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Implementation of a perioperative surgical home protocol for pediatric patients presenting for adenoidectomy



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ABSTRACT

Introduction: The perioperative surgical home (PSH) is a patient-centered model designed to improve health, streamline the delivery of health care, and reduce the cost of care. Following the national introduction of PSH in 2014 by the ASA, adult hospitals have reported success with this model, with studies validating the benefits of PSH including reducing length of stay, lowering costs, and improving patient satisfaction.

Methods: Eligible patients, ranging in age from 16–35 months of age, were identified by the pre-admission testing (PAT) registered nurses (RNs) and faculty anesthesiologists upon review of the patient history. Participation in Pediatric PSH (PPSH) was introduced to the families by the pediatric otolaryngologists. Either the patient's family or physician team could elect to decline participation in the PPSH model. On the day of surgery, the PPSH protocol included a paper checklist to ensure that all patients met eligibility standards. A standardized order-set was implemented in the electronic medical record (EMR) for pre-operative and post-operative nursing instructions and eligible medications. Patients received at least 3 hours of postoperative monitoring prior to discharge home to address post-operative issues. Prior to discharge, caregivers watched a standard teaching video, available on YouTube, which was developed in conjunction with the hospital educational and technical support staff. An attending anesthesiologist made a postoperative followup phone call on the evening of surgery to ensure no untoward events were experienced by the patient as well as elicit caregiver feedback concerning the discharge process. The protocol was discontinued if at any time family members, physicians, or nurses were uncomfortable with completing the protocol or felt that the patient did not meet discharge criteria.

Results: One hundred sixty-six patients were evaluated for PPSH inclusion. Forty patients were excluded (23 did not meet inclusion criteria, 5 had viral upper respiratory infections, and 10 for other non specified reasons such as tonsillectomy added, sibling with surgery, and incorrect documentation). Therefore, a total of 126 were eligible for PPSH (male/female = 69/57; age 22 ± 4 months). The comparison group included 1,029 children (male/female = 645/384; age 22 ± 7 months of age) undergoing adenoidectomy who were not evaluated for PPSH inclusion. Of the 126 PPSH participants included in the analysis, 27 were excluded at some point during the pathway. Nine cases experienced oxygen desaturation, laryngospasm, or required supplemental oxygen. Noncompliance with the protocol was noted in 5 cases, parental concerns were noted in 17 cases, and there were concerns from the pediatric anesthesiologist or otolaryngologist in 5 cases. In the comparison group, hospital length of stay was significantly longer than in the PSH group ($p < 0.001$), with 524 (51%) patients discharged on the day of service compared to 99 (79%) in the PSH group. No major morbidity or mortality occurred. There was no difference between the two groups in return to the emergency department (ED) visits within 30 days (PSH: 7/126, 6%; control: 59/1,029, 6%; $p = 0.935$). Within 14 days of the procedure, 4 PPSH patients visited urgent care or a primary care physician; 4 visited the ED; and 1 was readmitted to the hospital. Twenty families contacted the otorhinolaryngology triage phone line primarily related to pain and fever.

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Conclusion: We present our experience and success in developing a PPSH for patients, ranging in age from 16 to 35 months of age, undergoing adenoidectomy either alone or with tympanostomy tube insertion by protocolizing care, collaborating among care providers, and educating families. With this process in place, a significant percentage of these patients who were previously admitted were discharged home the same day of surgery.

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1. Introduction

The perioperative surgical home (PSH) is a patient-centered model designed to improve healthcare, streamline its delivery, and reduce the overall cost. Following the national introduction of PSH in 2014 by the American Society of Anesthesiologists (ASA), adult hospitals found success with this model, with studies validating the benefits of PSH including reducing length of stay, lowering cost, and improving patient satisfaction [1,2]. In adult patients undergoing hip surgery at the University of California-Irvine, the implementation of PSH achieved costs and length of stay that were below national benchmark averages [3]. Despite this and other success in the adult surgical population, there are limited data on the successful implementation of a pediatric perioperative surgical home (PPSH). The PPSH model was successfully applied to pediatric patients undergoing spine surgery, leading to decreased length of stay [4]. The PPSH is a novel concept in the realm of pediatrics with limited data on established PPSH programs. Most of the literature is conceptual and discusses only potential applications of establishing PPSH [5–7] (see Figs. 1–3)

