Implementing a Pediatric Perioperative Surgical Home Integrated Care Coordination Pathway for Laryngeal Cleft Repair

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BACKGROUND: The Pediatric Perioperative Surgical Home (PPSH) model is an integrative care model designed to provide better patient care and value by shifting focus from the patient encounter level to the overarching surgical episode of care. So far, no PPSH model has targeted a complex airway disorder. It was hypothesized that the development of a PPSH for laryngeal cleft repair would reduce the high rates of postoperative resource utilization observed in this population.
METHODS: Institutional review board approval was obtained for the purpose of data collection and analysis. A multidisciplinary team of anesthesiologists, surgeons, nursing staff, information technology specialists, and finance administrators was gathered during the PPSH development phase. Standardized perioperative (preoperative, intraoperative, and postoperative) protocols were developed, with a focus on preoperative risk stratification. Patients presenting before surgery with ≥1 predefined medical comorbidity were triaged to the intensive care unit (ICU) postoperatively, while patients without severe systemic disease were triaged to a lower-acuity floor for overnight observation. The success of the PPSH protocol was defined by quality outcome and value measurements.
RESULTS: The PPSH initiative included 120 patients, and the pre-PPSH period included 115 patients who underwent laryngeal cleft repair before implementation of the new process. Patients in the pre-PPSH period were reviewed and classified as ICU candidates or lower acuity floor candidates had they presented in the post-PPSH period. Among the 79 patients in the pre-PPSH period who were identified as candidates for the lower-acuity floor transfer, 70 patients (89%) were transferred to the ICU ($P < .001$). Retrospective analysis concluded that 143 ICU bedded days could have been avoided in the pre-PPSH group by using PPSH risk stratification. Surgery duration ($P = .034$) and hospital length of stay ($P = .015$) were found to be slightly longer in the group of pre-PPSH observation unit candidates. Rates of 30-day unplanned readmissions to the hospital were not associated with the new PPSH initiative ($P = .093$). No patients in either group experienced emergent postoperative intubation or other expected complications. Total hospital costs were not lower for PPSH observation unit patients as compared to pre-PPSH observation unit candidates (difference = 8%; 95% confidence interval, −7% to 23%).
CONCLUSIONS: A well-defined preoperative screening protocol for patients undergoing laryngeal cleft repair can reduce postoperative ICU utilization without affecting patient safety. Further research is needed to see if these findings are applicable to other complex airway surgeries. (Anesth Analg XXX;XXX:00–00)

KEY POINTS

- **Question:** What is the value added of the Perioperative Surgical Home model in pediatric surgical patients undergoing complex airway surgery?
- **Findings:** By using a Pediatric Perioperative Surgical Home risk stratification process, the use of high-cost intensive care resources may be modified.
- **Meaning:** A well-defined preoperative screening protocol for patients undergoing laryngeal cleft repair can reduce postoperative intensive care unit utilization without affecting patient safety.

Preoperative triage, evaluation, and planning are coordinated care activities involving multiple providers, many of whom may not be fully involved in all components of the episode of care.[1,2] The Perioperative Surgical Home (PSH) is a patient-centered, innovative model of delivering health care during the entire patient surgical/procedural experience, from the decision for surgery through the recovery phase, including postacute care disposition. The implementation of a PSH model has proven to be successful at conserving hospital resources, as well as reducing cost and length of stay in many surgical populations.[3–6] Through standardization, the PSH model emphasizes proactive and collaborative evidence-informed decision-making throughout the entire perioperative episode of care.

At Boston Children's Hospital, a Pediatric PSH (PPSH) was developed for patients with a diagnosis of laryngeal cleft undergoing endoscopic surgical repair. Although several PSH initiatives have been tested in pediatric populations, this is the first PPSH targeting a complex airway surgical procedure.[4,6,7] Laryngeal cleft is a rare congenital

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abnormality resulting in failure of fusion of the interarytenoid region of the larynx. The prevalence of laryngeal cleft is reported to be 1 in 10,000 to 1 in 20,000 live births.[8] According to the Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project website, the total cost for nonmalignant otolaryngology procedures was over $463 million in 2014 in the United States.[9] The decision to identify the cohort of patients undergoing congenital laryngeal cleft repair as the inaugural PPSH program was based on the expensive hospital resource utilization and cost.[8,10–12] It was hypothesized that determination of postoperative intensive care unit (ICU) disposition guided by preoperative risk stratification based on medical comorbidities would reduce the unnecessary utilization of high-cost resources and potentially reduce the overall cost of the perioperative episode of care. The goals of this article are to describe the design and implementation of the laryngeal cleft PPSH at Boston Children's Hospital and to report the impact of this program over a 24-month period.

