

# Perioperative Surgical Home in Pediatric Settings: Preliminary Results

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**BACKGROUND:** The Perioperative Surgical Home (PSH) is a patient-centered, team-based approach that aims to improve the value of perioperative care. We implemented a PSH for patients with adolescent idiopathic scoliosis who were undergoing posterior spinal fusion at Children's National Health System. We hypothesized that this PSH would improve patient surgical outcomes and reduce hospital length of stay (LOS).

**METHODS:** A multidisciplinary group created evidence-based protocols for the preoperative, operative, postoperative, and postdischarge care of this patient population. After a 5-month design and training period, PSH for spinal fusion was implemented in March 2015, with reduction in LOS as the primary outcome measure. Anesthesia comanagement of patients additionally allowed a new pathway for patients to recover in the postanesthesia care unit and reduce intensive care unit utilization. Patients before and after the implementation of the PSH were compared on clinical and efficiency metrics.

**RESULTS:** The spinal fusion PSH achieved the primary outcome measure by a significant reduction in LOS. Care improvement was illustrated by achievement of the secondary outcome measure of reduced perioperative transfusion.

**CONCLUSIONS:** The PSH model presented a ready structure that proved successful at our institution for patients with adolescent idiopathic scoliosis who underwent posterior spinal fusion. (Anesth Analg 2016;123:00–00)

The Perioperative Surgical Home (PSH) model has been proposed to improve the value of surgical care by increasing quality of care and patient experience while controlling or decreasing cost of care. To date, several studies have validated improved outcomes seen with application of the PSH model for specific orthopedic and general surgical procedures in adults.<sup>1–3</sup> These studies showed that the PSH model resulted in lower costs, shorter lengths of stay (LOS), and greater patient satisfaction. Although the literature provides discussion of PSH programs for pediatric populations,<sup>4–6</sup> data reporting the benefits of using such a model for pediatric procedures are lacking.

In developing a pediatric PSH at the Children's National Health System in Washington, DC, and selecting a patient population for it, we considered the potential financial impact. Keren et al<sup>7</sup> identified adolescent idiopathic scoliosis

(AIS) as the surgical condition associated with the greatest annual cumulative cost in pediatric inpatient care, followed by hypoplastic left heart syndrome and adenotonsillar hypertrophy. AIS ranked high because of the significant cost per case for the surgery required—posterior spinal fusion (PSF)—not because of the number of cases performed.<sup>8</sup> Interestingly, the annual number of spinal fusions for AIS has remained constant during the past 15 years, but the total cost of surgery has increased significantly, even with decreased LOS. A recent evaluation of the Kids' Inpatient Database showed that hospital LOS for spinal fusion for AIS decreased from 6 to 5 days, whereas charges tripled to \$177,176 from years 1995 to 2010.<sup>8</sup> The Kids' Inpatient Database is organized by Health Care Cost and Utilization Project and is the largest all-payer pediatric inpatient database. The Health Care Cost and Utilization Project is a collection of databases made possible by a federal–state–industry partnership and sponsored by the Agency for Healthcare Research and Quality and the US Department of Health and Human Services.

In this preliminary report, we describe the process by which we created a PSH for children with AIS who underwent PSF and present our initial 6 months of outcome data. We hypothesized that the implementation of this PSH model would decrease LOS for patients undergoing PSF for AIS.

## METHODS

Data collection was completed under institutional review board approval, and documentation of written consent was waived. Patients who underwent PSF for AIS from July 1, 2013, through September 1, 2015, enrolled in the study. The PSH team was partnered with a project manager with LEAN Six Sigma training to improve care of patients with scoliosis. LEAN Six Sigma is a process improvement methodology meant to reduce variability and increase efficiency

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and is one of the primary performance improvement methods used at our institution.

Children's National also enrolled in the first PSH Learning Collaborative of the American Society of Anesthesiology, an entity that provided the structure to bring together the 44 enrolled organizations to define, pilot, and evaluate whether the PSH model was superior to conventional perioperative care. The goal of the collaborative was to accelerate the dissemination of PSH concepts by sharing information, as well as successes and failures experienced during the implementation process. Other institutions in the collaborative provided valuable advice both informally and through formal presentations at quarterly meetings.