The creation of PPSH poses unique challenges with differences from the adult model. Ten percent of children with chronic illness represent 50% of total national expenses on children's medical care [8]. Yet, the rates of re-admission are significantly lower in children versus adults (6.3% versus 19.6%), meaning that the choice of quality metrics in pediatric surgery may be different from outcomes established in adult settings [8,9]. Choosing the surgical specialty in which to develop an integrated pathway is challenging, especially with limited information available on established pediatric models. However, the application of PPSH may be especially timely for surgical procedures that are major drivers of pediatric surgery costs. In recent analysis of the Pediatric Health Information System (PHIS), the procedures accounting for the highest share of total costs of pediatric surgery were bone marrow transplantation, craniotomy, spinal fusion, tonsillectomy and adenoidectomy, and congenital heart surgery [8].

We report our experience with implementing and developing a PPSH model at Nationwide Children's Hospital (NCH) for adenoidectomy in children with sleep disordered breathing (SDB) and/or clinical symptoms of OSA (obstructive sleep apnea). We chose an outpatient PPSH model that could be applied to a variety of settings in ambulatory, community, and academic centers. The uniqueness of our project was encompassing the entire perioperative domain starting in the surgeon's office and ending after patient's arrival home. The otolaryngologist was a pivotal player in helping design and execute the process. The benefits of participating to the otolaryngologist specifically was in having standardized patient education leading to earlier discharge home and possibly avoiding an inpatient admission. However, admittedly the process was designed so that the patient would benefit the most in terms of safety and cost. In addition, the decision to focus on adenoidectomy patients was based on the strong collaborative relationship that existed between the pediatric anesthesiology and pediatric otolaryngology departments. In evaluating the success of our PPSH

model, our primary aim was to determine length of stay (LOS) and the ability to result in a same day discharge after this procedure. Secondary aims included evaluating parental satisfaction and comfort with being discharged home.

2. Methods

NCH is a 431-bed, free-standing children's hospital in Columbus, Ohio, and was enrolled in the first PSH collaborative of the ASA to help disseminate the concepts of PSH. The NCH IRB waived review of this quality improvement project, undertaken using a rapid-cycle improvement model (Plan-Do-Study-Act). After identifying physician champions in anesthesiology and otolaryngology, a process map was developed for this project. The process map identified key steps and personnel involved for successful scheduled for adenoidectomy in the main operating room (OR) each year. In 2014, PPSH was implemented for children undergoing adenoidectomy, with or without tympanostomy tube insertion or another non-invasive procedure such as auditory brainstem evoked response monitoring. These patients were determined by a surgeon to require extended postoperative monitoring due to the presence of clinical signs and symptoms of sleep disordered breathing.

Screening for eligible patients started with identification of those patients who were 18–24 months of age and scheduled for adenoidectomy alone or with tympanostomy tube placement or an additional non-invasive procedure (MR imaging, auditory brainstem evoked response monitoring) was accomplished by a flag in the electronic medical record (EMR). Additional eligible patients, 16–18 and 25–35 months of age, were identified by the pre-admission testing (PAT) registered nurses (RNs) and pediatric anesthesiologists upon review of the patients' history and medical record during the preoperative screening phase. Participation in PPSH was introduced to the families by the pediatric otolaryngologists, who discussed the possibility of early discharge home during their clinic visit when the surgery was scheduled. Either the patient's family or the physician team could elect to decline participation in the PPSH model. Families using translator services were excluded due to the unavailability of instruction videos in languages other than English and lack of translator services available to support phone follow-up (see below). Patients initially considered for PPSH enrollment were excluded from the evaluation if they were ineligible, if they required overnight admission due to an upper respiratory infection, a sibling was having surgery that required admission, or they were scheduled to undergo tonsillectomy and adenoidectomy. None of the eligible patients for PPSH were included in the comparison group for analysis.