METHODS

Boston Children's Hospital Institutional Review Board approval was obtained with a waiver of consent. Data described in this analysis were obtained using an innovative institutional review board–approved PPSH dashboard. The dashboard utilizes real-time tracking of postprocedure department transfers, readmissions, complications, and cost, which aggregates and displays clinical and billing data based on a discreet surgical procedure.[13] The analysis included 235 patients who underwent endoscopic laryngeal cleft repair utilizing the carbon dioxide laser. Patients who presented with comorbid esophageal atresia were not included in the PPSH due to significant differences in surgical management compared to isolated laryngeal cleft repair.[14] The laryngeal cleft repair PPSH was piloted during the last quarter of 2015, followed by full implementation in February 2016. Patients admitted for laryngeal cleft repair after February 1, 2016 were automatically enrolled in the PPSH program and labeled in the surgical scheduling application as "PPSH" patients. A total of 115 patients were included in the PPSH initiative, and 120 patients admitted in 2014 and 2015 before implementation of the PPSH process (pre-PPSH) were included as a reference group. No families refused participation in the PPSH initiative.

Planning and Development

The PPSH team used an interdisciplinary construct consisting of individuals directly and indirectly involved in the care system that supports the PPSH. This team included anesthesiologists, surgeons, nurses, quality improvement specialists, information technology personnel, and professionals from finance. The PPSH team met regularly during the design, development, and monitoring phase. Clinical workflow was described using a process mapping algorithm to describe patient work pre-, intra-, and postoperatively (Figure 1). Duplication of care and areas of high resource use were identified and redesigned through the PPSH integrative approach. Key caregivers for this patient population were brought together for clinical decision-making, input, and evaluation. The laryngeal cleft repair population was identified as having high ICU utilization because all patients were automatically admitted to the ICU postoperatively before the PPSH process implementation. Decreasing the high rate of ICU admission was determined to be a valuable institutional outcome. Assignment of postoperative disposition during the preoperative segment of the episode of care to non-ICUs based on clinical acuity and associated comorbidities was planned as process improvement (Table 1). The standard intraoperative technique consisted of total intravenous anesthesia, spontaneous ventilation with a natural airway during suspension laryngoscopy, and carbon dioxide laser ablation for surgical correction.[8,15,16]

Measures

The measures used to evaluate the success of the PPSH protocol for laryngeal cleft repair were defined before the start of the intervention. The primary measure was the percentage of patients admitted to the ICU postoperatively. The secondary outcome measure was cost of care, which we expected to decrease as a result of avoiding the high facility costs associated with the ICU. Finally, the balance measures were the rate of complications defined as emergent postoperative intubation and readmission within 30 days postdischarge, which were used to evaluate the safety of the process change.

Risk Stratification and Postoperative Disposition

Patient complexity and presence of comorbidities were used to stratify the PPSH group into 2 patient populations. The high-acuity patients were triaged to ICU care postoperatively, whereas low-acuity patients were assigned to the observation unit after first-stage recovery.

- High-acuity population: These patients had significant medical comorbidities or craniofacial abnormalities that required a higher level of postoperative surveillance. Examples include tracheomalacia, previous tracheostomy, trisomy 21, chronic lung disease, and recurrent pneumonia.
- Low-acuity population: Patients who were otherwise healthy and did not have severe systemic disease or serious comorbid conditions.

Monitoring

The PPSH dashboard was used to monitor the process, outcome, and balance measures in real time allowing for rapid feedback regarding evidence-based improvements. The design and application of the PPSH dashboard, which is a computer application that queries, aggregates, and displays all relevant data from the hospital database regarding a defined procedure, has been described previously.[13]

Analysis

All data were queried from the institutional data warehouse and organized into SPSS version 24 (IBM, Armonk, NY) and Stata version 13.1 (StataCorp, College Station, TX) for analysis. Normality was assessed for all variables by the Shapiro–Wilk test and histogram visualization. Continuous patient factors and outcomes are expressed as medians

