showed only a small increase in the probability of readmission and that most of the variation in outcomes could be attributed to patient complexity and comorbidities.²⁶ This database was limited to focusing only on patients seen in children's hospitals undergoing nonelective admission in the United States, which represent tertiary and quaternary high-volume centers accredited by the Children's Hospital Association, making 20% of all children's admissions. However, these specialized hospitals may not be representative of most hospitals that provide care to children in the United States.²⁶⁻²⁸

Another interesting finding in our study was that most cases performed during our study period were not done in facilities in New York State with pediatric surgery fellows either by pediatric surgeons, general surgeons, or general surgical residents under the supervision of a general or pediatric surgeon. This may represent lost learning opportunities for pediatric surgery fellows. However, outcomes were not impacted, as there was no difference found in terms of outcomes for facilities having pediatric surgery fellows versus not having such fellows.

Some of the limitations of our study were the inability to identify causes of the statistically significant increased LOS, which we hypothesize may be due to delay in testing, given limited resource availability for magnetic resonance imaging, technicians for ultrasound point of care testing, and therapeutic/diagnostic procedures such as endoscopic retrograde cholangiopancreatography. However, our model did adjust for the severity and utilization given the disease presentation via the APR-DRG codes as previously described. The hospital charges may have been driven by the extra inpatient day that in the cohort of children admitted on the weekend versus the weekday. Another limitation was the inability to identify complications and specific comorbidities. However, our model used an all-payer diagnostic code and comorbidity adjustment factors that considered the severity of a child's presentation.^{10,11}

Finally, we were unable to compare pre-operative versus postoperative LOS given the limitations of the data set in noting what the day the child had a procedure. The focus of our study was to analyze the whole admission process on all comers because we wanted to consider the process a child undergoes through a hospital system that requires surgery and our analysis captures everything including transfers to other hospitals, triage in the emergency department or inpatient setting, and eventually to discharge. In this analysis, we also found that a large contributor to worse outcomes were ethnic and racial disparities, which should be addressed given the unique diversity of the New York State population in comparison to other states in the country. Moreover, the realities of surgical practice and possibly undue burden of imposing immediate surgery on all patients who come in at whatever time may lead to consumption of valuable resources that can be better utilized for more life-threatening procedures and it may unnecessarily lead to increased cost, decrease healthcare provider/nursing/operating room staff availability, and can compromise team morale. Hence, trying to optimize the care in other parts of the delivery of care spectrum instead of just the surgical procedure itself may maximize care without compromising team morale or other factors but this needs to be further investigated.

Unfortunately, record of who admitted the patient (pediatrician versus general surgery service) and methodology used to diagnose patients were omitted. Moreover, around 10% of children in our cohort likely had incurred a further LOS as they were admitted from another hospital. However, a sensitivity analysis excluding these transferred patients did not affect the results (Data not shown). Another

limitation is that this dataset is over 10 years old due to ICD-9 changes in coding and the lack of availability of costs, charges, and days of admission for patients after this date. Most notably, weekend versus weekday was omitted from subsequent publicly available SPARCS database from 2013 onward which limited our ability to extend our analysis further. Nevertheless, the median length of stay for children with gallbladder disease requiring surgery remained unchanged from January 1, 2013–December 31, 2017 at three days for the cohort. Hence, we do not believe any of these factors have significantly changed in the last 10 years in New York State. Finally, the weekend definition may be up for consideration as some may include Friday admissions instead of just Saturday and Sunday. When revised with this definition on a sensitivity analysis including Friday through Sunday, no differences were noted (Data not shown).

CONCLUSION

The present study is, to our knowledge, the first of its kind to investigate the association between weekend

admissions with LOS in pediatric cholecystectomy for benign noncongenital gallbladder disease in New York State. Our findings of increased LOS and hospital charges for children admitted over the weekend requiring non-elective cholecystectomy, compared with those admitted on weekdays, emphasize the need to investigate what is driving these adverse outcomes, which may be variation in the delivery of care, need for more healthcare consultants such as gastroenterologists or surgeons, and/or the optimization of healthcare resources to adjust for variations in case volumes. The central challenge to reducing variability in treating children with gallbladder diseases requiring surgery is standardizing and defining the optimal initial diagnostic test, the timing of therapeutic cholecystectomy, and the postoperative care, which is not thoroughly defined as in adult gallbladder disease.⁷ Further research should investigate how to provide quality surgical care as uniformly as possible throughout weekday and weekend hospitalizations and further investigate temporal variations in the delivery of care in surgical urgent and emergent cases in the pediatric population.

Supplemental Table 1. Linear regression analysis of length of stay by different clinical variables.