On the day of surgery, the PPSH protocol included a paper checklist to ensure that all patients met eligibility standards. Otolaryngologists utilized suction bovie (electrocautery) or coblation during the procedure. A standardized order-set was implemented in the EMR for pre-operative and post-operative nursing instructions and monitoring prior to discharge home to address postoperative issues and concerns. Prior to discharge, the primary caregiver watched a standard teaching video, available on YouTube

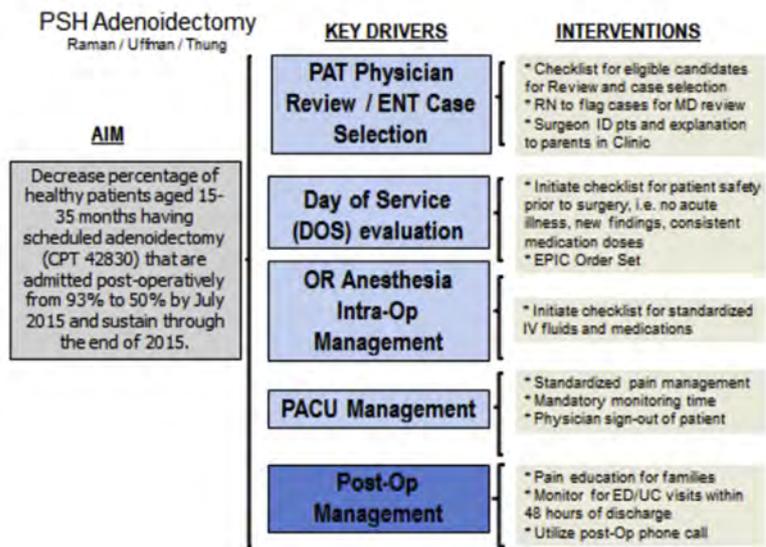
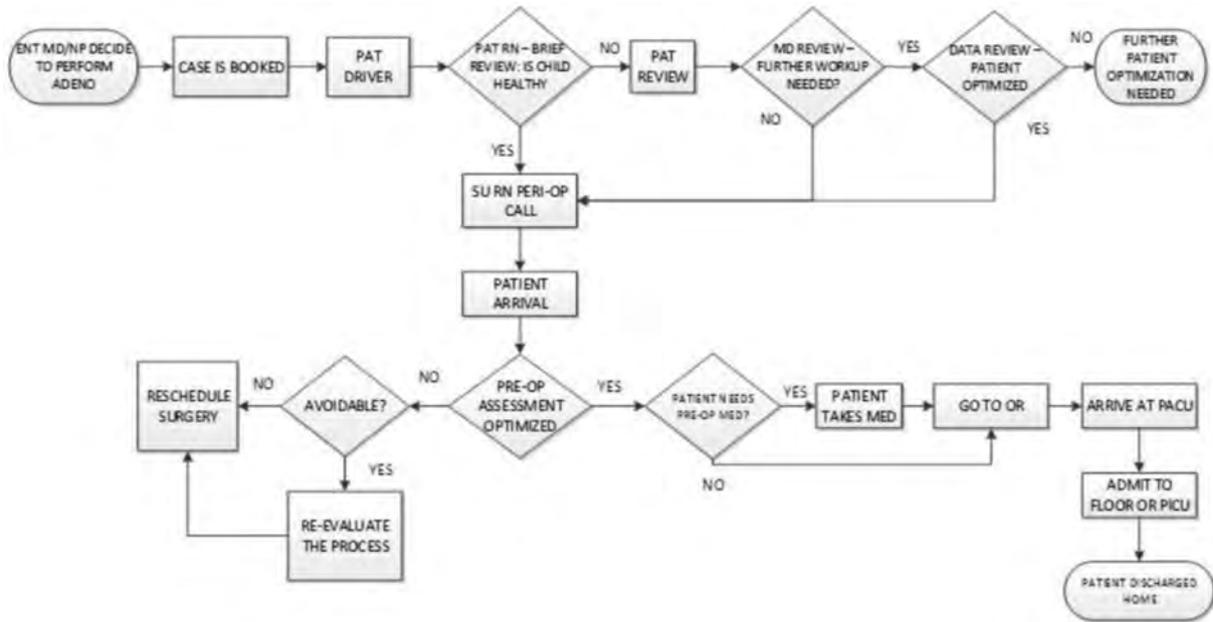


