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CLINICAL RESEARCH

Patient Factors Are Associated With Poor Short-term Outcomes After Posterior Fusion for Adolescent Idiopathic Scoliosis

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Abstract

Background   Posterior spinal fusion (PSF) is commonly performed for patients with adolescent idiopathic scoliosis (AIS). Identifying factors associated with perioperative morbidity and PSF may lead to strategies for reducing the frequency of adverse events (AEs) in patients and total hospital costs.

Questions/purposes   What is the frequency of and what factors are associated with postoperative: (1) AEs, (2) extended length of stay (LOS), and (3) readmission in patients with AIS undergoing PSF?

Patients and Methods   Patients, aged 11 to 18 years, who underwent PSF for AIS during 2012, were identified from the American College of Surgeons National Surgical Quality Improvement Program® (ACS NSQIP®) Pediatric database. Patient were assessed for characteristics associated with AEs, extended LOS (defined as more than 6 days), and hospital readmission using multivariate logistic regression. Individual AEs captured in the database were grouped into two categories, "any adverse event" (AAE) and "severe adverse events" (SAEs) for analysis. A total of 733 patients met inclusion criteria.

Results   Twenty-seven patients (3.7%) had AAE and 19 patients (2.6%) had SAEs. Both AAE and SAEs were associated with BMI-for-age ninety-fifth percentile or greater (AAE: odds ratio [OR], 3.31; 95% CI, 1.43–7.65; p = 0.005. SAE: OR, 3.46; 95% CI, 1.32–9.09; p = 0.012). Extended LOS occurred for 60 patients (8.2%) and was associated with greater than 13 levels instrumented (OR, 2.00; 95% CI, 1.11–3.61; p = 0.021) and operative time of 365 minutes or more (OR, 2.57; 95% CI, 1.39–4.76; p = 0.003). Readmission occurred for 11 patients (1.5%), most often for surgical site infection, and was associated with the occurrence of any complication during the initial hospital stay (OR, 180.44; 95% CI, 35.47–917.97; p < 0.001).

Conclusions   Further research on prevention and management of obesity and surgical site infections may reduce perioperative morbidity for patients with AIS undergoing PSF.

Level of Evidence   Level III, prognostic study. See Instructions for Authors for a complete description of levels of evidence.

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Introduction

Adolescent idiopathic scoliosis (AIS) is a common disorder with an overall prevalence of 0.5% to 5.2%, according to the literature [22]. During the past few decades, an increased proportion of patients have undergone multilevel posterior spinal fusion (PSF) for correction of AIS [6]. These are large, invasive operations, and careful patient

(and parent) counseling is important before performing surgery.

Currently, there is inadequate information regarding which patient factors are associated with the occurrence of adverse events (AEs), prolonged length of stay (LOS), and readmission after PSF for AIS. Such factors are not only important clinically and for setting appropriate patient expectations, but they also are closely tied to total hospital costs associated with the procedure [30]. The information we have on risk factors for AEs in patients undergoing PSF have been derived mainly from studies that either were limited by small sample size [21, 41, 44, 54], only studied one variable [2, 16, 25, 29, 31, 42, 44, 45, 50, 55], included patients with neuromuscular scoliosis and cerebral palsy [5, 19, 20, 24, 32, 43], used potentially flawed administratively coded or self-reported data [5, 7, 35, 51], or included adult patients with deformity [35].

We therefore sought to address some of these shortcomings in our knowledge by querying a large, high-quality, national database about patients undergoing PSF for AIS to determine the frequency of, and factors associated with: (1) AEs, (2) extended LOS, and (3) readmission after surgery.

Patients and Methods

We conducted a retrospective cohort study using the newly developed American College of Surgeons National Surgical Quality Improvement Program® (ACS NSQIP®) Pediatric database [1, 38], which is a high-quality, national dataset that uses trained clinical reviewers to prospectively collect data on pediatric surgical patients from 50 US hospitals (Appendix 1).

