

Value Added from Same-day Discharge after Appendectomy for Children with Simple Appendicitis

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Abstract

Introduction: Same-day discharge of children after appendectomy for simple appendicitis is safe and associated with enhanced parent satisfaction. Our general pediatric surgeons aimed to improve the rate of same-day discharge after appendectomy for simple appendicitis. **Methods:** We implemented a clinical practice guideline in September 2019. A surgeon-of-the-week service model and the urgent operating room started in November 2019 and January 2020, respectively. Data for children with simple appendicitis from our academic medical center were gathered prospectively using National Surgical Quality Improvement Program-Pediatric. Patient outcomes before intervention implementation (n = 278) were compared with patients following implementation (n = 264). **Results:** The average monthly percentage of patients discharged on the day of surgery increased in the postimplementation group (32% versus 75%). Median postoperative length of stay decreased [16.5 hours (interquartile range, 15.9) versus 4.4 hours (interquartile range, 11.7), $P < 0.001$], and the proportion of patients discharged directly from the postoperative anesthesia care unit increased (22.8% versus 43.6%; $P < 0.001$). There were no differences in balancing measures, including the return to the emergency department and readmission. Fewer children were discharged home on oral antibiotics after implementation (6.8% versus 1.5%, $P = 0.002$), and opioid prescribing at discharge remained low (2.5% versus 1.1%, $P = 0.385$). **Conclusions:** Using quality improvement methodology and care standardization, we significantly improved the rate of same-day discharge after appendectomy for simple appendicitis without impacting emergency department visits or readmissions. As a result, our health care system saved 140 hospital days over the first 21 months. (*Pediatr Qual Saf* 2023;8:e629; doi: 10.1097/pq9.0000000000000629; Published online January 16, 2023.)

INTRODUCTION

Appendicitis is the most common general surgical condition affecting children. Simple or uncomplicated

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appendicitis is defined based on a recent consensus definition as appendicitis without visible perforation, diffuse fibrinopurulent exudate, fecalith found outside the appendix, or intraabdominal abscess.¹ From a resource utilization perspective, uncomplicated appendicitis has been identified as an important target for value-based care—not only due to the total cost burden related to its prevalence but also due to its wide cost variation among hospitals.² Simple appendicitis accounts for the greatest cost variation and resource utilization among all common pediatric surgery conditions, even more than complicated appendicitis.²

Clinical practice guidelines (CPGs) for appendicitis in children improve outcomes, reduce care disparities, and decrease resource utilization after surgery.^{3–5} Furthermore, robust evidence demonstrates that discharging patients on the same day as appendectomy for simple appendicitis is safe and effective.^{5–9} Same-day discharge after appendectomy is also associated with high parent satisfaction, especially when expectations are communicated before surgery.^{6,10}



Our team designed a quality improvement project to improve same-day discharge after appendectomy for simple appendicitis. The team hypothesized that a standardized CPG would improve quality and value for our patients and the healthcare system. This report outlines the design and use of a clinical pathway to facilitate same-day discharge, uniting stakeholders to achieve a common goal via a shared mental model.

METHODS

Quality Improvement Methodology

A multidisciplinary, interprofessional team (composed of pediatric surgeons, a general surgery resident, advanced practice providers, an infectious disease specialist, and a quality improvement specialist) was formed to improve same-day discharge after appendectomy for simple

appendicitis at our institution. Key drivers of same-day discharge and change ideas were identified (Fig. 1). We used this information to create a CPG (Fig. 2) and used plan-do-study-act cycles to test proposed changes.

