Journal of Pediatric Surgery 49 (2014) 1087–1091

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

The "weekend effect" in pediatric surgery — increased mortality for children undergoing urgent surgery during the weekend

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ARTICLE INFO

Article history:
Received 29 July 2013
Received in revised form 5 January 2014
Accepted 11 January 2014

Key words:
Surgical outcomes
National Inpatient Sample
Kids' Inpatient Database
Weekend effect
Patient safety
Pediatric surgery

ABSTRACT

Background: For a number of pediatric and adult conditions, morbidity and mortality are increased when patients present to the hospital on a weekend compared to weekdays. The objective of this study was to compare pediatric surgical outcomes following weekend versus weekday procedures.

Methods: Using the Nationwide Inpatient Sample and the Kids' Inpatient Database, we identified 439,457 pediatric (<18 years old) admissions from 1988 to 2010 that required a selected index surgical procedure (abscess drainage, appendectomy, inguinal hernia repair, open fracture reduction with internal fixation, or placement/revision of ventricular shunt) on the same day of admission. Outcome metrics were compared using logistic regression models that adjusted for patient and hospital characteristics as well as procedure performed.

Results: Patient characteristics of those admitted on the weekend (n = 112,064) and weekday (n = 327,393) were similar, though patients admitted on the weekend were more likely to be coded as emergent (61% versus 53%). After multivariate adjustment and regression, patients undergoing a weekend procedure were more likely to die (OR 1.63, 95% CI 1.21–2.20), receive a blood transfusion despite similar rates of intraoperative hemorrhage (OR 1.15, 95% CI 1.01–1.26), and suffer from procedural complications (OR 1.40, 95% CI 1.14–1.74).

Conclusion: Pediatric patients undergoing common urgent surgical procedures during a weekend admission have a higher adjusted risk of death, blood transfusion, and procedural complications. While the exact etiology of these findings is not clear, the timing of surgical procedures should be considered in the context of systems-based deficiencies that may be detrimental to pediatric surgical care.

Pediatric surgeons frequently perform urgent and emergent surgical procedures outside the regularly scheduled operating room hours due to the time-sensitive nature of the disease processes and because delays in care may contribute adversely to outcomes. However, operating room staffing and hospital resource availability are variable outside of the traditional Monday through Friday work week, and evidence has emerged that for a number of pediatric and adult conditions, morbidity and mortality increase when patients present to the hospital on a weekend compared to a weekday [1–16].

Whether this so-called "weekend effect" occurs with regard to pediatric surgical procedures is unknown. The objective of this study was therefore to analyze two large national databases to evaluate the potential effect of weekend admission on surgical outcomes in the pediatric population.

1. Methods

1.1. Data sources

A retrospective analysis was performed using a non-overlapping combination of the Nationwide Inpatient Sample (NIS) (1988–2010) and the Kids' Inpatient Database (KID) (1997, 2000, 2003, 2006, and 2009). This study was deemed exempt by the Institutional Review Board of Johns Hopkins Medicine given the deidentified nature of the data. Both the NIS and KID are aggregated from all-payer state discharge databases and are made available to researchers through the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ).

1.2. Study population

Patients less than 18 years of age were selected from the NIS and KID databases if they underwent a surgical procedure on the same calendar day as their inpatient hospital admission. Selected index operations for analysis were chosen via an institutional review of common weekend cases in the American College of Surgeons Pediatric

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http://dx.doi.org/10.1016/j.jpedsurg.2014.01.001
0022-3468/

National Surgical Quality Improvement Program (NSQIP-Pediatric) and then defined by International Classification of Diseases, Clinical Modification (ICD-9 CM) procedure codes present in the discharge data. Index procedures chosen were: abscess drainage (AD), appendectomy (App), inguinal hernia repair (IHR), open reduction with internal fixation of bone fracture (ORIF), and placement or revision of ventricular shunt (VS). Records were excluded if the admission or operative day was unknown or if the admission was coded as elective. A complete list of the selection criteria and corresponding ICD-9 CM procedure codes is provided in Table 1.

Patients meeting these selection criteria were then sub-grouped based on the day of the week that the patient was admitted and operated upon; those admitted on a Saturday or Sunday were designated as weekend cases while those admitted on any other day were designated weekday cases. The outcomes of interest were death, hemorrhagic complications, accidental puncture or laceration, wound-related complications, infectious complications, transfusion of blood products, length of hospital stay, and total hospital charges. A complete list of the corresponding procedure and diagnosis codes for each index occurrence type is provided in Table 2. Finally, the number of co-morbid conditions was assessed by counting the number of unique ICD-9 diagnosis codes associated with each admission.

1.3. Data analysis

Gender, race, insurance status (uninsured or insured), number of co-morbid conditions, geographic region (Northeast, Midwest, South or West), type of hospital (urban teaching, urban non-teaching or rural) and type of surgical procedure performed were compared between weekend vs. weekday admission using Pearson's chi-square test for categorical variables and the Kruskal–Wallis test for non-normally distributed continuous variables.