Following institutional review board approval, the ACS NSQIP® Pediatric database from 2012 was queried to identify patients 11 to 18 years old who underwent PSF for AIS. Patients initially were selected with the postoperative diagnosis of AIS (ICD-9 737.30). From the initially selected patients, only those with the primary Current Procedural Terminology (CPT) codes for posterior fusion for deformity (22800 [1–6 levels], 22802 [7–12 levels], and 22804 [13 or more levels]) were included in our study.

Patients undergoing anterior spinal fusion, revision surgery, other spinal procedures, and patients with previous evidence of infection were excluded from our analysis. In addition, patients with cerebral palsy, other neuromuscular disorders, an American Society of Anesthesiologists classification of 3 or greater (indicating severe systemic disease), or any comorbidity that would suggest nonidiopathic scoliosis were excluded from our study. For example, patients with a history of cardiac disease were excluded from the study, as congenital heart disease is

strongly associated with development of nonidiopathic scoliosis [18]. Patients also were excluded if they had missing perioperative data. Of an initial 1181 patients identified by ICD-9 and CPT codes, 733 (62.1%) were included in our study.

The ACS NSQIP® Pediatric database collects numerous demographic and comorbidity variables for each patient, including age, sex, height, and weight. Patient BMI is calculated by height and weight and categorized according to CDC BMI-for-age charts [8]. Per CDC guidelines, pediatric patients with less than the fifth percentile BMI-for-age are categorized as underweight; patients with BMI-for-age greater than the eighty-fifth percentile are categorized as overweight; and patients with BMI-for-age greater than the ninety-fifth percentile are categorized as obese (Appendix 2) [3, 4, 14]. Of the comorbidities collected by the ACS NSQIP®, only a history of asthma occurred with sufficient frequency to be used for our analysis. CPT codes 22210, 22212, and 22214 were used to determine if an osteotomy was performed. Operative time was defined as the time in minutes from opening incision to end-of-wound closure. For analysis, operative time was dichotomized at one SD greater than the mean operative time.

Demographics of Study Population

Of the 733 patients who met inclusion criteria, average age was 14.0 ± 1.7 years (mean ± SD). The cohort was 81.6% female (Table 1). The BMI distribution was right-

Table 1. Study patient and operative characteristics

Characteristic	Number	Percentage (%)
Overall	733	100
Age (years)		
11–13	302	41.2
14–15	258	35.2
16–18	173	23.6
Female sex	598	81.6
BMI-for-age		
< 5th percentile (underweight)	14	1.9
5th–85th percentile	495	67.5
85th–95th percentile (overweight)	96	13.1
≥ 95th percentile (obese)	128	17.5
History of asthma	41	5.6
Number of levels fused		
1–6	39	5.3
7–12	542	73.9
≥ 13	152	20.7
Osteotomy performed	253	34.5
Operative time ≥ 365 minutes	108	14.7
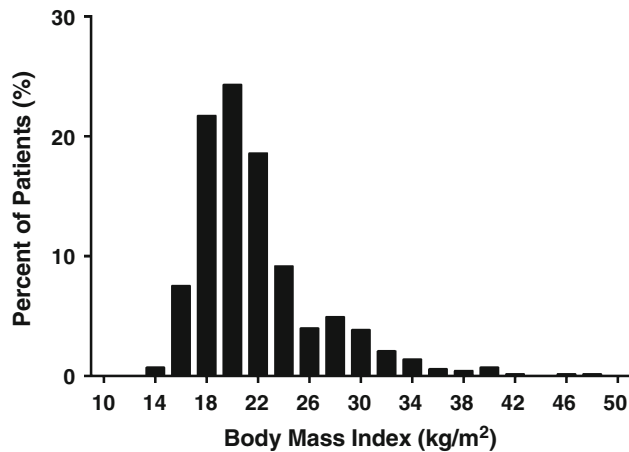
Fig. 1 Distribution of BMI for study patient population is shown.

Fig. 2 Postoperative LOS* after PSF in patients with AIS is shown. *Extended LOS defined as > 90th percentile LOS or 6 days. Patients to the right of the dashed vertical line had extended LOS.