Multivariate Regression	Beta	p-Value	Lower 95% CI	Upper 95% CI
Gender				
Male	Ref.	—	—	—
Female	- 0.003	0.930	- 0.412	0.377
Race				
Caucasian	Ref.	—	—	—
African-American or Other	0.057	0.021	0.068	0.817
Insurance Status				
Private	Ref.	—	—	—
Government insurance/Self-pay	0.036	0.302	- 0.206	0.665
Ethnicity				
Non-Hispanic	Ref.	—	—	—
Hispanic or Other	-0.84	0.002	-0.977	-0.217
APR severity of illness				
Minor and moderate	Ref.	—	—	—
Major and extreme	0.248	<0.005	2.937	4.029
Admission				
Emergency department	Ref.	—	—	—
Transfer/direct admission	0.051	0.013	0.127	1.061
Residency type				
No pediatrics residency	Ref.	—	—	—
Pediatrics residency	0.175	<0.005	0.783	1.600
Admission type				
Urgent	Ref.	—	—	—
Emergent	0.438	<0.005	2.111	3.045
Indication				
Any biliary disease	Ref.	—	—	—
Gallstone pancreatitis	0.110	<0.005	1.298	2.645
Approach				
Laparoscopic	Ref.	—	—	—
Open	0.147	<0.005	3.769	6.037
Day of admission				
Weekday	Ref.	—	—	—
Weekend	0.038	0.048	0.004	0.893

Supplemental Table 2. Linear regression analysis of length of stay by different clinical variables excluding patients who had pancreatitis.

Multivariate Regression	Beta	p-Value	Lower 95% CI	Upper 95% CI
Gender				
Male	Ref.	—	—	—
Female	0.011	0.742	- 0.336	0.471
Race				
Caucasian	Ref.	—	—	—
African-American or Other	0.007	0.021	0.145	0.922
Insurance Status				
Private	Ref.	—	—	—
Government insurance/Self-pay	0.034	0.375	- 0.244	0.646
Ethnicity				
Non-Hispanic	Ref.	—	—	—
Hispanic or Other	- 0.104	0.001	- 1.073	- 0.292
APR severity of illness				
Minor and moderate	Ref.	—	—	—
Major and extreme	0.243	<0.005	3.115	4.310
Admission				
Emergency department	Ref.	—	—	—
Transfer/direct admission	0.052	0.020	0.090	1.047
Residency type				
No pediatrics residency	Ref.	—	—	—
Pediatrics residency	0.183	<0.005	0.755	1.606
Admission type				
Urgent	Ref.	—	—	—
Emergent	0.447	<0.005	1.965	2.924
Approach				
Laparoscopic	Ref.	—	—	—
Open	0.162	<0.005	3.715	5.972
Day of admission				
Weekday	Ref.	—	—	—
Weekend	0.048	0.023	0.075	0.988

References:

1. Ananthakrishnan AN, McGinley EL. Weekend hospitalisations and post-operative complications following urgent surgery for ulcerative colitis and Crohn’s disease. *Aliment Pharmacol Ther.* 2013;37(9):895–904.
2. Egberg MD, Galanko JA, Kappelman MD. Weekend surgical admissions of pediatric IBD patients have a higher risk of complication in hospitals across the US. *Inflamm Bowel Dis.* 2020; 26(2):254–260.
3. Murphy PB, Vogt KN, Winick-Ng J, McClure JA, Welk B, Jones SA. The increasing incidence of gallbladder disease in

- children: a 20 year perspective. *Journal of Pediatric Surgery.* 2016;51(5):748–752.
4. Waldhausen JH, Benjamin DR. Cholecystectomy is becoming an increasingly common operation in children. *Am J Surg.* 1999;177(5):364–367.
5. Gee KM, Rosenberg D, Kim ES. Normalization of serum lipase levels versus resolution of abdominal pain: a comparison of preoperative management in children with biliary pancreatitis. *J Surg Res.* 2020;252:133–138.
6. Lee YJ, Park YS, Park JH. Cholecystectomy is feasible in children with small-sized or large numbers of gallstones and in

those with persistent symptoms despite medical treatment. *Pediatr Gastroenterol Hepatol Nutr.* 2020;23(5):430–438.

7. Pelizzo G, Bussani R, De Silvestri A, et al. Laparoscopic cholecystectomy for symptomatic cholelithiasis in children: defining surgical timing. *Front Pediatr.* 2020;8

8. Allore EA, Ward JL, Todd SR, et al. Ideal timing of early cholecystectomy for acute cholecystitis: an ACS-NSQIP review. *Am J Surg.* 2019;218(6):1084–1089.