Fig. 1. The process map (above) and key-driver diagram (below) used for the development of our pediatric perioperative surgical program for patients following adenoideotomy.

at <https://youtu.be/u3W3yYigSa0>. This video was developed which was developed in conjunction with the hospital educational and technical support staff. An attending pediatric anesthesiologist made a postoperative follow-up phone call the evening of surgery to ensure no untoward events were experienced by the patient and to elicit caregiver feedback concerning the discharge process. The protocol was discontinued if at any time family members, physicians, or nurses were uncomfortable with completing the protocol during to patient or family concerns or if the patient did not meet discharge criteria. Patients were gradually enrolled from November 2014 to November 2016. Over this period, patient enrollment expanded to include all pediatric anesthesiologists and otolaryngologists at our institution.

The primary outcome was the length of hospital stay in days, classified as outpatient (discharged same day), overnight (discharged next day), or extended (discharged on postoperative day

[POD] ≥ 2). Post-anesthesia care unit (PACU) length of stay, use of opioids in the PACU, and emergency department (ED) revisits within 30 days were secondary outcomes. These study outcomes were compared to a cohort of patients, ranging in age from 15 to 36 months, undergoing adenoideotomy with or without other procedures (e.g. tympanostomy tubes or non-invasive procedures such as ABER monitoring or MRI) from November 2015 through November 2016.

Continuous data were summarized as means with standard deviations, and compared using unpaired t-tests. Ordinal data were summarized as medians with interquartile ranges. Categorical data were summarized as counts with percentages, and compared using Chi-square tests or Fisher's exact tests for rare events (cell size <5). Parental satisfaction, cost savings, and need for hospital readmission were also described for the PPSH cohort. Data analysis was performed in Stata/IC 13.1 (College Station, TX: StataCorp LP) and