### Process Mapping

As a first step, a multidisciplinary steering committee that consisted of individuals from orthopedic surgery, anesthesiology, pain management, case management, nursing, and physical therapy met to determine common objectives. After 2 initial steering committee meetings to identify stakeholders and goals, 4 smaller focus teams were created: preoperative, intraoperative, postoperative, and postdischarge. Each of these teams included an anesthesiologist, an orthopedic surgeon specializing in spinal fusion, and specific staff members identified as stakeholders in the care of patients with scoliosis. The project manager met separately with each of the 4 teams to map the entire perioperative process from identification of the surgical condition to postdischarge orthopedic clinic follow-up. After completion of the mapping phase, the steering committee met again to review the entire perioperative process, linking the process maps and highlighting the transitions of care.

**Standardized Clinical Pathways.** The 4 teams next evaluated existing literature and created a set of standardized care pathways for the preoperative, intraoperative, postoperative, and postdischarge care of patients with AIS undergoing spinal fusion.<sup>9-28</sup> When the teams did not feel the literature was clear, a best practice guideline was recommended and agreed on by all participants. The teams also reviewed literature describing enhanced recovery after surgery<sup>21,29</sup> and incorporated goals of early mobilization, use of non-opioid pain medication, early removal of drains, and early advancement of diet. A timeline was established for the care changes to be implemented for the preoperative, intraoperative, and postoperative hospital courses. Because early reports from the orthopedic community through abstract presentation revealed that a 3-day LOS was possible for scoliosis surgery, this target became our goal.<sup>12,30</sup> Standardized postoperative and pain order sets were created within the electronic health record (EHR) to hardwire the pathways for the planned 3-day hospital stay and to reduce variability. Details of the major clinical pathway changes and the associated goals are shown in Table 1. The main foci of each team are outlined to follow.

**Preoperative Team.** Three main goals were identified for the preoperative component of the PSH: (1) to prevent

cancellation of surgery, (2) to better prepare patients and families for their roles in recovery, and (3) to simplify and standardize the preoperative process and communication.

**Intraoperative Team.** At the request of the surgeons and to enhance pathway compliance, we formed a team of 8 attending anesthesiologists for spinal fusion cases. Four anesthesiologists comprised the permanent "core" of the team, and the remaining 4 rotated every 12 to 18 months to allow involvement of new members and to avoid exclusivity.

**Postoperative Team.** The PSH care pathway changes were implemented on March 1, 2015, but the patients continued to recover in the intensive care unit (ICU). A "fast track" pathway was added on April 15, 2015, in which otherwise-healthy patients with AIS could recover in the postanesthesia care unit (PACU) overnight and be discharged to the floor. Formal bedside handoffs were implemented before patient transfer from the PACU to floor nursing and from the anesthesiologist to the orthopedic attending. In addition, the postoperative team worked with physical therapists to optimize timing of their visits, prepare families for progress, and train other care providers to mobilize patients. We supported the physical therapy group through our institution's work force management committee to create an alternative staffing model that expanded weekend physical therapy services to facilitate weekend discharge.

**Postdischarge Team.** Our patients with AIS had low baseline rates of readmission after surgery. Therefore, additional postdischarge goals addressed the 2 most common historical reasons why patients contact the orthopedic service after discharge: (1) parental discomfort with removal of the surgical dressing at home and (2) use of pain medication and pain management after discharge.

### Outcome Measures and Data Collection

The primary outcome measure, reported in days, was hospital LOS, calculated as time of departure from the hospital minus time of entry into the operating room (OR). Secondary outcomes included efficiency and clinical outcomes discussed to follow. For OR time measures, first case starts are not reported because the first case on-time start rate at our institution is >90% and thus was not a differentiator. We collected total operative time (measured as time from incision to dressing placement) and total room time from nursing and anesthesia records in the EHR, and the difference between the 2 times was considered to be the induction, preparation, and emergence time, referred to as "nonoperative time."

Postoperative complication data, including superficial or deep wound infection, urinary tract infection, pneumonia, and neurologic injury, were collected. Blood transfusion data were collected as a binary outcome indicating whether the patient received a transfusion or not and in which timeframe, intraoperatively or postoperatively. Pain scores were collected directly from the nursing documentation within the EHR. A numeric pain score was used, with 0 representing no pain and 10 representing the worst pain.