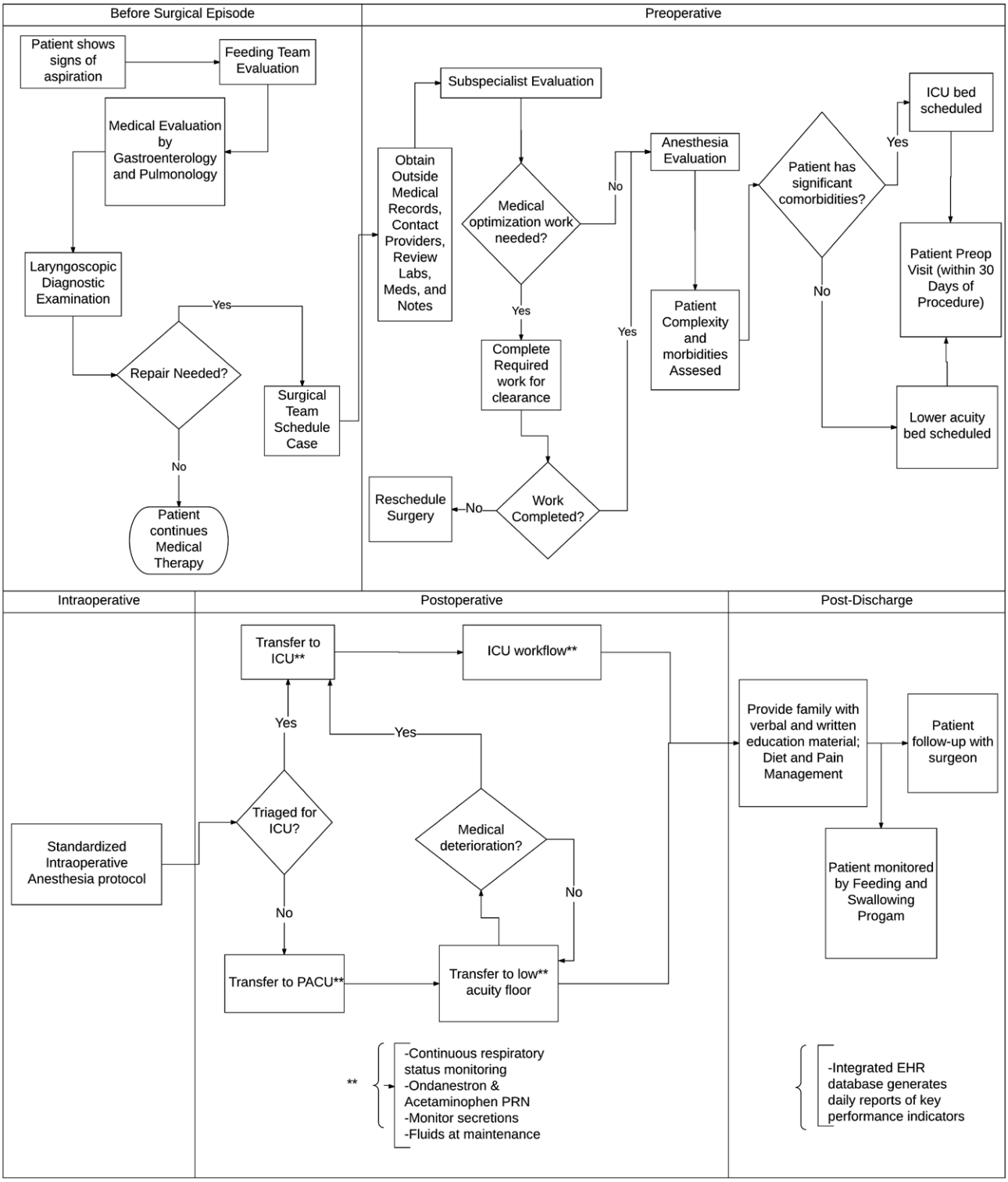

Figure 1. The change in the perioperative care for laryngeal cleft repair patients was visualized using process mapping. Significant changes in clinical flow were instituted in the preoperative phase, where patients underwent a case review to determine postoperative disposition, based on medical comorbidities. Another significant development was the mechanism for rapid upgrade of care from the low-acuity floor in the case of medical deterioration. EHR indicates electronic health record; ICU, intensive care unit; PICU, pediatric intensive care unit; PRN, pro re nata.

and interquartile ranges, and categorical patient factors and outcomes are presented as frequencies and percentages. Patients in the pre-PPSH group were retrospectively reviewed and evaluated to have been either ICU candidates or observation unit candidates. Comparisons between pre-PPSH observation unit candidates and post-PPSH observation unit patients were made using the Wilcoxon rank sum test for continuous variables and the Fisher exact test or the

Table 1. A Standardized Intraoperative Anesthetic Management Guideline for Laryngeal Cleft Repair Was Developed as Part of the Perioperative Surgical Home

Preoperative
Midazolam 0.05 mg/kg orally when required for preoperative anxiolysis
Spontaneous ventilation with natural airway
Induction
Spontaneous ventilation maintained throughout
Option 1: inhalation of sevoflurane in oxygen and nitrous oxide by mask
Option 2: intravenous administration of propofol at 2–4 mg/kg
Intraoperative
Maintain spontaneous ventilation with a natural airway, anesthesia, and unconsciousness via
Propofol infusion at 300 μg/kg/min + Remifentanil infusion at 0.05–0.15 μg/kg/min
Aerosolized 4% lidocaine <2 mg/kg for topicalization of the airway
Rescue process for oxygen saturation decreases or apnea: jet ventilation
Standard intraoperative anesthesia monitoring
Endoscopic repair of the laryngeal cleft accomplished using the carbon dioxide laser followed by laryngeal sutures
Postoperative
Continuous bedside monitoring with close observation of respiratory and airway status
Vital signs (HR, RR, Sat, every 1 h and blood pressure every 15 min to 4 h, temp q4)
Minimum blow-by oxygen to maintain baseline oxygen saturations
Ondansetron administration to avoid vomiting
Pain control with morphine and acetaminophen
Intravenous fluids at maintenance rate

Abbreviations: HR, heart rate; RR, respiratory rate; Sat, oxygen saturation.