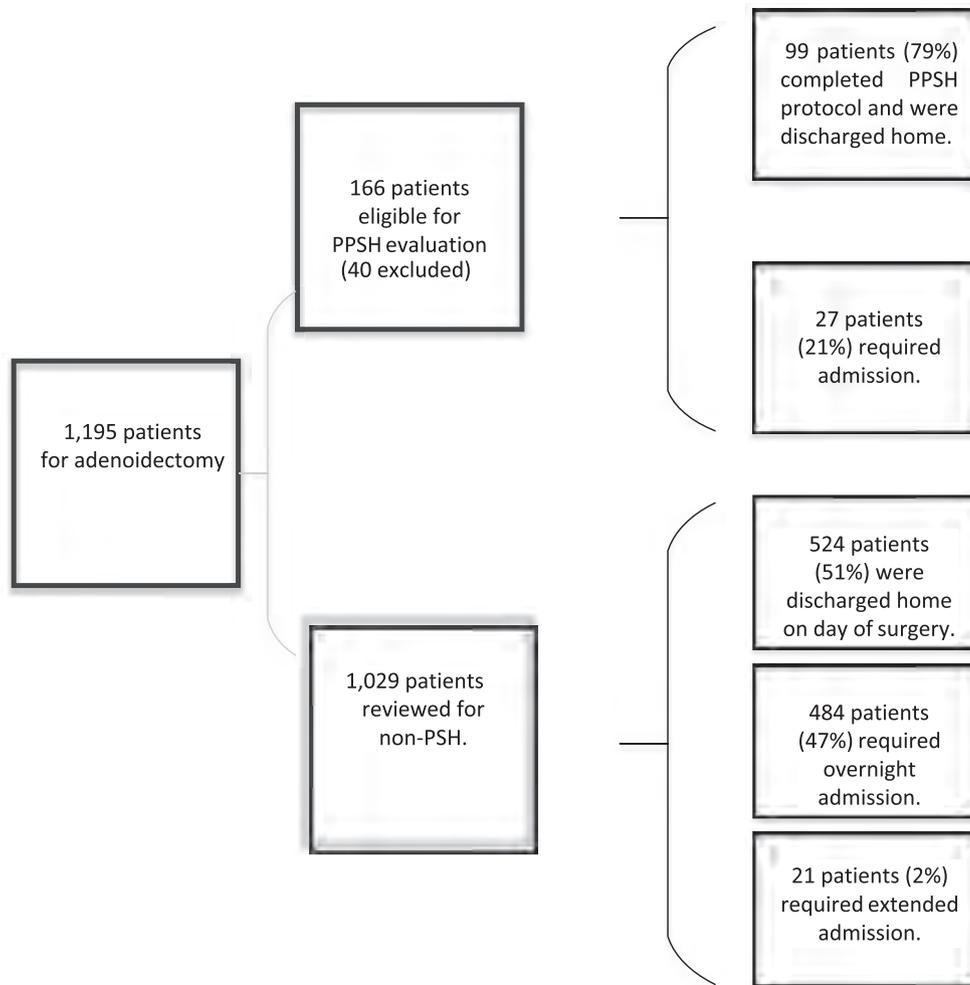


Fig. 2. Diagram demonstrating pathway and outcomes of patients evaluated for the pediatric perioperative surgical program (PPSH) for patients following adenoidectomy as well as the outcomes of patients during the same time period who were not evaluated for PPSH.

$P < 0.05$ was considered statistically significant (see [Table 1](#)).

3. Results

One hundred sixty-six patients were evaluated for PPSH inclusion, of whom 126 were eligible for PPSH and included in the present analysis (69/57 male/female; age 22 ± 4 months of age). Exclusions of 38 patients included 23 that did not meet inclusion criteria, 5 with viral upper respiratory infections, and 10 for non-specified reason such as tonsillectomy added, sibling with surgery, and incorrect documentation. The comparison group included 1029 children (645/384 male/female; age 22 ± 7 months of age) undergoing adenoidectomy who were not evaluated for PPSH inclusion. The demographic characteristics and clinical outcomes of the PPSH and comparison groups are compared in [Table 2](#). Of the 126 PPSH participants included in the analysis, 9 cases experienced oxygen desaturation, laryngospasm, or required supplemental oxygen. Non-compliance with the protocol was noted in 5 cases; parental concerns were noted in 17 cases, and pediatric anesthesiologist or otolaryngologist concerns were noted in 5 cases. Thereby only 99 patients completed the PPSH protocol. All children in both the PPSH and the non-PPSH groups were admitted to the post-anesthesia care unit (PACU) after the operating and then to the inpatient ward after a standard PACU stay.

In the comparison group (non-PPSH patients), hospital length of stay was significantly longer ($p < 0.001$), with 524 (51%) patients discharged on the day of service, 484 (47%) requiring overnight admission, and 21 (2%) requiring extended admission. In the PPSH group, 99 (79%) of the patients were discharged on the same day and 27 (21%) were admitted overnight, but none required extended admission of more than 1 day. Length of stay in the PACU was longer in the PPSH patients (average of 85 versus 65 min, $P < 0.00$) and more patients in the PPSH required opioid analgesia in the PACU than the control group (49/126, 39% vs. 171/1,029, 17%, $p < 0.001$).

No cases of major morbidity or mortality were observed in either group. There was no difference between the two groups in ED visits within 30 days (PSH: 7/126, 6%; control: 59/1,029, 6%; $p = 0.935$). Within 14 days of the procedure, 4 PPSH patients visited urgent care or a primary care physician; 4 visited the ED; and 1 was readmitted to the hospital. Twenty families contacted the otorhinolaryngology triage phone line within 14 days of surgery. Reasons for phone calls and acute care revisits were primarily related to pain and fever. Data on parental satisfaction were collected via a standard questionnaire from 124 of 126 families in the PPSH group ([Table 3](#)). The majority of families reported being comfortable with being discharged home (59%) and that their child was comfortable at the time of follow-up (56%). Fifty-two percent of families