**Table 1. PSH Clinical Pathways for Patients With AIS Who Undergo PSF**

Focus	Changes to Implement	Goals	Implementation Date
<b>Preoperative</b>			
Efficient scheduling laboratory, blood, MRI, and POCC	Create patient database	Keep planned surgery date	March 1, 2015
Standardize autologous blood donation	Bank 1 unit of autologous blood	1. Decrease wasted blood	March 1, 2015
Improve patient education	Prepare iron supplement prescriptions/letters	2. Reduce variability	April 15, 2015
	Create web-based videos, update website	Decrease LOS	
Standardize MiraLax use	Revise handbook	Decrease LOS	March 1, 2015
	Conduct preoperative evening class to practice transfers		
	Prescribe MiraLax 3 days preoperatively		
<b>Intraoperative</b>			
Implement/standardize prewarming	Raise OR temperature	1. Reduce hypothermia	April 15, 2015
Reduced patient prep/positioning time in OR	Implement active prewarming	2. Attain quality measures	March 1, 2015
	Standardize workflow of surgical staff	1. Reduce nonoperative OR time	
Standardize anesthesia intraoperative protocols	Standardize workflow of surgical staff	2. Reduce variability	March 1, 2015
	Administer IV Tylenol during closing	1. Reduce variability	
	Reduce crystalloid goal-directed therapy	2. Decrease LOS	
Standardization of cell saver	Implement new Amicar dosing	Decrease blood transfusion rate	April 15, 2015
	Administer intrathecal morphine or methadone		
Safety protocol for change of neuromonitoring	Protocolize bowl sizes and reassess	Safety	March 1, 2015
Standardize workflow for OR RN and scrub technicians	Create anesthesia protocols	Efficiency	April 15, 2015
	RN and scrub tech breaks to occur at noncritical times		
	Ensure correct equipment and bed in room at 7:00 AM		
	Ensure second nurse to set up and open sterile field		
Standardize spinal fusion team			
<b>Postoperative</b>			
Standardize postoperative care	Start orals on POD 0	1. Decrease LOS	April 15, 2015
	Patient sits up day of surgery	2. Reduce variables	
	Remove Foley and catheter at midnight on POD 1		
	Remove drains morning of POD 2		
	Remove A-line after surgery		
Patient and family education and progress to discharge	Modify care sets and order sets	Decrease LOS	April 15, 2015
	Interactive game board tracks progress		
Create fast track PACU recovery	Patient remains in PACU overnight	Reduce ICU use	April 15, 2015
Facilitate weekend progress and discharge	Standardize physician and nursing handoff	Decrease LOS	April 15, 2015
	Increase shifts for physical therapy on weekend (Saturdays and Sundays)		
<b>Postdischarge</b>			
Wound care and dressing management education	Provide predischarge teaching	1. Increase patient satisfaction	June 1, 2015
		2. Decrease ED visits, phone calls	
Follow-up phone call to discharged families	Ortho NP or POCC RN calls patient at home for follow-up	1. Increase patient satisfaction	June 1, 2015
		2. Decrease ED visits and readmissions	

Abbreviations: AIS, adolescent idiopathic scoliosis; ED, emergency department; ICU, intensive care unit; IV, intravenous; LOS, length of stay; MRI, magnetic resonance imaging; NP, nurse practitioner; OR, operating room; PACU, postanesthesia care unit; POCC, pediatric perioperative care clinic; POD, postoperative day; PSF, posterior spinal fusion; PSH, perioperative surgical home; RN, registered nurse.

As the number of pain scores recorded in the EHR varied by patient, for the purpose of this report, we selected 2 measures: the worst pain score recorded and the average of any pain scores that were recorded per postoperative day (POD). We elected not to include pain medication given in the OR and on the first postoperative night because patients who undergo PSF received either intrathecal morphine or intravenous (IV) methadone in the OR, and including the intrathecal morphine increased the complexity of the calculation of morphine equivalents. All opioid pain medications given through the IV or oral route were collected, including patient-controlled analgesia dose of morphine and hydromorphone, IV morphine and hydromorphone, and oral

oxycodone. When we compared opioid consumption on a given POD, only patients who remained in the hospital for the entire day were included. We did not collect specific patient satisfaction metrics because the number of Press Ganey survey responses from this patient population was too small to analyze.