χ^2 test for categorical variables. A 95% confidence interval (CI) was computed for the difference in total hospital costs between pre-PPSH observation unit candidates and post-PPSH observation unit patients. To appropriately analyze the association between the intervention and outcomes where the data come from subsequent time periods, segmented regression analysis was performed. Two years of patient-level data were available in the pre-PPSH period, and 2 years of patient-level data were available in the post-PPSH period. To determine whether the intervention was associated with the outcomes variables, 2 regression coefficients were examined. The change in slope from preintervention to postintervention (the intervention by time interaction terms in the segmented regression model) was examined, as well as the change in average level of the outcome variables immediately after the PPSH intervention, that is, the change in the average level from the end of the pre-PPSH period to the start of the post-PPSH period (the main effect of the PPSH intervention term in the segmented regression model).[17] Statistical significance was set at .05.

Our sample size of 120 patients in the preimplementation period and 115 patients in the postintervention period was derived from patients presenting for laryngeal cleft repair from January 2014 to March 2018. With a 2-tailed α level of .05, this sample size provides 80% power to detect a 10% reduction in the rate of ICU utilization in the post-PPSH period, assuming an ICU utilization rate of 95% in the pre-PPSH period. Power and sample size considerations were performed in nQuery Advisor version 7.0 (Statistical Solutions Ltd, Cork, Ireland). However, the sample size limited our ability to perform time-series analyses.

RESULTS

All patients had the diagnosis of type 1, 2, or 3 laryngeal cleft, which was repaired endoscopically. The PPSH initiative included 120 patients, and the pre-PPSH period included 115 patients who underwent the same procedure before implementation of the new process. Baseline demographic data of all are included in Table 2. PPSH observation unit patients were found to be similar to pre-PPSH observation unit candidates in age (P = .999), American Society of Anesthesiologists physical status (P = .209), and number of preexisting complex chronic conditions (P = .661), revealing comparability in the complexity of patients in these 2 groups.

Outcomes

Operative Outcomes. Both scheduled and unplanned admission to the ICU were tracked using the PPSH dashboard. Among the 79 patients in the pre-PPSH period who were identified as candidates for the observation unit, 70 patients (89%) were transferred to the ICU (P < .001; Figure 2). Retrospective analysis concluded that 143 ICU bedded days could have been avoided in the pre-PPSH group by using PPSH risk stratification. Operating room duration (P = .034) and hospital length of stay (P = .015) were found to be slightly longer in the group of pre-PPSH observation unit candidates (Table 2). Segmented regression analysis did not find a statistically significant reduction in the average ICU utilization rate from just before to just after implementation of the PPSH intervention (estimated change = −0.31; 95% CI, −0.71 to 0.09; P = .126) nor a significant change in the slope (rate of change in ICU utilization; estimated change in slope after PPSH intervention = −0.002; 95% CI, −0.06 to 0.06; P = .956). There was no significant change in mean length of stay from just before to just after implementation of the PPSH intervention (estimated change = 0.19; 95% CI, −0.46 to 0.84; P = .567) nor a change in slope over time from before as compared to after the PPSH intervention (estimated change in slope after PPSH intervention = −0.06; 95% CI, −0.18 to 0.07; P = .384; Figure 3).

Safety Outcomes. Increased rates of 30-day unplanned readmissions to the hospital were not associated with the new PPSH initiative. The readmission rate among PPSH observation unit patients was 4.7% as compared to 2.5% among the pre-PPSH observation unit candidates (P = .683). The first postoperative pain score among PPSH observation unit patients was 1 (interquartile range, 0–5) as compared to a first postoperative pain score of 0 (interquartile range, 0–2) among pre-PPSH observation unit candidates (P = .093; Table 2). Segmented regression analysis did not find a statistically significant change on readmission rates from just before to just after implementation of the PPSH intervention (estimated change = −0.05; 95% CI, −0.18 to 0.08; P = .472) nor a significant change in the slope (rate of change in readmission rate; estimated change in slope after PPSH intervention = 0.005; 95% CI, −0.02 to 0.03; P = .623; Figure 3). No patients in either group experienced emergent postoperative intubation or other expected complications.