Pt Name _____
DOS _____
DOB ____/____?
MRN# _____

Adenoidectomy Script

- 1) Is your child comfortable? Y or N; if no, explain _____
- 2) Has your child a) been drinking? Y or N ;How much? ____ ounces/hr
b) wet diapers/gone to bathroom? ____times/day
c) bleeding?
d) vomiting? Mild moderate severe
- 3) Was the video that you watched helpful? Y or N? Scale 1 2 3 4 5 (5 being most helpful)
- 4) Did you have to give pain medication? Y or N ? How manydoses? ____
- 5) How did you feel being discharged home? Scale 1 2 3 4 5 (5 being most comfortable).
- 6) Would you have rather stayed in the house(hospital)? Y or N
- 7) Any other concerns or questions?
- 8) Do you know what numbers to call if you have a problem?
Rn line **614 722 6547** (m-f 8:30am-4:30pm)
Else call NCH Hospital **614 722-2000**(ask for ENT MD to be paged)
If emergency, call 911 and proceed to nearest emergency room.

Fig. 3. Data collection form.

reported that the standardized instruction video was helpful.

4. Discussion

Fragmented fee-for-service healthcare in United States has made it one of the most expensive healthcare systems in the world. The core values of PPSH are collaboration, integration, parental satisfaction, and cost control which are in accordance with the IHI Triple Aim framework consisting of improving the experience of

care, improving the health of populations, and reducing per capita costs of health care. In an attempt to improve care while providing cost savings for the health care system, a PPSH pathway was developed at our institution for children having a common surgical procedure, adenoidectomy. We have summarized our preliminary experience in designing and implementing this outpatient PPSH program. This pathway resulted in a decrease of the need for overnight stay after adenoidectomy from 49% to 21%. Additionally, the implementation of the PPSH pathway, eliminated the need for an extended hospital admission (2 or more nights in the hospital) when compared to 2% of the non-PPSH group. Despite the overall shorter length of stay in the PPSH group with approximately half of the patients discharged home the day of surgery, there was no difference in the number of postoperative phone calls, 30 day ED re-visits, and the need for readmission to the hospital in these patients thereby providing preliminary data to show that this PPSH pathway was able to attain earlier discharge without compromising safety and quality.

Although the argument can be made that 30 day re-admission is not a truly pertinent metric in pediatric health care, we believe that these data support the overall safety of this pathway. This potential limitation of our study as highlights the lack of pertinent metrics to guide the implementation of such programs in the pediatric

Table 1

Standardized perioperative care for PPSH patients.

Preoperative care:
Double-check to ensure that patient meets PPSH criteria
Premedication with oral midazolam
Intraoperative care:
Inhalation induction with sevoflurane in nitrous oxide/oxygen
Placement of peripheral IV and fluid loading with 20 mL/kg
Maintenance anesthesia with isoflurane in oxygen/air
Analgesia with fentanyl or morphine
Postoperative care:
Primary care giver watches instructional video
Postoperative phone call the day of surgery by pediatric anesthesiologist

Table 2
Demographic and clinical characteristics of PPSH and comparison group.

Variable	PPSH (N = 126)	Comparison group (N = 1029)	P value
	Mean (SD) or N (%)	Mean (SD) or N (%)	
Age (m)	22 (4)	22 (7)	0.56
Male gender	69 (55%)	645 (63%)	0.08
BMI (kg/m ²) ^a	17 (2)	17 (2)	0.11
ASA status ^b			
1	32 (25%)	200 (20%)	<0.01
2	92 (73%)	720 (71%)	<0.01
3–4	2 (2%)	99 (10%)	<0.01
PACU LOS (minutes) ^c	85 (27)	65 (33)	<0.01
PACU opioid analgesia	49 (39%)	171 (17%)	<0.01
Hospital length of stay			
Outpatient (<24 h)	99 (79%)	524 (51%)	<0.01
Overnight admission (24–48 h)	27 (21%)	484 (47%)	<0.01
Prolonged admission (>48 h)	0	21 (2%)	<0.01
ED revisit within 30 days	7 (6%)	59 (6%)	0.94

ASA = American Society of Anesthesiologists; BMI = body mass index; ED = emergency department; PACU = post-anesthesia care unit; PPSH = pediatric perioperative surgical home; SD = standard deviation.