### Statistical Analysis

The primary outcome of the study was LOS. Normality of all variables was assessed with the Shapiro–Wilk normality test and a visualization of each distribution. A square root transformation was applied to morphine equivalents for analysis. When data transformation was not adequate,

nonparametric tests were used. Patients LOS and OR and surgery times for procedures performed before implementation of the PSH model were compared with those for procedures performed after implementation, using a nonparametric Wilcoxon rank sum test. Results are reported as medians and 95% confidence intervals (CIs). CIs were calculated by using the binomial method and without making assumptions of the underlying distribution. Assessment and comparison of transfusion rates were performed by using logistic regression analysis, where pre-PSH patients were considered the reference group. Reported pain and morphine equivalents (square root transformed data) were compared with the Student *t* test. Results from the morphine equivalents data are presented in the original scale for ease of interpretation. To further assess the validity of LOS

as our primary end point, the rank correlation between each secondary outcome and LOS was assessed. Statistical significance was set at the  $\alpha = .05$  level, and all analyses were performed using Stata V13 (College Station, TX).

The reference group sample size was selected primarily on practical considerations related to the initiation of the anesthesia information systems at Children’s National. The work was completed as a quality improvement project, and the initial selection of 6 months of data after PSH implementation was not based on a precalculated sample size but based on a natural temporal end point to analyze results.

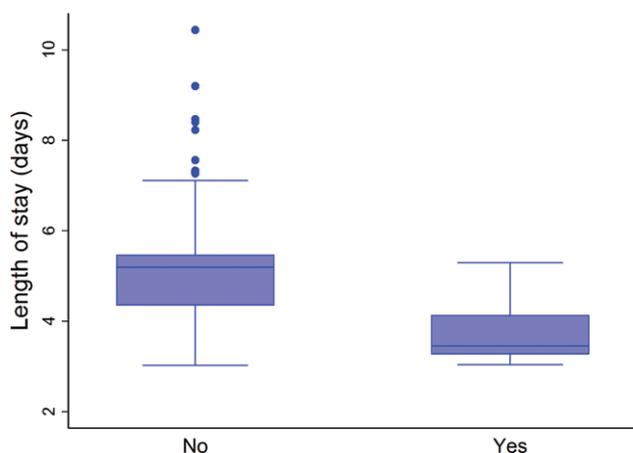
**RESULTS**

All patients who underwent PSF for AIS from July 1, 2013, through September 1, 2015, were included in the analysis. The reference group (before PSH implementation) included 116 patients who underwent PSF from July 2013 through February 2015. The PSH group included 27 patients who underwent PSF from March through September 2015. Primary outcome measures were evaluated in all patients (N = 143), and secondary outcomes were evaluated in only 67 patients for whom we had complete data.

**Clinical Results**

Median LOS decreased significantly after implementation of the PSH (5.2 [4.5–5.3] days vs 3.4 [3–4] days,  $P < .001$ ) (Figure 1 and Table 2). The incidence of 30-day readmission was known for 58 patients, of whom 3.2% (1/31) were reference group patients ( $P = .99$ ) and 0% (0/27) were PSH patients. No perioperative mortality was reported in either group. All patients in both groups were discharged to home.

**ICU Use.** As discussed previously, we implemented the clinical care changes in the PSH model in 2 phases. Phase 1 did not involve the PACU, and we expanded the PSH



**Figure 1.** Length of stay for patients in Perioperative Surgical Home (PSH) patients versus reference group. The y-axis represents length of hospital stay, in days, for patients after posterior spinal fusion for adolescent idiopathic scoliosis. Of the 2 groups, “no” represents not a part of the PSH or the reference group. “Yes” represents the 27 patients who were part of the PSH group.

Table 2. Comparison of the Length of Stay by Inclusion in PSH				
PSH Patient	N	Length of Stay		P Value
		Mean ± SD	Median (Range)	
No	116	5.18 ± 1.25	5.19 (3.02–10.43)	<.001
Yes	27	3.64 ± 0.56	3.45 (3.03–5.29)	

*P* value from Wilcoxon rank sum test.  
Abbreviations: PSH, perioperative surgical home; SD, standard deviation.