The team implemented the CPG in late September 2019. Before this effort, discharge criteria varied by the surgeon. These criteria typically consisted of the patient tolerating oral intake and managing the child’s pain with nonopioid oral analgesics. There was no specific length of stay targets. The CPG standardized postoperative care, discharge readiness, and postoperative pain management for pediatric patients with simple appendicitis undergoing appendectomy (Fig. 2). Children were not prescribed antibiotics postoperatively. Pain was managed with scheduled nonopioid analgesics for 72 hours and as needed after that. Opioids were not routinely prescribed at discharge. We deemed patients safe for discharge if they tolerated a regular diet and were ambulating, and their pain was

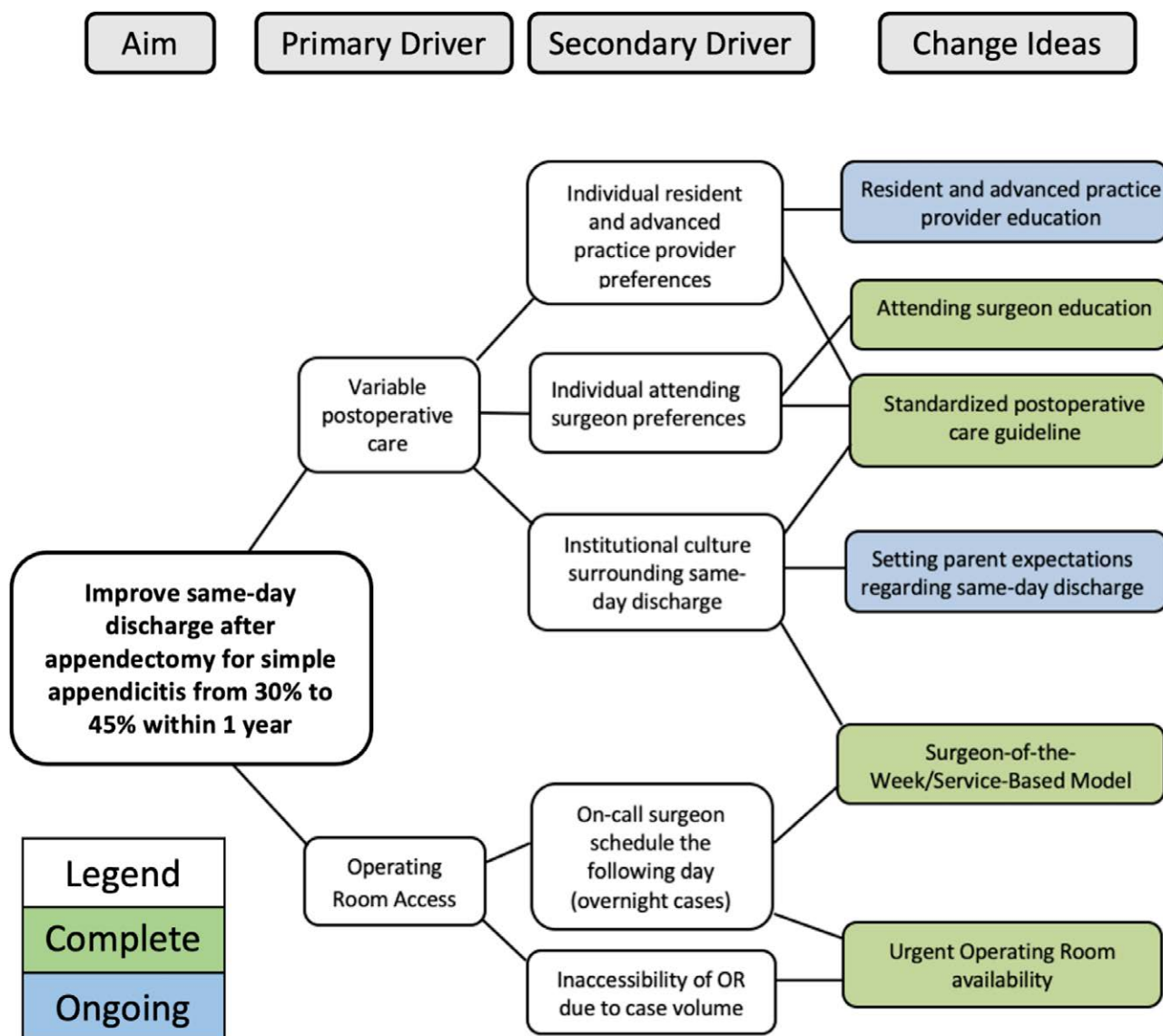


Fig. 1. Key driver diagram demonstrating the quality improvement aim, key drivers contributing to same-day discharges, and change ideas.