Table 2. Frequency of other comorbidities in the patient population

Comorbidity	Number	Percentage
Additional comorbidities*		
Steroid use	3	0.4
Bleeding disorder	3	0.4
Hematologic disorder	3	0.4
Diabetes	1	0.1
Premature birth	1	0.1
Immune disorder	1	0.1
Patients excluded†		
Neuromuscular disorder	195	
ASA classification ≥ 3	94	
Age younger than 11 years	53	
Incomplete/missing data	51	
Impaired cognitive status	47	
History of cardiac disease	40	
Seizure disorder	7	
Preexisting infection	7	
Malignancy	5	
Tracheostomy	3	
Cerebrovascular accident	3	
On ventilator	2	
Central nervous system tumor	2	
Organ transplant	2	
Oxygen support	1	
Marrow transplant	1	
Chemotherapy	1	

ASA = American Society of Anesthesiologists

* Patients with these comorbidities were included in the study but the comorbidities were not analyzed separately because of their low incidence

† Patients with these comorbidities were excluded as these comorbidities suggested nonidiopathic scoliosis
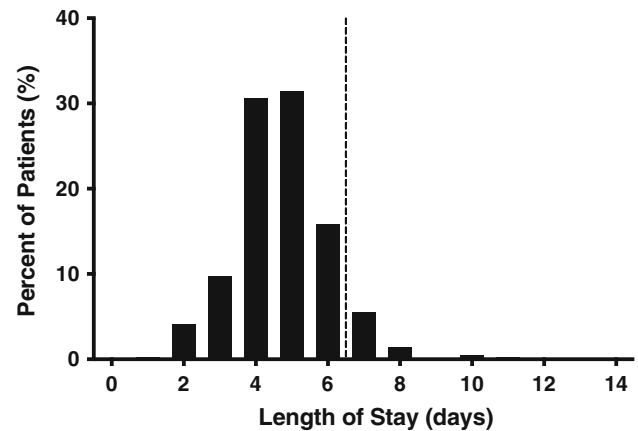
skewed, with the majority of patients having a low-to-normal BMI (mean BMI of 21.8 ± 4.8 kg/m^2), with a long tail of patients with greater BMI (Fig. 1). Other comorbidities with frequencies less than 1% are shown (Table 2). The average operative time was 275 ± 90 minutes (mean $\pm$ SD), and the average LOS was 5.0 ± 4.8 days (mean $\pm$ SD) (Fig. 2). Although the postoperative LOS for some patients was shorter than that typically seen at many institutions, certain centers have accelerated discharge pathways that allow patients to be discharged in as few as 2 days after surgery [13].

Adverse Events

The ACS NSQIP® Pediatric database tracks patients for the occurrence of individual AEs occurring during the first 30 postoperative days. A severe AE (SAE) was defined as: death, coma more than 24 hours, on ventilator more than 48 hours, stroke or cerebrovascular accident, thromboembolic event (pulmonary embolism or deep vein thrombosis), cardiac arrest requiring cardiopulmonary resuscitation, renal failure, sepsis, return to the operating room, wound dehiscence, deep surgical site infection, organ or space infection, nerve injury (spinal cord, nerve root, or peripheral nerve injury), or graft, prosthesis, or flap failure. A minor AE was defined as: superficial surgical site infection, urinary tract infection, pneumonia, and progressive renal insufficiency. Any AE (AAE) was defined as the occurrence of a severe or minor AE.

LOS

LOS is defined in the ACS NSQIP® Pediatric database as calendar days from patient surgery to hospital discharge.

An extended LOS is defined as an LOS greater than the ninetieth percentile LOS. The ninetieth percentile LOS was chosen as a cutoff to account for normal variations in LOS and differing practices of surgeons, while still capturing patients with abnormally extended LOS. During the period of time covered by our database inquiry, an LOS greater than 6 days met the definition for "extended" LOS.

Readmission

The ACS NSQIP® Pediatric database also collects data on readmissions during the first 30 postoperative days. For our study, readmission was defined as positive when a patient had an unplanned readmission at least once after surgery.