Table 3. Comparisons of Categorical Transfusion-Related Outcomes					
	Pre-PSH Patients	PSH Patients	Odds Ratio	P Value	95% Odds Ratio Confidence Interval
Cell saver given					
No	7	3	1.00		
Yes	33	24	1.70	.47	0.40–7.24
Occurrence of intraoperative transfusion					
No	30	25	1.00		
Yes	10	2	0.24	.08	0.05–1.20
Occurrence of postoperative transfusion					
No	33	26	1.00		
Yes	7	1	0.18	.12	0.02–1.57
Occurrence of perioperative transfusion					
No	25	24	1.00		
Yes	15	3	0.21	.024	0.05–0.81

Abbreviation: PSH, perioperative surgical home.

into the PACU only after 6 weeks. After the expansion of the PSH into the PACU, 84% of all patients (16/19) bypassed the ICU and were cared for in the PACU, with an anesthesiologist-based comanagement model. Of the 3 ICU patients, 2 had scheduled ICU admissions because of their medical history, 1 had moderate asthma, and the other had a seizure disorder. The remaining patient had intermittent paroxysmal atrioventricular block in the recovery room and was transferred to the cardiac ICU until an event monitor was placed before discharge on POD 4.

**Transfusion.** Patients in the PSH group were significantly less likely to undergo any perioperative transfusion (35% vs 11%, OR = 0.21; 0.05–0.81;  $P = .024$ ; Table 3). No significant differences in intraoperative or postoperative transfusion rates were observed. In addition, no difference was observed between groups in preoperative or postoperative hemoglobin and hematocrit levels, as detailed in Table 4; however, we did observe significant reduction in crystalloid infusion (Table 5).

**OR Time Measures.** No substantive differences were observed between the 2 groups in overall OR or surgical time (skin to skin; Table 6). Nonoperative time, including anesthesia preparation, positioning, and emergence, decreased slightly but significantly after the implementation of the PSH model (1.6 hours [95% CI, 1.5–1.6] vs 1.4 hours [95% CI, 1.3–1.6,  $P = .017$ ]). There was no correlation with LOS.

**Pain and Opioid Consumption Measures.** Evaluation of the average pain scores on PODs 0 to 4 revealed relatively similar average pain scores in both groups when they were compared day to day (Table 7 and Figure 2). The PSH patients' pain scores were generally slightly better, with the exception of POD 2, which coincided with discontinuation of patient-controlled analgesia.

An additional secondary outcome measure was opioid consumption on PODs 1, 2, and 3, as measured by conversion to morphine equivalents. A decrease was noted in mean opioid consumption on all 3 days: 9% on POD 1, 11% on POD 2, and 52% on POD 3 (not shown in the table). The decrease in morphine equivalents in the PSH patients may have been statistically significant on POD 3 ( $P = .015$ ; Table 7 and Figure 3).

**Complications.** Complications, including urinary tract infection, pneumonia, superficial or deep wound infection, and neurologic injury, were not present in either group. One patient in the pre-PSH group was readmitted, and no patients in the PSH were readmitted.

### Validity of LOS as Primary Outcome

The choice of LOS as a valid primary outcome was assessed through rank correlations between LOS and each secondary outcome and showed several significant relationships, including OR time, occurrence of a transfusion, and amount of crystalloid infused (Table 8).

## DISCUSSION

Under the conditions of this study, we found that the PSH model allowed us to improve our care for patients with AIS undergoing PSF during the course of 1 year, achieving our primary goal of significantly reducing LOS by >1.5 days. The PSH also was effective at achieving several secondary measures, including decreasing ICU use, reducing perioperative blood transfusion, reducing nonoperative or preparation time in the OR, and reducing opioid consumption and maintaining stable pain scores while enhancing recovery. Although none of these changes were novel, they represent significant care improvements. Although reduction in ICU use and OR time may not clearly provide direct benefit to an individual patient, it contributes to providing greater