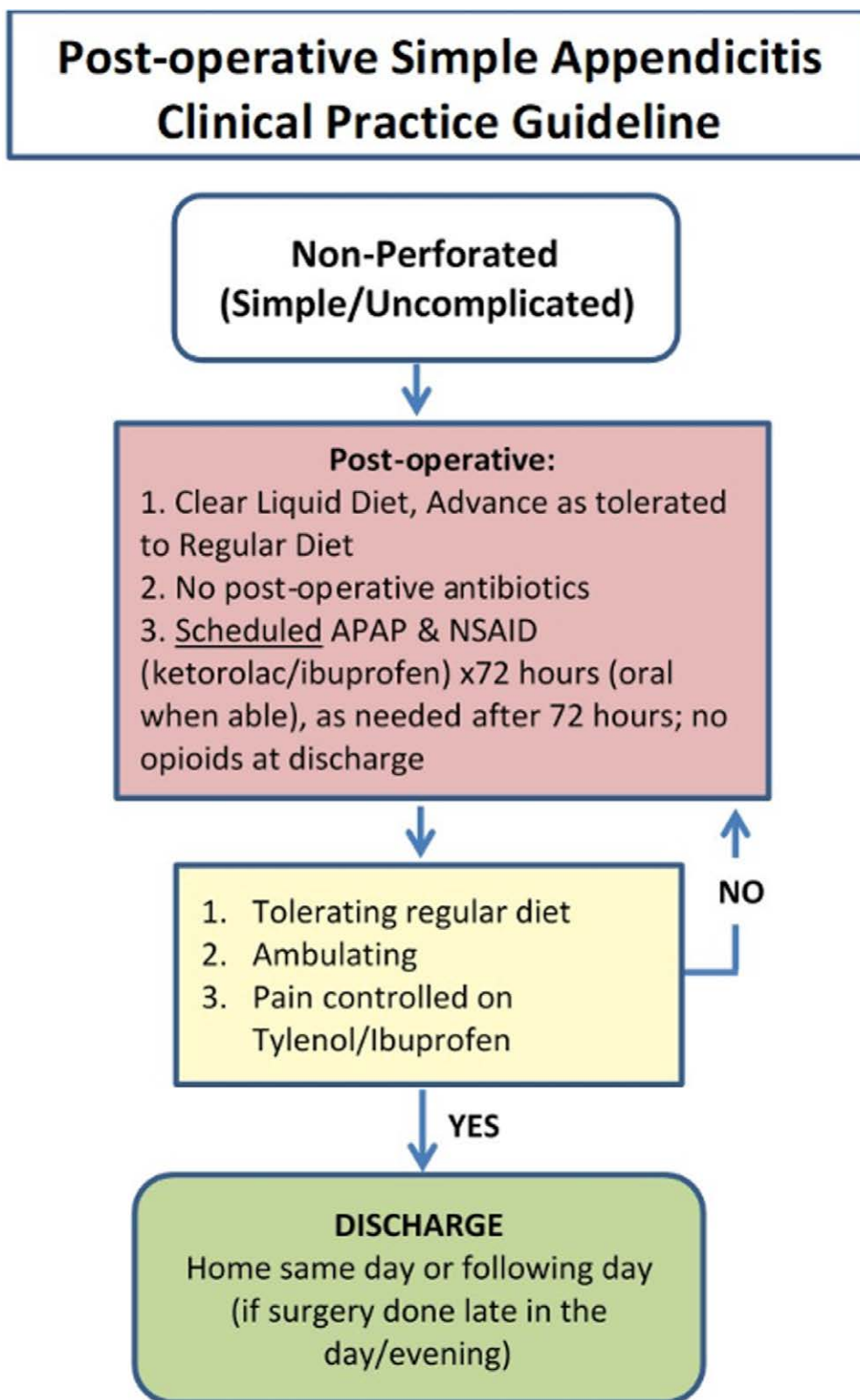


Fig. 2. CPG after appendectomy for simple appendicitis in children. APAP indicates acetaminophen; NSAID, nonsteroidal anti-inflammatory drug.

controlled with oral medications. The intended patient flow was from the emergency department (ED) to the preoperative area and then to the operating room (OR). Postoperative diet advancement, pain control, and ambulation occurred in the postanesthesia care unit (PACU) if

the patient was not previously admitted. Inpatient admission was deferred unless the postoperative milestones were not met. Importantly, all surgeons in the group agreed that same-day discharge would become part of the usual care pathway.