9. Shen Y. Applying the 3M all patient refined diagnosis related groups grouper to measure inpatient severity in the VA. *Med Care.* 2003;41(6 Suppl):II103–110.

10. Coller RJ, Klitzner TS, Lerner CF, Chung PJ. Predictors of 30-day readmission and association with primary care follow-up plans. *J Pediatr.* 2013;163(4):1027–1033.

11. Wang H, Johnson C, Robinson RD, et al. Roles of disease severity and post-discharge outpatient visits as predictors of hospital readmissions. *BMC Health Serv Res.* 2016;16(1):564.

12. TI EA, M.B C. New York State Inpatient Hospital Cost Trends. *Office of Quality and Patient Safety Division of Information and Statistics.* 2015 2009-2012 Statistical Brief #10 1-21.

13. Lascano D, Finkelstein JB, Barlow LJ, et al. The correlation of media ranking's "best" hospitals and surgical outcomes following radical cystectomy for urothelial cancer. *Urology.* 2015;86(6):1104–1112.

14. Lee SY, Lee SH, Tan JHH, et al. Factors associated with prolonged length of stay for elective hepatobiliary and neurosurgery patients: a retrospective medical record review. *BMC Health Serv Res.* 2018;18(1):5.

15. Moran JL, Solomon PJ. A review of statistical estimators for risk-adjusted length of stay: analysis of the Australian and New Zealand Intensive Care Adult Patient Data-Base, 2008-2009. *BMC Med Res Methodol.* 2012;12:68.

16. Goldstein SD, Papandria DJ, Aboagye J, et al. The "weekend effect" in pediatric surgery - increased mortality for children undergoing urgent surgery during the weekend. *Journal of Pediatric Surgery.* 2014;49(7):1087–1091.

17. Thompson RT, Bennett WE, Finnell SME, Downs SM, Carroll AE. Increased length of stay and costs associated with weekend admissions for failure to thrive. *Pediatrics.* 2013;131(3):E805–E810.

18. Adil MM, Vidal G, Beslow LA. Weekend effect in children with stroke in the Nationwide Inpatient Sample. *Stroke.* 2016;47(6):1436–U1161.

19. Bell D, Lambourne A, Percival F, Lavery AA, Ward DK. Consultant input in acute medical admissions and patient outcomes in hospitals in England: a multivariate analysis. *Plos One.* 2013;8(4):e61476.

20. Butler M, Schultz TJ, Halligan P, et al. Hospital nurse staffing models and patient and staff-related outcomes. *Cochrane Database Syst Rev.* 2019;4:CD007019).

21. Profit J, Petersen LA, McCormick MC, et al. Patient-to-nurse ratios and outcomes of moderately preterm infants. *Pediatrics.* 2010;125(2):320–326.

22. Miller AD, Piro CC, Rudisill CN, Bookstaver PB, Bair JD, Bennett CL. Nighttime and weekend medication error rates in an inpatient pediatric population. *Ann Pharmacother.* 2010;44(11):1739–1746.

23. Lane RS, Tashiro J, Burroway BW, Perez EA, Sola JE. Weekend vs. weekday appendectomy for complicated appendicitis, effects on outcomes and operative approach. *Pediatr Surg Int.* 2018;34(6):621–628.

24. Lascano D, Cohen D, Pandya S. No association between weekend admission and length of stay for appendicitis in pediatric patients. *Integrated Quick Shot Presentations Session II Clinical/Outcomes at the 15th Annual Academic Surgical Congress,* 2020. Accessed February 5, 2020 at: <https://www.academicsurgicalcongress.org/wp-content/uploads/2020/01/ASC-2020-Final-Program-1.pdf>.

25. Bray BD, Cloud GC, James MA, et al. SSNAP oration. Weekly variation in health-care quality by day and time of admission: a nationwide, registry-based, prospective cohort study of acute stroke care. *Lancet.* 2016;388(10040):170–177.

26. Markham JL, Richardson T, Hall M, et al. Association of weekend admission and weekend discharge with length of stay and 30-day readmission in children's hospitals. *J Hosp Med.* 2019;14(2):75–82.

27. Rice-Townsend S, Hall M, Barnes JN, Lipsitz S, Rangel SJ. Variation in risk-adjusted hospital readmission after treatment of appendicitis at 38 children's hospitals: an opportunity for collaborative quality improvement. *Ann Surg.* 2013;257(4):758–765.

28. Anandalwar SP, Cameron DB, Graham DA, et al. Association of intraoperative findings with outcomes and resource use in children with complicated appendicitis. *JAMA Surg.* 2018;153(11):1021–1027.