**Table 4. Comparisons of Hemoglobin and Hematocrit Levels**

	Pre-PSH Patients			PSH Patients			P Value
	N	Mean ± SD	Median (Range)	N	Mean ± SD	Median (Range)	
Hemoglobin level							
Preoperative	34	13.5 ± 1.2	13.7 (10.8–16.1)	25	13.6 ± 1.2	13.6 (10.9–15.7)	.70
Immediately postoperative	37	10.3 ± 1.0	10.1 (8.7–12.5)	25	10.8 ± 1.2	10.6 (8.7–14.1)	.08
POD 1	38	9.7 ± 1.0	9.6 (7.8–12.9)	27	9.8 ± 1.3	9.5 (7.5–12.9)	.85
Hematocrit level							
Preoperative	34	39.2 ± 3.1	40.0 (32.9–46.5)	25	39.7 ± 3.4	39.8 (30.9–44.1)	.65
Immediately postoperative	37	30.4 ± 2.9	29.9 (26.1–36.3)	25	31.8 ± 3.4	31.5 (25.9–39.6)	.09
POD 1	39	28.3 ± 3.1	28.1 (24.5–38.1)	27	28.7 ± 4.0	28.6 (21.9–36.1)	.60

Abbreviations: POD, postoperative day; PSH, perioperative surgical home; SD, standard deviation.

**Table 5. Comparisons of Cell Saver and Albumin Given**

	Pre-PSH Patients			PSH Patients			P Value
	N	Mean ± SD	Median (Range)	N	Mean ± SD	Median (Range)	
Amount of cell saver given <sup>a</sup>	33	275.13 ± 221.40	250 (25–964)	24	293.78 ± 275.91	221 (121–1350)	.75
Amount of cell saver given per body weight <sup>a</sup>	33	5.02 ± 4.25	3.33 (0.51–19.36)	24	5.10 ± 4.00	4.08 (1.59–16.67)	.82
Amount of albumin given	31	486 ± 246	500 (50–1000)	21	524 ± 249	500 (250–1000)	.59
Amount of crystalloid given <sup>a</sup>	40	2326 ± 956	2250 (500–4001)	27	1393 ± 498	1300 (600–2500)	<.001

<sup>a</sup>Analysis performed on square root transformed data; raw data values presented.

Abbreviations: PSH, perioperative surgical home; SD, standard deviation.

**Table 6. Comparison of Median OR Time**

	Pre-PSH Patients		PSH Patients		P Value
	N	Median Hours (Range)	N	Median Hours (Range)	
Total OR time	40	6.4 (5.0–11.2)	27	6.3 (4.2–7.4)	0.14
Surgery time	40	4.9 (3.2–8.6)	27	4.8 (2.5–5.9)	0.44
Nonoperative time	40	1.6 (1.2–3.1)	27	1.4 (1.2–1.9)	0.017

Abbreviations: OR, operating room; PSH, perioperative surgical home.

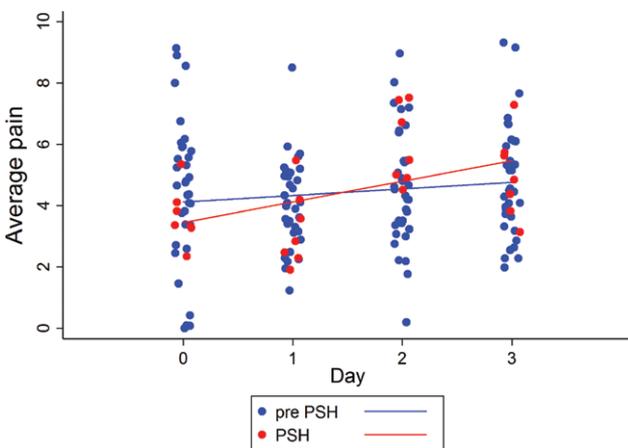
**Table 7. Comparisons of Pain-Related Outcomes (Limited to Days 0–3, Including Only POD 3 Data for Those Patients Who Had a POD 4 Assessment)**