Suspected reasons for readmission and the total days from the surgery to readmission also were collected. Suspected reasons for readmission are entered in the database as either a category (such as superficial surgical site infection) or specified by an ICD-9 diagnosis code. The number of days between discharge and readmission was calculated by subtracting each patient's LOS from the days between surgery and readmission.

Statistical Analysis

Statistical analyses were conducted using Stata® version 11.2 (StataCorp LP, College Station, Texas, USA). Patient and operative characteristics were tested for association with the binary outcome variables AAE, SAE, extended LOS, and readmission using bivariate logistic regression (Appendix 3). Multivariate logistic regressions were performed for each outcome variable using a backward stepwise process that initially included all patient and operative variables, and sequentially excluded variables with the highest p value until only those with a p value less than 0.200 remained. Variables with a p value between 0.050 and 0.200 were left in the model to control for potential confounding but were not considered to be statistically significant. Only variables with a p value less than 0.05 were considered statistically significant. Extended LOS and the occurrence of any complication during the initial patient admission for PSF were assessed as independent variables in the readmission analysis because the information was available at the time of discharge and would be useful to include in a model that predicts odds of readmission. The fitness of the final logistic regression models was assessed using the C statistic and the Hosmer-Lemeshow goodness-of-fit test.

Table 3. Frequency of outcomes in the patient population

Outcome	Number	Percentage (%)
Any adverse event	27	3.7
Serious adverse event	19	2.6
Death	0	0.0
Coma greater than 24 hours	0	0.0
Unplanned intubation	0	0.0
Stroke/cerebrovascular accident	0	0.0
Thromboembolic event (DVT/PE)	0	0.0
Cardiac arrest requiring CPR	0	0.0
Acute renal failure	0	0.0
Sepsis	0	0.0
Return to the operating room	13	1.8
Wound dehiscence	4	0.6
Deep surgical site infection	4	0.6
Organ space infection	0	0.0
Central line associated blood stream infection	0	0.0
Seizure	0	0.0
Nervous injury	3	0.4
Graft/prosthesis/flap failure	0	0.0
Minor adverse event	12	1.6
Superficial surgical site infection	7	1.0
Urinary tract infection	5	0.7
Pneumonia	1	0.1
Progressive renal insufficiency	0	0.0
Length of stay more than 6 days	60	8.2
Readmitted	11	1.5

DVT = deep vein thrombosis; PE = pulmonary embolism; CPR = cardiopulmonary resuscitation

Results

AEs

Twenty-seven of 733 patients (3.7%) had AAEs and 19 of 733 (2.6%) had an SAE (Table 3). Nervous injury occurred in 3 patients (0.41% of all patients), and the rate of nervous injury in patients receiving an osteotomy (1 of 253 patients [0.40%]) was similar to the rate of nervous injury in patients who did not receive an osteotomy (2 of 480 patients [0.42%]). Fourteen of the 27 patients (51.8%) had AEs during initial hospital stay, and of the fourteen patients, seven (50.0%) had surgical site infections, four (28.6%) had urinary tract infection, two (14.3%) had nervous injury, two (14.3%) had wound dehiscence, and one (7.1%) had pneumonia. Using multivariate logistic regression, which controlled for the influence of likely confounding variables (Table 4), BMI-for-age in the 95th or greater percentile continued to be the only factor independently associated with the occurrence of any adverse event (odds ratio [OR]; 3.31;

Table 4. Results of multivariate analyses

Outcome/associated factor	Odds ratio (95% CI)	p value
Any adverse event		
BMI-for-age ≥ 95th percentile versus 5th–95th percentiles	3.31 (1.43–7.65)	0.005
Serious adverse event		
BMI-for-age ≥ 95th percentile versus 5th–95th percentiles	3.46 (1.32–9.09)	0.012
Length of stay more than 6 days		
≥ 13 levels instrumented versus 7–12 levels	2.00 (1.11–3.61)	0.021
Operative time ≥ 365 minutes	2.57 (1.39–4.76)	0.003
Readmission		
Any inpatient complication	180.44 (35.47–917.97)	< 0.001