Table 2. Comparison of ICU and Observation Unit Patients and Candidates

	Pre-PPSH Observation Unit Candidates n = 79	PPSH Observation Unit Patients n = 86	*P* Value[a]	Pre-PPSH ICU Candidates n = 36	PPSH ICU Patients n = 34
Age (y)	2 (1–4)	2 (1–5)	.999	3 (1–9)	3 (2–6)
Payer mix			**.008**		
Public	20 (25%)	17 (20%)		10 (28%)	10 (29%)
Private	50 (63%)	51 (59%)		21 (58%)	21 (62%)
Mixed	5 (6%)	18 (21%)		5 (14%)	3 (9%)
Unavailable	4 (5%)	0 (0%)		0 (0%)	0 (0%)
ASA physical status			.209		
I	0 (0%)	0 (0%)		1 (3%)	0 (0%)
II	29 (37%)	30 (35%)		5 (14%)	10 (29%)
III	50 (63%)	52 (60%)		28 (78%)	22 (65%)
IV	0 (0%)	4 (5%)		2 (6%)	2 (6%)
Postoperative disposition			**<.001**		
ICU	70 (89%)	0 (0%)		34 (94%)	34 (100%)
Mandell	…	86 (100%)		…	0 (0%)
PACU	9 (11%)	…		2 (6%)	…
OR duration (h)	1.6 (1.4–1.7)	1.5 (1.3–1.7)	**.034**	1.6 (1.3–2.1)	1.6 (1.4–1.8)
LOS (d)	2.1 (1.9–2.1)	2 (1.1–2.1)	**.015**	2.1 (1.9–2.2)	2.1 (1.2–2.2)
Readmission	2 (2.5%)	4 (4.7%)	.683	3 (8.3%)	1 (2.9%)
First pain score	0 (0–2)	1 (0–5)	.093	0 (0–4)	3 (0–6)
Time to first pain score (min)	158 (30–292)	35 (23–60)	**<.001**	85 (23–215)	56 (27–91)
CCC count	2 (1–3)	2 (1–4)	.661	5 (3–6)	3 (1–4)
Congenital	15 (19%)	29 (34%)	**.036**	23 (64%)	14 (41%)
Cardiovascular	25 (32%)	20 (23%)	.294	23 (64%)	17 (50%)
GI	18 (23%)	32 (37%)	.062	28 (78%)	15 (44%)
Hematologic/immunologic	17 (22%)	17 (20%)	.848	11 (31%)	6 (18%)
Malignancy	4 (5%)	5 (6%)	.999	4 (11%)	2 (6%)
Metabolic	4 (5%)	4 (5%)	.999	9 (25%)	1 (3%)
Miscellaneous	1 (1%)	3 (3%)	.622	8 (22%)	4 (12%)
Neonatal	5 (6%)	2 (2%)	.261	7 (19%)	1 (3%)
Neuromuscular	14 (18%)	9 (10%)	.260	16 (44%)	6 (18%)
Renal	3 (4%)	8 (9%)	.215	3 (8%)	3 (9%)
Respiratory	79 (100%)	86 (100%)	…	36 (100%)	34 (100%)

Values are median (interquartile range) for continuous variables and frequency (%) for categorical variables.

P values are calculated using the Wilcoxon rank sum test for continuous variables and Fisher exact test for categorical variables. The *P* value for first pain score is adjusted for time to first pain score.

Any *P* value less than .05 is statistically significant, which is reflected in boldface.

Abbreviations: ASA, American Society of Anesthesiologists, CCC, complex chronic conditions; GI, gastroenterologic; ICU, intensive care unit; LOS, length of stay; OR, operating room; PACU, postanesthesia care unit; PPSH, Pediatric Perioperative Surgical Home.

[a]*P* values are comparing PPSH observation unit patients versus pre-PPSH observation unit candidates.

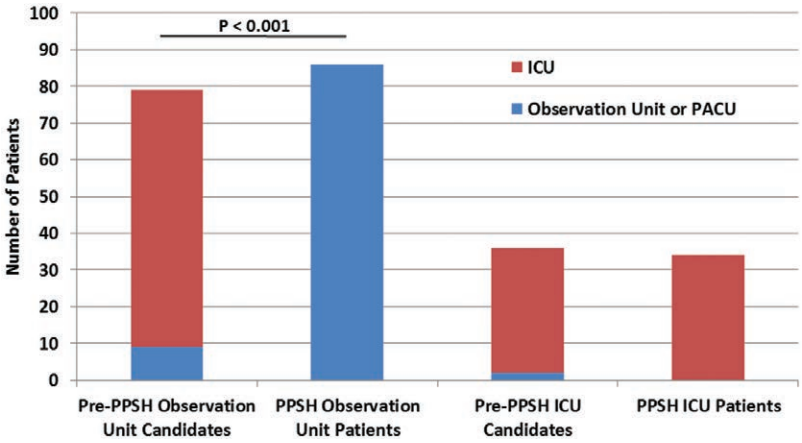

Figure 2. The number of patients with each postoperative disposition among the pre-PPSH observation unit candidates, PPSH observation unit patients, pre-PPSH ICU candidates, and PPSH ICU patients. The proportion of patients with a postoperative disposition of being sent to the ICU significantly dropped comparing pre-PPSH observation unit candidates and PPSH observation unit patients. ICU indicates intensive care unit; PACU, postanesthesia care unit; PPSH, Pediatric Perioperative Surgical Home.

Cost of Care Outcomes. Cost of care was calculated by hospital finance experts based on staff expenses, medical supplies and equipment, and operating room utilization using the Strata system (Strata Decision Technology, Chicago, IL). Total hospital costs were not lower for PPSH observation unit patients as compared to pre-PPSH observation unit candidates (difference = 8%; 95% CI, –7% to 23%). This cost reduction was due to a different level of skilled nursing care required in the observation unit cohort. Segmented regression analysis did not find a significant change in total costs associated with the PPSH intervention ($P = .321$).