The simple appendicitis quality improvement team met regularly to monitor implementation progress, discuss feedback from providers, nurses, and parents, and address issues with guidelines and discharge efforts. The CPG is the product of the first plan-do-study-act cycle, a snapshot of the ongoing improvement process.

Following discussion among surgeons, a surgeon-of-the-week service model, originally designed for acute care surgery services, was started in November 2019.^{11,12} It was created with the primary goal of focusing a single surgeon on the inpatient census and new consultations. Through efforts by our division chief, including collaboration and negotiations with OR leadership and other divisions such as pediatric orthopedics, an OR for urgent cases became available in January 2020. This OR had time blocked in the morning to prioritize patients requiring urgent procedures who presented overnight. The urgent OR is reserved daily starting at 7:30 A.M. for overnight add-on cases. Patients from January 2018 to September 2019 (preimplementation cohort) were compared with patients from October 2019 to June 2021 (postimplementation cohort). These cutoff dates marked the time point of our initial intervention, the CPG.

Objectives and Outcome Measures

We aimed to increase same-day discharge following appendectomy for simple appendicitis from 30% to 45% (an increase of 25%) in 1 year. The primary outcome measure was to discharge on the same calendar day of surgery. Postoperative antibiotic prescriptions were tracked as an additional outcome measure. The proportion of patients discharged from the PACU was tracked as a process measure related to patient flow. Occurrences of postoperative ED visits and readmissions were used as balancing measures. We also included opioid prescriptions at discharge as an additional balancing measure as we aimed to maintain prior successes in opioid stewardship.

Study Design and Data Collection

This study was reviewed and determined exempt by the institutional review board at our institution (STUDY00005457). Therefore, informed consent was not required.

The American College of Surgeons National Surgical Quality Improvement Program-Pediatric (NSQIP-P, American College of Surgeons, Chicago) database was used to identify patients younger than 16 years old who underwent appendectomy for simple appendicitis from January 2018 to June 2021 at our tertiary care facility. All pediatric patients who undergo appendectomy have data gathered prospectively and are captured in our NSQIP-P database. We abstracted patient demographics, clinicopathologic factors, operative details, and postoperative outcomes from the NSQIP-P institutional dataset. The team queried our electronic medical record to supplement data regarding opioid prescribing and length-of-stay metrics, including time in the PACU. Data related to opioid

prescribing at discharge started in 2019 due to limitations in extracting this variable from our electronic medical record system before that time. Patients 16 years and older were excluded, because the pediatric surgery service did not manage them at our institution. We also excluded patients with complicated appendicitis, those with a different diagnosis intraoperatively, and those undergoing elective, interval appendectomy.

Statistical Analysis

Our primary outcome measure was displayed monthly using a statistical process control chart (p chart) created using QI Macros (QI Macros, KnowWare International, Denver, Colo.). Special cause variation was determined using rules suggested for health care.¹³ Summative data are presented as mean (standard deviation), median (interquartile range), or percentage. Univariate comparisons were made using an unpaired *t* test or Wilcoxon rank sum test, as appropriate, for continuous data and the chi-square or Fisher exact test for proportions. All analyses for summative data comparisons for this study were performed using MATLAB R2020a (1994–2020, The MathWorks Inc, Natick, Mass.) and GraphPad Prism 9.2.0 (GraphPad Software, San Diego, Calif.). *P*-values less than 0.05 were considered statistically significant.