Table 5. Reasons for readmission within 30 days

Reason for readmission	Number	Percentage (%)	Days from discharge to readmission (mean ± SD)
Total patients readmitted	11	100.0	10.1 ± 6.3
Surgical site infection	4	36.4	16.8 ± 3.0
Superficial incisional surgical site infection (n = 2)			
Deep incisional surgical site infection (n = 2)			
Wound disruption	2	18.2	10.0 ± 4.2
Ileus/gastrointestinal complaints	2	18.2	5.5 ± 3.5
Unspecified	3	27.3	4.3 ± 3.5

95% CI, 1.43–7.65; p = 0.005) and severe adverse events (OR, 3.46; 95% CI, 1.32–9.09; p = 0.012).

LOS

Sixty patients had extended LOS (defined as LOS greater than ninetieth percentile or more than 6 days in our cohort). In the multivariate model, 13 or more levels instrumented (OR, 2.00; 95% CI, 1.11–3.61; p = 0.021) and operative time of 365 minutes or more (OR, 2.57; 95% CI, 1.39–4.76; p = 0.003) were found to be independently associated with extended LOS (Table 4).

Readmission

Eleven of 733 patients (1.5%) were readmitted within 30 days of undergoing PSF. On multivariate analysis

(Table 4), the occurrence of any inpatient complication was the only variable associated with readmission (OR, 180.44; 95% CI, 35.47–917.97; p < 0.001). The most common cause of readmission was surgical site infection (Table 5). Readmissions for surgical site infections occurred, on average (mean ± SD = 16.8 ± 3.0 days), approximately 2 weeks after discharge. Three of 11 patients (27%) who were readmitted did not have a suspected reason for readmission reported in the database. The average time from discharge to readmission was 10.1 ± 6.3 days (mean ± SD) (Table 5).

Each multivariate logistic regression model was subsequently assessed using the C statistic and the Hosmer-Lemeshow goodness-of-fit test. The C statistic of the final multivariate model for readmission (0.87) indicated a very good distinguishing capacity, while the distinguishing ability of each multivariate model of AAE, SAEs, and extended LOS was more moderate (C statistic range, 0.68–0.72). Hosmer-Lemeshow goodness-of-fit tests showed no evidence of a lack of fit for the multivariate models for any AE, SAE, extended LOS, or readmission, indicating that the predicted event rates from each model did not differ significantly from the observed event rates.

Discussion

Posterior fusion for patients with AIS is a common pediatric orthopaedic procedure, yet there is incomplete information regarding factors associated with short-term outcomes after the surgery [2, 5–7, 16, 19–22, 24, 29, 32, 35, 41–44, 50, 51, 54, 55]. We identified patient and operative characteristics associated with the occurrence of AEs, extended LOS, and readmission using multivariate logistic regression to control for potentially confounding variables. We found that obesity (BMI-for-age ≥ 95th percentile) was associated with increased rates of AAEs and SAEs; an increased number of levels instrumented and increased operative time were associated with LOS more than 6 days, and any inpatient complication was associated with readmission.

Our study has several limitations. First, there is lack of data for scoliosis-specific outcomes in the database, such as preoperative curve magnitude and complexity, pain, and scoliosis-specific outcome instruments. As such, our study was designed to analyze more general patient outcomes after undergoing PSF for AIS: the occurrence of AEs, extended LOS, and readmission. Operative time, number of levels fused, and the performance of osteotomies were included in multivariate analyses in order to control for curve magnitude and complexity. Additionally, occurrence of AEs and