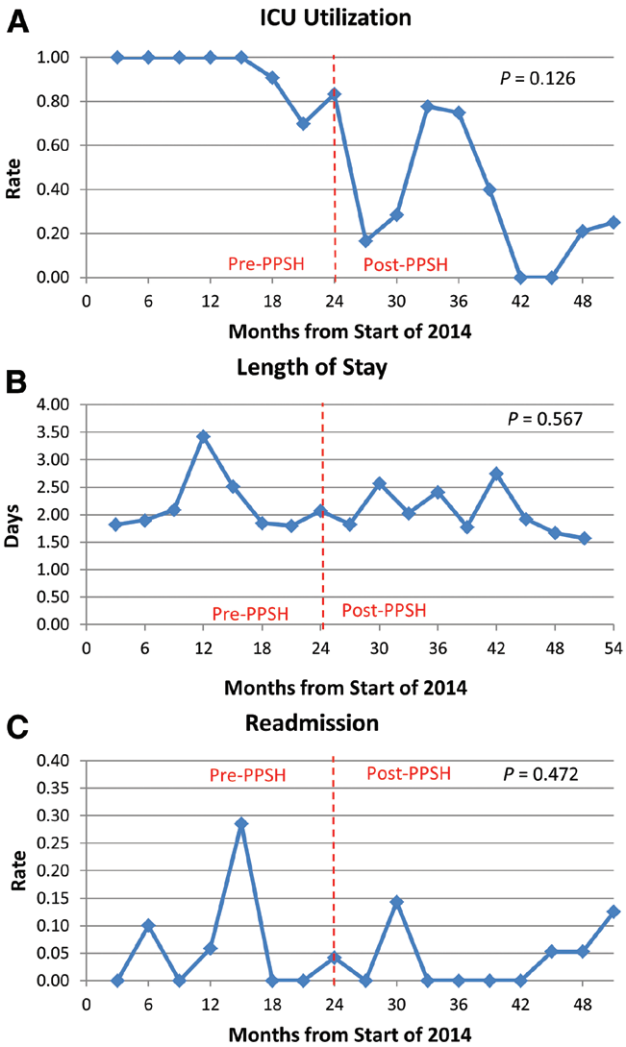

Figure 3. Postoperative outcome data are displayed in panels A, B, and C. Segmented regression analysis of (A) rates over time of ICU utilization. Test of change in average level from just before to just after implementation of the PPSH intervention (P = .126) and test of change in slope after PPSH (P = .956). B, Mean length of stay over time. Test of change in average level from just before to just after implementation of the PPSH intervention (P = .567) and test of change in slope after PPSH (P = .384). C, Readmission rates over time. Test of change in average level from just before to just after implementation of the PPSH intervention (P = .472) and test of change in slope after PPSH (P = .623). All red vertical dashed lines represent the PPSH intervention, and all P values displayed in the figure represent the test of the change in average level from just before to just after implementation of the PPSH intervention. ICU indicates intensive care unit; PPSH, Pediatric Perioperative Surgical Home.

DISCUSSION

This model demonstrates a novel PPSH directed approach to laryngeal cleft repair. By using the PPSH framework for process improvement, rates of ICU utilization decreased substantially without an increase in postoperative complications or rate of readmission, both important measures of patient safety. The reduction in ICU admission for laryngeal cleft patients resulted in a subsequent increase in the availability of beds for high-acuity medical and surgical patients, which is an important finding in the context of hospital capacity management. The availability of ICU capacity has been found to impact clinical decision-making when high-acuity patients are less likely to be admitted to the ICU when bed availability is low.[18,19] The lack of ICU resources may also increase the risk of overall patient mortality.[20,21] These associations between resource availability and patient course as described in the literature illustrate an area where the PPSH model, with its focus on perioperative standardization and risk stratification, can improve health outcomes. This PPSH study supports the hypothesis that increased investment in the preoperative period through careful triage based on patient comorbidities can result in decreased resource utilization without compromising patient safety, with a result of better value in health care as defined by quality, safety, and patient satisfaction with respect to cost.[22]

Health care in the United States has recently undergone a large number of changes that have transformed care from volume based to value based. The primary driver for this change has been the Center for Medicare & Medicaid Services, followed by commercial payers.[23,24] The movement away from "fee-for-service" reimbursement to flat-rate bundled payments is an attempt to encourage care coordination among health care providers, which consequently reduces the patient's risk of adverse outcomes.[25] Engaging perioperative physicians in the process of reducing health care costs while improving patient outcomes is a critical component of health care reform. Single bundled payments that include all costs of the entire surgical episode will require careful alignment of treatment that optimizes outcomes in the most economically efficient manner.[26] However, surgical bundled payments are not a solution to the problems of medical inefficiency but rather an encouragement to test and implement value-driven care models, such as the PSH.

The implementation of a pediatric PSH model requires input from a variety of stakeholders, both executive and clinical.[27] It is through these multiple approaches to patient care: clinical, operational, logistical, and analytical, that an institution can create a successful structure for more efficient patient care without compromising quality. Disrupting the standard clinical throughput for a specific patient population poses challenges. The PPSH framework, which has been described here, provides a discreet structure on which to implement evidence-based change.[28] The additional use of process mapping provides context for clinicians to understand their role in the team-based perioperative approach to the surgical episode of care for a specific patient population.[29] Clarification and understanding of the shared responsibilities that other providers have for a common patient population may decrease duplication of care efforts.