^a Data missing in 6 PPSH and 11 comparison group cases.

^b Data missing in 10 comparison group cases.

^c Data missing in 5 comparison group cases.

surgical population [10]. It would be worthwhile to develop such metrics as a benchmark against which to test the value of these programs. Metrics in pediatrics not only lag behind adult patients, but more importantly, adult metrics may not be applicable to the pediatric population. Despite this, as pediatric healthcare providers working in a free standing children's hospital, we are challenged to find ways to provide safe, effective, and high-quality care while limiting costs. These processes result in what has been termed, value-based healthcare or keeping costs low while providing or maintaining the desired outcomes [11].

Postoperative hospitalization is based on the medical needs of the patient including pain control, ongoing medical management, and the need for monitoring for adverse events. The ability of families to successfully navigate these issues on an outpatient basis contributes to the overall success of discharging the patient. Among families invited to participate in our PPSH after meeting inclusion criteria, 13% of parents declined due to concerns of being discharged home on the same day of surgery. This finding highlights the potential social and parental factors which can influence patient care and health care costs. Although there was no explicit description as to why families refused participation in the PPSH, cited reasons for refusal varied from a lack of transportation resources should the child have any postoperative issue to concerns of how the child would react to general anesthesia following first exposure despite an uncomplicated surgical course. While there are many articles describing parental expectations and clinician prescribing behavior, few highlight the need for overnight

admission due to parental concerns or socio-economic factors [12–14].

More importantly, although 59% of those discharged home were comfortable with the process, a significant proportion (41%) expressed ongoing concerns of same-day discharge which paralleled the concerns which compelled families to decline participation in the PPSH pathway in the first place. Another key factor in same day discharge is the assurance of safe and effective post-operative pain control. In our preliminary experience, although 56% noted that their children were comfortable, this still leaves a significant percentage (44%) with concerns of postoperative pain management. The latter may be particularly relevant in this patient population with sleep disordered breathing or even undiagnosed obstructive sleep apnea with increased sensitivity to the respiratory depressant effects of opioids, in whom the home use of opioid-analgesics is discouraged [15]. The PPSH intraoperative anesthetic protocol that we developed, specifically limited the intraoperative dose of opioids (fentanyl 2 µg/kg or morphine 50 µg/kg) to mitigate such concerns. However, the trade-off to such care is that more patients may require supplemental analgesia in the PACU which may partly explain the prolonged PACU stay that we noted as most PACUs have protocols in place that require a fixed period of monitoring when supplemental opioid analgesia is administered. Our current protocol for patients with documented or suspected OSA or sleep disordered breathing includes ongoing continuous monitoring during inpatient admission. These concerns also mandated a prolonged period of monitoring on the inpatient ward (at least 3 h). Following discharged, home analgesia included only non-steroidal anti-inflammatory agents and acetaminophen without the use of oral opioids. The use of opioids in the non-PPSH group was standardized and hence not restricted as these patients following our previously reported pathway for inpatient monitoring [16]. This illustrates the need to balance effective analgesia with the need for same-day hospital discharge as well as the need for future studies identifying the most effective analgesic regimens with a focus on non-opioid techniques for such procedures.

Justifying the effort and costs associated with implementing a PPSH may remain a struggle in many institutions. The current PPSH process took significant coordination, education, and re-education of clinicians and perioperative services to achieve success and understanding. Furthermore, funding was required for the

Table 3
Parental satisfaction reported by families of children in PPSH cohort.

Question	Cases missing data	N (%) or median (IQR)
Child is comfortable? ^a	0	69 (56%)
Complications (bleeding, vomiting)? ^a	0	2 (2%)
Was the video that you watched helpful? ^a	0	65 (52%)
How helpful was the video (1–5 scale)? ^b	59	5 (4, 5)
Did you have to give pain medication? ^a	0	47 (38%)
Comfortable with being discharged home? ^a	0	73 (59%)

IQR: interquartile range; PPSH = pediatric perioperative surgical home.

^a Yes or no response; percent shown for yes responses.