readmissions were captured only up to 30 days postoperatively (including after discharge) in the ACS NSQIP® Pediatric database. Although AEs occurring 30 days after PSF were not available, it is an improvement over other large databases that use administratively coded datasets, which only capture AEs occurring inpatient or those associated with a readmission. The risk factors for adverse outcomes identified in our study may be less applicable to long-term outcomes. Third, although our study contained a large number of patients, it represents only a proportion of the total number of patients with AIS treated surgically during the same time period of our study. Only 50 hospitals were included in the database and the ACS NSQIP® does not capture every patient. The ACS NSQIP® also does not record the number of surgeons or the percentage of all cases at each hospital included in the database. As the ACS NSQIP® includes a sample of cases at a limited number of pediatric hospitals, there may be selection bias. In addition, surgical technique may vary by surgeon, institution, and the number of procedures performed, but these variables were not available in the dataset. However, by using a large national database, surgeon- and institution-specific biases were thought to be minimized. Fourth, a limitation inherent to database research is the difficulty of identifying patients with a precise diagnosis and specific procedure from the dataset. In order to ensure that only patients with AIS who underwent PSF were included in our study, we had extensive inclusion and exclusion criteria based on CPT codes, ICD-9 codes, and patient characteristics. Of the initially identified patients, 37.9% were excluded, which could potentially introduce selection bias; however, excluded patients (Table 2) were those with a noted neuromuscular disorder, other characteristics suggestive of nonidiopathic scoliosis, or missing data. The risk of selection bias was therefore believed to be outweighed by the advantages of ensuring a homogenous population of patients with AIS.

In our study, the only factor found to be associated with AEs was obesity (BMI-for-age ≥ 95th percentile). Previous studies have had conflicting results regarding increased BMI in patients with AIS [16, 45]. Importantly, previous studies used BMI-for-age greater than the eighty-fifth percentile as a clinical cutoff and did not further separate patients with BMI-for-age greater than the ninety-fifth percentile, as was done in our study. In our study, only patients who had BMI-for-age greater than the ninety-fifth percentile had an increased frequency of AEs, whereas patients with BMI-for-age between the eighty-fifth and ninety-fifth percentiles did not. This finding suggests that BMI-for-age greater than the ninety-fifth percentile may be an important clinical cutoff, and future studies in pediatric orthopaedics should

consider stratifying BMI percentiles as we have done. Our study also highlights the issue of childhood obesity, which is increasing in the United States and is associated with numerous health consequences [12]. However, despite increased attention given to prevention and treatment, childhood obesity remains a resistant problem [46]. Several weight-loss methods show promise, including outpatient or inpatient weight management programs, medication, and bariatric surgery, however, the long-term efficacy and safety of such interventions are debated [9, 34, 46, 56]. Our study highlights a clear need for future research regarding the prevention, perioperative management, and long-term treatment of obesity in pediatric patients, particularly in the AIS population.

Postoperative LOS greater than 6 days after PSF for patients with AIS was significantly associated with 13 or more levels instrumented and increased operative time. A greater number of levels instrumented and increased operative time likely indicate a more complex procedure that could be associated with a greater number of postoperative issues, such as pain management and prolonged rehabilitation. A greater number of levels fused also has been associated with increased blood loss and thus, need for a blood transfusion, which could prolong LOS [11, 17, 54]. There may be a benefit to reducing operative blood loss in order to reduce postoperative LOS. Several methods of reducing intraoperative blood loss show promise, including, tranexamic acid [26, 47, 53], use of a bipolar sealer [15, 28], and intrathecal morphine [23]. While minimally invasive procedures have been reported to reduce postoperative LOS and blood loss in patients treated with other spinal procedures [10, 36, 40, 48], minimally invasive surgery for AIS has not yet shown the same benefits [39]. These strategies, among others, for potentially reducing LOS in patients with AIS undergoing larger operations warrant further study in order to establish safety and efficacy.

Readmission was very strongly associated with the occurrence of any complication during the initial procedure or hospitalization. After adjusting for potentially confounding variables, a patient with any inpatient complication was readmitted nearly 200 times more often than a patient who did not have an inpatient complication. Inpatient complications may cause clinical sequelae that could predispose the patient to having additional complications develop after discharge. Surgical site infection was the most common inpatient complication and cause for readmission, underlining the need for improved strategies for preventing surgical site infections in patients with AIS undergoing PSF. Risk factors for surgical site infections in adult patients undergoing spine surgery are often related to medical comorbidities [2, 5, 37, 52]; however, due to the general

lack of medical comorbidities in the AIS population, such infections are likely related to potentially modifiable surgical factors, including bacterial screening, skin preparation, antibiotic administration, and sterile technique [27, 33, 49]. Optimization of these factors could potentially reduce the rate of infection-related readmissions, however, further study is needed to determine the ideal perioperative routine [27, 33, 49].