One challenge specific to the PPSH as compared to other integrated care models is that the pediatric surgical population is fundamentally different than the adult surgical population.[30,31] The translation of care integration initiatives from the adult to the pediatric population may seem intuitive, but pediatric patients frequently present with chronic conditions and comorbidities not seen in adults. As a result of these differences, the pediatric population requires a separate—but parallel—development of a PSH, including varied medical specialists, parents, and social workers.[32–34] Despite this challenge, the preliminary benefits of an integrative, standardized preoperative optimization program for complex patients have been substantial. Many institutions have

already reported positive outcomes with the implementation of PSH initiatives, 3 of which were applied to a pediatric surgical population.[3,4,6,7] Encouraged by these early successes, others have advocated for expanding their PSH programs to include more pediatric surgical populations.[30,31]

Our study should be considered in the context of its limitations. One limitation is the relatively small sample size due to the low prevalence of laryngeal cleft. The implementation of PPSH as the study design includes a preimplementation period and a postimplementation period. The most appropriate method for statistical analysis method for these data is a segmented regression time-series analysis. However, this method requires a large enough sample size to estimate outcomes at regular, evenly spaced intervals in both time periods. We are unable to precisely estimate the rate of ICU utilization, our primary outcome, during each time interval with our sample size. While we are unable to adequately perform segment regression and adjust for confounding, our approach of identifying pre-PPSH observation unit candidates reveals comparability between these patients and observation unit patients in the post-PPSH period. A second limitation of our study is the lack of a patient/family satisfaction metric. We attempted to use patient satisfaction survey scores from a commercially available tool, but the survey response rate was too low for conclusions to be drawn. Previous studies have shown that adult patients admitted to the ICU can have persistent psychological symptoms of stress postdischarge, and similar symptoms of stress can be found in the parents of pediatric ICU patients.[35–38] Therefore, one can hypothesize that higher patient and family satisfaction could be associated with reduced ICU admission rates. Further research is needed to determine the impact of bypassing the ICU through a PPSH initiative on patient and family psychosocial health.

Ultimately, the nuances of implementing an integrated care program are institution specific. There is no universal perioperative pathway that will decrease cost and improve quality at every institution; however, the pediatric PSH is a method for a comprehensive approach to pediatric surgical patients, which results in value added for discrete patient populations.

DISCLOSURES

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REFERENCES

1. Chow VW, Hepner DL, Bader AM. Electronic care coordination from the preoperative clinic. *Anesth Analg*. 2016;123:1458–1462.
2. Desebbe O, Lanz T, Kain Z, Cannesson M. The perioperative surgical home: an innovative, patient-centred and cost-effective perioperative care model. *Anaesth Crit Care Pain Med*. 2016;35:59–66.
3. Kash BA, Zhang Y, Cline KM, Menser T, Miller TR. The perioperative surgical home (PSH): a comprehensive review of US and non-US studies shows predominantly positive quality and cost outcomes. *Milbank Q*. 2014;92:796–821.
4. Kim E, Lee B, Cucchiaro G. Perioperative surgical home: evaluation of a new protocol focused on a multidisciplinary approach to manage children undergoing posterior spinal fusion operation. *Anesth Analg*. 2017;125:812–819.
5. Vetter TR, Barman J, Hunter JM Jr, Jones KA, Pittet JF. The effect of implementation of preoperative and postoperative care elements of a perioperative surgical home model on outcomes in patients undergoing hip arthroplasty or knee arthroplasty. *Anesth Analg*. 2017;124:1450–1458.
6. Thomson K, Pestieau SR, Patel JJ, et al. Perioperative surgical home in pediatric settings: preliminary results. *Anesth Analg*. 2016;123:1193–1200.
7. Raman VT, Tumin D, Uffman J, et al. Implementation of a perioperative surgical home protocol for pediatric patients presenting for adenoidectomy. *Int J Pediatr Otorhinolaryngol*. 2017;101:215–222.
8. Ferrari LR, Zurakowski D, Solari J, Rahbar R. Laryngeal cleft repair: the anesthetic perspective. *Paediatr Anaesth*. 2013;23:334–341.
9. Healthcare Cost and Utilization Project (HCUP). *HCUP National Inpatient Sample (NIS)*. Rockville, MD: Agency for Healthcare Research and Quality; 2014.
10. Delahunty JE, Cherry J. Congenital laryngeal cleft. *Ann Otol Rhinol Laryngol*. 1969;78:96–106.
11. Alexander NS, Liu JZ, Bhushan B, Holinger LD, Schroeder JW Jr. Postoperative observation of children after endoscopic type 1 posterior laryngeal cleft repair. *Otolaryngol Head Neck Surg*. 2015;152:153–158.
12. Johnston DR, Watters K, Ferrari LR, Rahbar R. Laryngeal cleft: evaluation and management. *Int J Pediatr Otorhinolaryngol*. 2014;78:905–911.
13. Leahy IC, Borczuk R, Ferrari LR. Making the pediatric perioperative surgical home come to life by leveraging existing health information technology. *Curr Opin Anaesthesiol*. 2017;30:383–389.
14. Londahl M, Irace AL, Kawai K, Dombrowski ND, Jennings R, Rahbar R. Prevalence of laryngeal cleft in pediatric patients with esophageal atresia. *JAMA Otolaryngol Head Neck Surg*. 2018;144:164–168.
15. Watters K, Ferrari L, Rahbar R. Minimally invasive approach to laryngeal cleft. *Laryngoscope*. 2013;123:264–268.
16. Quintal MC, Cunningham MJ, Ferrari LR. Tubeless spontaneous respiration technique for pediatric microlaryngeal surgery. *Arch Otolaryngol Head Neck Surg*. 1997;123:209–214.
17. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther*. 2002;27:299–309.
18. Stelfox HT, Hemmelgarn BR, Bagshaw SM, et al. Intensive care unit bed availability and outcomes for hospitalized patients with sudden clinical deterioration. *Arch Intern Med*. 2012;172:467–474.
19. Mery E, Kahn JM. Does space make waste? The influence of ICU bed capacity on admission decisions. *Crit Care*. 2013;17:315.
20. Wunsch H, Angus DC, Harrison DA, et al. Variation in critical care services across North America and Western Europe. *Crit Care Med*. 2008;36:2787–2793, e1–e9.
21. Sinuff T, Kahnamoui K, Cook DJ, Luce JM, Levy MM; Values Ethics and Rationing in Critical Care Task Force. Rationing critical care beds: a systematic review. *Crit Care Med*. 2004;32:1588–1597.
22. Vetter TR, Jones KA. Perioperative surgical home: perspective II. *Anesthesiol Clin*. 2015;33:771–784.