RESULTS

Patient Demographics

In the preimplementation period from January 2018 to September 2019, 278 children underwent appendectomy for simple appendicitis. In the postimplementation period from October 2019 to June 2021, 264 children underwent appendectomy for simple appendicitis. Demographic data are shown in Table 1. There were no significant differences between the groups concerning age and sex.

Quality Improvement Outcomes

Outcome Measures

During the baseline period, the average monthly percent of same-day discharge following simple appendicitis was 32% (Fig. 3). Following standardization through a CPG, implementing the surgeon-of-the-week model, and increasing OR availability, special cause variation was noted

Table 1. Patient Demographics

Variable	Preimplementation	Postimplementation	<i>P</i>
Number of patients	278	264	—
Age, mean [years (SD)]	10.9 (3.2)	11.4 (2.9)	0.070*
Sex [% female (n)]	38.9 (108)	37.5 (99)	0.791†

*Indicates testing performed with an unpaired *t* test.

†Indicates testing performed with the Fisher exact test.

Continuous variables are presented as mean [standard deviation (SD)], and categorical variables are presented as percent (number, n).

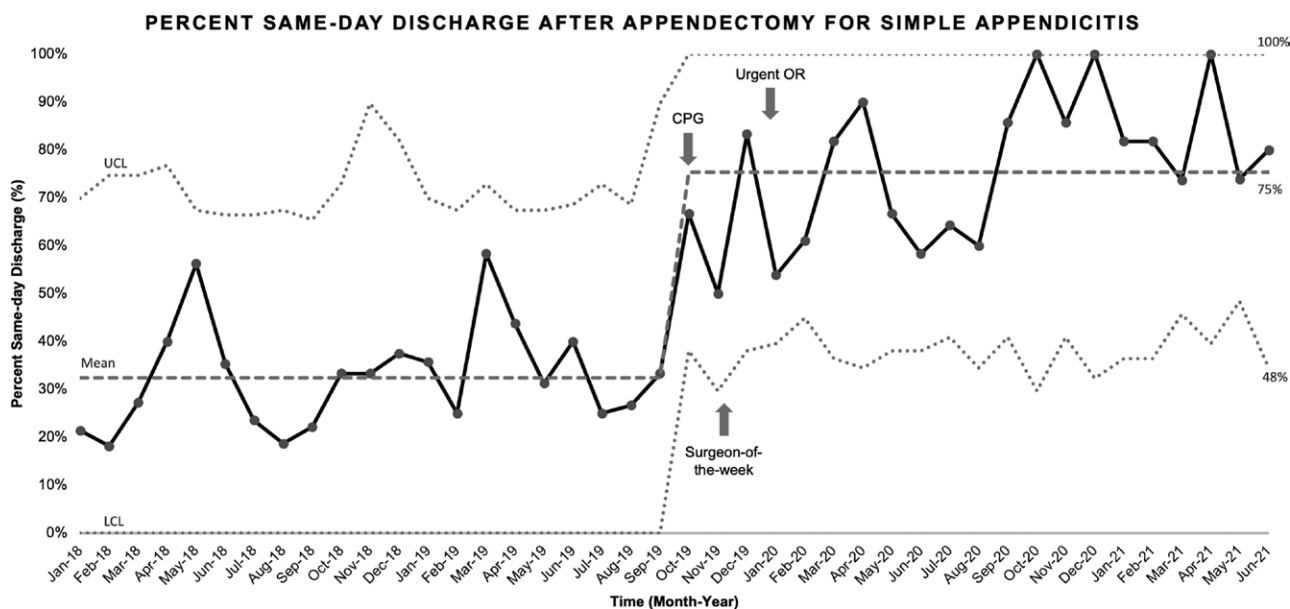


Fig. 3. Annotated P chart of monthly same-day discharge rate after appendectomy for simple appendicitis. Total number of cases = 542. The dashed line denotes the mean monthly same-day discharge rate, which increased significantly from 32% to 75% after implementation of a CPG, surgeon-of-the-week service model, and urgent operating room. UCL and LCL are displayed as dotted lines. LCL indicates lower control limit; UCL, upper control limit.

beginning in October 2019, represented by 8 or more consecutive points above the baseline mean (Fig. 3). As a result, the average monthly percentage of same-day discharge increased to 75%, representing more than 130% improvement. We have sustained this improvement for more than 20 months. It equates to an estimated 60–70 more patients being discharged the same day following appendectomy for simple appendicitis each year in our hospital.