In conclusion, obesity (BMI-for-age $\geq$ 95th percentile) was significantly associated with short-term AEs, reinforcing the urgent need for improved strategies to manage the challenging and growing problem of pediatric obesity. Larger and longer surgical procedures were found to be associated with a hospital stay of a week or more, and strategies for minimizing LOS may include reducing operative blood loss and the need for postoperative transfusion. The occurrence of a complication during the initial procedure or hospital stay was highly associated with patient readmission within 30 days, and inpatient complications and readmissions were most often due to surgical site infections. In the relatively healthy AIS population, optimizing surgeon-related factors, such as perioperative antibiotic administration and sterile technique, have the potential to significantly impact the frequency of inpatient complications and subsequent readmissions. The results of our study should be used for preoperative risk stratification, postoperative planning, and directing future research efforts in order to reduce short-term morbidity associated with PSF in patients with AIS.

Appendix 1. Characteristics of the ACS NSQIP® Pediatric Database

The American College of Surgeons National Surgical Quality Improvement Program® (ACS NSQIP®) database initially included only the adult population and subsequently was expanded to the pediatric population [38]. The first year data were released to participating institutions was 2012 [1]. The ACS NSQIP® Pediatric database captures data from a sample of pediatric surgery patients taken from 50 participating hospitals across the United States [1, 38]. In the ACS NSQIP® Pediatric database, 129 patient variables are collected to assess 30-day adjusted surgical outcomes. A trained Surgical Clinical Reviewer (SCR) prospectively identifies patients and captures data at each hospital using a variety of methods, including medical chart abstraction and patient interviews. The ACS NSQIP® additionally conducts Inter-Rater Reliability (IRR) audits of participating sites, and reports an inter-rater disagreement rate of approximately 2% for all assessed program variables. The SCR collects patient data in 8-day cycles, and is required to submit data from 40 of

46 8-day cycles (87.0%) in 1 year. Case selection and case mix are monitored by the program on a weekly basis to ensure appropriate sampling [1]. Clinical data are collected for the entire 30-day postoperative period, regardless of discharge status during this time [38].

Appendix 2. BMI Percentiles* by Sex and Age

Age (years)	BMI (kg/m^2)		
	5th percentile	85th percentile	95th percentile
Men			
11	14.6	20.2	23.2
12	15.0	21.0	24.2
13	15.5	21.9	25.2
14	16.0	22.7	26.0
15	16.6	23.5	26.8
16	17.1	24.2	27.6
17	17.7	24.9	28.3
Women			
11	14.4	20.9	24.1
12	14.8	21.7	25.3
13	15.3	22.6	26.3
14	15.8	23.3	27.3
15	16.3	24.0	28.1
16	16.8	24.7	28.9
17	17.2	25.2	29.6

* Percentiles per CDC guidelines.

Appendix 3. Results of Bivariate Analyses

Outcome/associated factor	OR (95% CI)	p value
AAE		
BMI-for-age $\geq$ 95th percentile versus 5th–95th percentile	2.93 (1.31–6.56)	0.009
SAE		
BMI-for-age $\geq$ 95th percentile versus 5th–95th percentile	2.79 (1.08–7.24)	0.035
LOS > 6 days		
$\geq$ 13 levels instrumented versus 7–12 levels	2.45 (1.39–4.32)	< 0.001
Operative time $\geq$ 365 minutes	3.04 (1.69–5.47)	< 0.001
Readmission		
Any inpatient complication	107.10 (27.04–424.12)	< 0.001

AAE = any adverse event; SAE = severe adverse event; LOS = length of stay.

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