	Pre-PSH Patients			PSH Patients			P Value
	N	Mean ± SD	Median (Range)	N	Mean ± SD	Median (Range)	
Average pain							
POD 0	40	4.4 ± 2.4	4.5 (0.0–9.0)	27	3.7 ± 2.0	3.6 (0.5–7.7)	.20
POD 1	40	3.8 ± 1.4	3.5 (1.5–8.5)	27	3.4 ± 1.6	3.1 (0.9–6.5)	.23
POD 2	40	4.2 ± 2.0	4.1 (0.0–9.0)	27	4.7 ± 1.7	4.7 (1.8–7.5)	.37
POD 3	34	4.8 ± 1.8	4.5 (2.0–9.3)	8	5.0 ± 1.2	4.9 (3.2–7.3)	.76
Morphine equivalents (mg/kg/d)							
POD 1	40	42.3 ± 31.6	35.3 (0.0–141.6)	27	38.3 ± 24.3	32.5 (11.0–122.8)	.93
POD 2	40	40.8 ± 24.2	38.2 (3.0–104.0)	27	36.0 ± 19.6	30.8 (7.5–77.7)	.52
POD 3	34	31.8 ± 20.1	26.3 (5.0–72.8)	9	15.2 ± 6.4	15.0 (7.5–29.0)	.015

Abbreviations: POD, postoperative day; PSH, perioperative surgical home; SD, standard deviation.

<sup>a</sup>Patients only included in POD 3 calculation if they had a POD 4 assessment.

<sup>b</sup>Analysis performed on square root transformed data; raw data values presented.



**Figure 2.** Numeric pain scores postoperative days 0–3 in Perioperative Surgical Home (PSH) group versus reference group. The y-axis represents the mean numeric pain score (0–10), and the x-axis represents the postoperative day. The blue line represents the pre-PSH group (reference group), and the red line represents the PSH group.

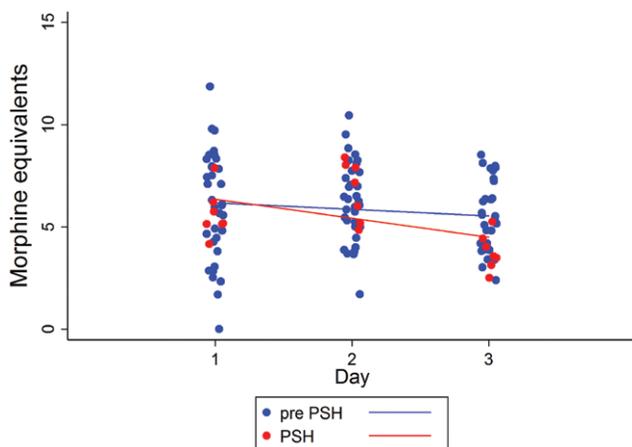
value care to the population and may free OR resources and critical care beds on an institutional level.

Blood transfusion can be considered an independent quality metric for surgery. Within our PSH, we observed a reduction in the overall perioperative transfusion rate from approximately 35% to 11% and found that PSH patients were significantly less likely to undergo perioperative transfusion. Regarding preoperative and postoperative hemoglobin and hematocrit levels, we observed no difference between groups (Table 4). Multiple changes were simultaneously implemented in the PSH that could have contributed to the reduction in transfusion. As shown in Table 5, we noted a significant reduction in crystalloid infusion and a slight increase in transfusion of cell saver blood.

As detailed in Table 1, our intraoperative PSH protocol changes included modification of aminocaproic acid dosing and primary use of intrathecal morphine, which has been shown to decrease blood loss and transfusion during PSF for AIS.<sup>31</sup> As the number of patients in the PSH increases, we plan to more closely evaluate the patient and surgical characteristics that are associated with transfusion.

Opioid consumption and pain scores were not significantly different between the reference and the PSH group on PODs 0 to 2 (Table 7). Reducing the LOS without a significant increase in pain scores could be considered a success in an enhanced recovery pathway. There are some suggestions in Table 8 of a relationship between pain scores on POD 1 and POD 2 and LOS. We plan to study a larger number of patients in the future to further evaluate the possibility of a significant opioid reduction within the PSH and the relationship between early pain scores, opioid consumption, and hospital LOS.

The PSH model presented a ready structure that proved successful at our institution for patients with AIS, but the PSH is not the only model with which to improve surgical care of patients who undergo spinal fusion. A 2015 multi-center study presented a fast track pathway with an LOS of 2.2 days, although discharge criteria only included flatus and not return to bowel function.<sup>12</sup> This is a significant change from the average LOS of 5 days reported in the Kids' Inpatient Database as recently as 2012.<sup>8</sup> A 3-day pathway with optional early discharge on POD 2 represents a significant paradigm change.<sup>12,30</sup> It is challenging to make direct comparisons: our PSH involved all patients who underwent PSF for AIS, including those with comorbidities (eg, asthma, mild developmental delay and chronic pain secondary to chronic Lyme disease), not only those who qualified for a true fast track pathway. Some institutions have already implemented some of the changes made in our PSH, including bypassing the ICU, creating a spinal fusion



**Figure 3.** The y-axis represents the morphine equivalents that have been square root transformed. The x-axis represents the postoperative day. The blue line represents the pre-PSH group (reference group), and the red line represents the PSH group.