Outcomes of surgical procedure performed on the weekend versus weekday were compared using multivariable logistic regression and linear regression models adjusting for age, gender, race, insurance status, comorbid diagnoses, geographic region, type of hospital, admission type, and surgical procedure. Adjusted odds ratios (aOR) are presented using weekday as the reference group. Statistical analyses were performed using Stata MP, version 11 (College Station, TX).

2. Results

2.1. Study population

A total of 439,457 admissions meeting inclusion criteria were identified, consisting of 327,393 (74.5%) with a weekday procedure and 112,064 (25.5%) with a weekend procedure. Children undergoing procedures on the weekend were slightly older; were more frequently male, white, and uninsured; and had less comorbidity at discharge (Table 3).

Children undergoing procedures on the weekend were more likely to have been admitted emergently (60.9% vs. 52.6%) and were slightly less likely to be at teaching hospitals or at facilities located in the West region of the country (Table 4). Weekend procedures were less frequently AD, IHR, and VS and were more frequently App and ORIF (Table 5).

Table 1
Patient selection criteria.

Age (years)	0–17 inclusive
Procedures Performed	ICD-9-CM Procedure Codes
AD:	27.0, 28.0, 47.2, 47.20, 49.01, 50.0, 54.19, 59.09, 60.81, 86.01
App:	47.0, 47.01, 47.09, 47.1, 47.11, 47.19
IHR:	53.00, 53.01, 53.02, 53.10, 53.11, 53.12, 53.13
ORIF:	79.3, 79.30, 79.31, 79.32, 79.33, 79.34, 79.35, 79.36, 79.37, 79.38, 79.39
VS:	02.3, 02.31, 02.32, 02.33, 02.34, 02.35, 02.39, 02.4, 02.41, 02.42, 02.43, 54.94
Operative Date	Day of Admission (weekend or weekday)
Hospital Admission	
Excluded Types	Elective
Years	1988–2009

ICD-9-CM: International Classification of Diseases, Clinical Modification.
AD: Abscess Drainage, App: Appendectomy, IHR: Inguinal Hernia Repair, ORIF: Open Reduction/Internal Fixation of Fracture, VS: Revision of Ventricular Shunt.

Table 2
Selected outcomes with corresponding diagnosis codes.

Outcome Assessed	
Death	*Directly reported in database*
Condition Assessed	ICD-9 Diagnosis Codes
Hemorrhagic Complications	998.1, 998.11, 998.12, 998.13
Accidental Puncture or Laceration	998.2
Wound Dehiscence or Nonhealing	998.3, 998.30, 998.31, 998.32, 998.33, 998.83
Wound infection or abscess	998.5, 998.50, 998.51, 998.52, 998.53, 998.54, 998.55, 998.56, 998.57, 998.58, 998.59
Intervention Assessed	ICD-9-CM Procedure Codes
Transfusion	99.0, 99.00, 99.01, 99.02, 99.03, 99.04, 99.05, 99.06, 99.07, 99.09

ICD-9: International Classification of Diseases, Ninth Revision.
ICD-9-CM: International Classification of Diseases, Clinical Modification.

2.2. Unadjusted outcomes: weekend vs. weekday

In unadjusted analysis, 373 (0.11%) patients in the weekday group and 156 (0.14%) in the weekend group died prior to discharge ($p = 0.099$). Patients undergoing weekend procedures more frequently experienced an accidental puncture or laceration (0.21% vs. 0.18%, $p = 0.018$) and received transfusion of blood products (0.71% vs. 0.60%, $p = 0.002$). Patients in the weekend group were less likely to receive the diagnosis of dehisced or non-healing wound (0.11% vs. 0.13%, $p = 0.044$). The weekend and weekday groups were similar with regard to rates of hemorrhage and wound infections (Table 6).

2.3. Adjusted outcomes: weekend vs. weekday

After adjusting for the type of procedure performed as well as patient and facility characteristics, patients undergoing an index operation on the weekend were significantly more likely to die before discharge compared to patients undergoing a procedure on a weekday (aOR 1.63, 95% CI: 1.21–2.20, Fig. 1). Patients undergoing weekend procedures were also more likely to suffer an accidental puncture or laceration (aOR 1.40; 95% CI: 1.14–1.74) and to receive a blood transfusion (aOR 1.14; 95% CI: 1.01–1.26).

Other complications examined did not demonstrate significant associations with weekend versus weekday procedures. Specifically, patients undergoing weekend procedures had a similar risk of intraoperative hemorrhage (aOR 0.94, 95% CI: 0.77–1.15), wound dehiscence or nonhealing wound (aOR 0.97, 95% CI: 0.73–1.27), and wound infection (aOR 1.02, 95% CI: 0.93–1.12).

3. Discussion

This analysis of two large national databases comparing outcomes of select pediatric surgical procedures found a higher risk of death, blood transfusion, and procedural complication for patients admitted for urgent or emergent surgery over the weekend compared to on a weekday. The increased rate of transfusions was in the context of similar rates of reported hemorrhagic events. Importantly, these differences were independent of variations in patient and hospital characteristics. Our results are consistent with a growing body of