23. Becker GJ, Bosma JL, Burleson J, Borgstede JP. Introduction to value-based payment modifiers. *J Am Coll Radiol*. 2012;9:718–724.
24. Burwell SM. Setting value-based payment goals: HHS efforts to improve U.S. health care. *N Engl J Med*. 2015;372:897–899.
25. Delisle DR. Big things come in bundled packages: implications of bundled payment systems in health care reimbursement reform. *Am J Med Qual*. 2013;28:339–344.
26. Porter ME. A strategy for health care reform: toward a value-based system. *N Engl J Med*. 2009;361:109–112.
27. Vetter TR, Ivankova NV, Goeddel LA, McGwin G Jr, Pittet JF; UAB Perioperative Surgical Home Group. An analysis of methodologies that can be used to validate if a perioperative surgical home improves the patient-centeredness, evidence-based practice, quality, safety, and value of patient care. *Anesthesiology*. 2013;119:1261–1274.
28. Ferrari LR, Antonelli RC, Bader A. Beyond the preoperative clinic: considerations for pediatric care redesign aligning the patient/family-centered medical home and the perioperative surgical home. *Anesth Analg*. 2015;120:1167–1170.
29. Tagge EP, Thirumoorthi AS, Lenart J, Garberoglio C, Mitchell KW. Improving operating room efficiency in academic children's hospital using Lean Six Sigma methodology. *J Pediatr Surg*. 2017;52:1040–1044.
30. Vetter TR. The pediatric perioperative surgical home: children and adolescents should not have to wait again for their turn. *Anesth Analg*. 2015;120:974–977.
31. Ferrari LR, Antonelli RC, Bader A. The pediatric perioperative surgical home. *Anesth Analg*. 2016;122:295–296.
32. Berry JG, Ash AS, Cohen E, Hasan F, Feudtner C, Hall M. Contributions of children with multiple chronic conditions to pediatric hospitalizations in the United States: a retrospective cohort analysis. *Hosp Pediatr*. 2017;7:365–372.
33. Glassgow AE, Martin MA, Caskey R, et al. An innovative health-care delivery model for children with medical complexity. *J Child Health Care*. 2017;21:263–272.
34. Judson L. Global childhood chronic illness. *Nurs Adm Q*. 2004;28:60–66.
35. Scragg P, Jones A, Fauvel N. Psychological problems following ICU treatment. *Anaesthesia*. 2001;56:9–14.
36. Noyes EM, Schlesinger JJ. ICU-related PTSD: a review of PTSD and the potential effects of collaborative songwriting therapy. *J Crit Care*. 2017;42:78–84.
37. Pochard F, Azoulay E, Chevret S, et al; French FAMIREA Group. Symptoms of anxiety and depression in family members of intensive care unit patients: ethical hypothesis regarding decision-making capacity. *Crit Care Med*. 2001;29:1893–1897.
38. Long AC, Kross EK, Davydow DS, Curtis JR. Posttraumatic stress disorder among survivors of critical illness: creation of a conceptual model addressing identification, prevention, and management. *Intensive Care Med*. 2014;40:820–829.