**Table 8. Rank Correlations Between Length of Stay and Secondary Outcomes**

Secondary Outcome	r	P Value
OR time	0.251	.040
Surgical time	0.208	.092
Nonsurgical time	0.146	.240
Intraoperative transfusion	0.196	.115
Postoperative transfusion	0.284	.019
Perioperative transfusion	0.318	.009
Amount of cell saver given	-0.057	.674
Amount of albumin given	0.137	.331
Amount of crystalloid given	0.306	.012
Pain score (POD 0)	0.152	.219
Pain score (POD 1)	0.282	.020
Pain score (POD 2)	0.252	.040
Pain score (POD 3)	0.224	.069

r represents Spearman rank correlation. Blood transfusion data were collected as a binary outcome.

Abbreviations: OR, operating room; POD, postoperative day.

“team,” and reducing the transfusion rate, and perhaps another target for PSH development should be considered at those institutions.

Our PSH protocol now calls for comanagement by the anesthesiologist only on the evening of surgery with a handoff back to the orthopedic team the following morning. Our anesthesiology pain service closely follows these patients until at least POD 3, but we do not assume complete responsibility for postoperative care. Cross-coverage of the pain and orthopedic services by trainees and attending physicians who are not part of the PSH program has intermittently decreased compliance with the pathway. The addition of a true PSH service could increase pathway compliance and potentially further decrease LOS. However, the incremental approach allowed our anesthesiology group a successful first step toward comanagement that provided direct benefit to the hospital in a practical way.

A limitation of our study is the lack of patient satisfaction metrics. The PSH is described as “patient centric,” and patient satisfaction is a key component. Design and implementation of the PSH moved very quickly; however, development of

the software intended for use within the EHR to send satisfaction surveys to patients and families was delayed. We are working to incorporate measurement of patient satisfaction into our PSH and will have these data for future patients.

In a 2015 special PSH issue of *Anesthesia and Analgesia*, the authors of several editorials discussed the future of the PSH in pediatrics and suggested that perioperative management of chronic pediatric medical conditions was a stronger basis for a PSH than was a specific surgical procedure.<sup>4-6</sup> We submit that patients with AIS who undergo PSF provide an opportunity for a PSH model to add value and to achieve the triple aim for specific surgical procedures. Because PSF is a costly elective procedure, we have a strong obligation to achieve high-value care for patients who undergo it. Exploration should continue to develop the PSH care model around other pediatric surgical conditions and populations to add value to perioperative care. ■

## DISCLOSURES

**Name:** Karen Thomson, MD.

**Contribution:** This author was involved in all aspects of the study and approved the final manuscript.

**Conflicts of Interest:** Karen Thomson declares no conflicts of interest.

**Name:** Sophie R. Pestieau, MD.

**Contribution:** Sophie R. Pestieau was involved in all aspects of the study and approved the final manuscript.

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**Contribution:** This author helped design the study, conduct the study, and prepare the manuscript.

**Conflicts of Interest:** Janish J. Patel declares no conflicts of interest.

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**Contribution:** This author helped perform the statistical analysis, prepare the manuscript, and approve the final manuscript.

**Conflicts of Interest:** Heather Gordish-Dressman declares no conflicts of interest.

**Name:** Ariana Mirzada.

**Contribution:** This author helped collect the data and contributed to the manuscript and approved the final manuscript.

**Conflicts of Interest:** Ariana Mirzada declares no conflicts of interest.

**Name:** Zeev N. Kain, MD, MBA.

**Contribution:** This author helped design the study and prepare the manuscript.

**Conflicts of Interest:** Zeev N. Kain is in Edwards speaker bureau; SIS advisory board; President, American College of Perioperative Medicine

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**Contribution:** This author contributed to all portions of the study and manuscript preparation and approved the final manuscript.

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