^b 1–5 Likert scale from least to most; median and IQR shown for numeric response. Responses shown for families who stated the video was helpful.

development of the video used for postoperative education. Utilizing the QI methodology from the National Institute of Health of PDSA (plan-do-study-act), we implemented this PPSH with ongoing revisions and changes following each cycle. With spiraling costs of health care in the United States, there needs to be an internal re-evaluation at individual institutions. Per patient, the hospital charge is approximately \$3000 for postoperative admission. As we move to bundled payments, as we have in Ohio, it is imperative we control these charges. Furthermore understanding the complex cost structure is more important than actual patient charges in order to actually control healthcare costs.

Given the many economic restrictions and concerns, cost data are difficult to compute. Charges also are complex due to multi-payer payment models. We estimate that we have saved the family approximately 30% in hospital charges by discharging them home albeit after a slightly longer PACU stay. A standardized perioperative medication regimen also decreased pharmacy charges to the family excluding more expensive intravenous medications such as dexmedetomidine and intravenous acetaminophen. Although these medications may have a role in the perioperative care of such patients, there remains limited evidence based-medicine to demonstrate their cost effectiveness. Another cost-savings in the ability to achieve same day discharge is a potential decrease in the parental need to miss days of work. Overnight admission frequently requires parents to take a second day off of work in addition to the day of surgery. Despite the successes demonstrated, these patients would have failed in a strict ambulatory surgery setting since 21% of the PPSH cohort required overnight inpatient admission. Additionally, all of the patients required at least 3 h of postoperative monitoring which is not feasible in the outpatient setting. In this preliminary trial, we could not predict which patients would require admission due to lack of objective pre-operative data to identify the degree of sleep disordered breathing or obstructive sleep apnea. Specifically, most of these children did not have sleep studies prior to undergoing adenoidectomy. Future trials with the developed of clinical scoring systems to identify such co-morbid conditions may be relevant in risk-stratifying this population [17].

Limitations of the study include a lack of standardization in the treatment received in the non-PPSH group including the intra-operative anesthetic regimen. However, we would suggest that the regimens used in the non-PPSH group parallel those used throughout operating rooms in the United States. Furthermore, eligibility criteria for PPSH may have skewed this group towards having fewer co-morbid conditions. While this may have potentially biased comparisons of PPSH and non-PPSH groups, it is clear that appropriate patient selection is important for PPSH implementation. This was addressed in our protocol with a standardized checklist used on the day of surgery. As the impact of recent or frequent upper respiratory illnesses in children undergoing a general anesthetic can be difficult to predict, these patients were eliminated on the day of surgery from consideration for PPSH. They were considered non-candidates for PPSH and included with other patients who were admitted for extended monitoring.

With these caveats in mind, we believe that the development of PPSH may significantly improve the perioperative care of pediatric patients following several different surgical procedures. In the current cohort, we found that same day hospital discharge was feasible following adenoidectomy. To ensure patient safety, the entire process took almost 2 years to implement. This was due not only to the development of the pathway and order sets, but the need to ensure cooperation by physicians in both anesthesiology and otolaryngology, perioperative services, and information technology services. Ongoing education of the entire perioperative team may be frequently required due to changes in staffing and or

adjustments in the protocol based on ongoing PDSA cycles.

In conclusion, we present our experience and success in developing a PPSH for patients 16–35 months of age, undergoing adenoidectomy either alone or with tympanostomy tube insertion or a non-invasive procedure (i.e. ABR, MRI, or other radiology diagnostic procedures) by protocolizing care, collaborating among care providers, and educating families. Most importantly, there was follow-up of each patient that was discharged by an evening phone call. Although, the information provided by such phone calls may be limited, we believe that this personal follow-up helped us to obtain useful information as to how families felt regarding the instructional video and whether they felt comfortable with discharge. It also provided another opportunity to support families and allay their concerns. Early identification of candidates and consistent education of the entire care team is critical. Further study is needed to continue to improve our perioperative process while not impacting safety, outcomes, and parental satisfaction.

Conflict of interest statement(s), disclosure(s), and/or financial support information

There was no conflict of interest and no external financial support for this project.

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