Postoperative length of stay decreased {16.5 hours [interquartile range (IQR), 15.9] versus 4.4 hours (IQR, 11.7), $P < 0.001$ } related to a decrease in postoperative length of stay for patients discharged from both the floor and the PACU [floor: 18.1 hours (IQR, 14.5) versus 5.7 hours (IQR, 11.6), $P < 0.001$; PACU: 11.5 hours (IQR, 13.0) versus 2.0 hours (IQR, 3.4), $P < 0.001$; Table 2].

Time to the OR increased (581 versus 669 minutes, $P = 0.011$; Table 2), but total time in hospital from ED presentation to discharge was reduced (29.2 hours versus 21.0 hours, $P < 0.001$; Table 2). No appendectomies were performed that entered the OR after 9:30 P.M. in the postimplementation group compared with 13 cases in the preimplementation era ($P < 0.001$). Antibiotics were prescribed at discharge significantly less often after guideline implementation (6.8% versus 1.5%, $P = 0.002$; Table 2).

Process Measures

The proportion of patients discharged directly from the PACU instead of the inpatient floor increased significantly (22.8% versus 43.6%, $P < 0.001$; Table 2).

Balancing Measures

Postoperative ED visits (5.8% versus 7.7%; $P = 0.491$) and readmissions (1.2% versus 2.7%; $P = 0.212$) were

not different between the preimplementation and postimplementation cohorts (Table 2). Opioid prescribing at discharge did not differ between the preimplementation and postimplementation cohorts [2.5% (3 patients) versus 1.1% (3 patients), $P = 0.385$]. Total morphine milliequivalents prescribed at discharge were not different (172.5 versus 86.3, $P = 0.378$).

Value Measures

The preintervention cohort contained 278 patients accounting for 220 hospital days (which are tracked as integers that accrue based on the number of hospital midnights). In contrast, the postintervention cohort contained 264 patients accounting for 68 hospital days. Therefore, based on the difference in average hospital days per patient in the preintervention group compared with the postintervention group (0.79–0.26 = 0.53 hospital days per patient), we estimate that the guideline saved 0.53 hospital days per patient, or 140 hospital days total when considering the 264 patients in the postintervention group.

DISCUSSION

Following the implementation of a CPG, surgeon-of-the-week model, and the use of an urgent OR, the rate of same-day discharge in children after appendectomy for simple appendicitis increased significantly and has been sustained for more than 20 months. We reduced hospital length of stay without significantly impacting ED visits or readmissions. Postoperative antibiotic stewardship also improved, which may be related to guideline compliance. Postoperative opioid prescribing remained low,

Table 2. Postoperative Outcomes of Children Who Underwent Appendectomy for Simple Appendicitis before and after Quality Improvement Bundle Implementation

Measure	Preimplementation	Postimplementation	P
Total length of stay [mean hours (SD)]	29.2 (22.0)	21.0 (11.3)	<0.001*
Postoperative length of stay, hours [median (IQR)]	16.5 (15.9)	4.4 (11.7)	<0.001†
PACU postoperative length of stay, hours [median (IQR)]	11.5 (13.0)	2.0 (3.4)	<0.001†
Floor postoperative length of stay, hours [median (IQR)]	18.1 (14.5)	5.7 (11.6)	<0.001†
Discharge location [percent (n)]			<0.001‡
Floor	77.2% (213)	56.4% (150)	<0.001§
PACU	22.8% (63)	43.6% (116)	<0.001§
Time to OR [mean minutes (SD)]	581 (424)	669 (368)	0.011*
Healthcare Resource Utilization [Percent (n)]	Preimplementation	Postimplementation	P
ED visit	5.8 (16)	7.7 (20)	0.491§
Readmission	1.1 (3)	2.7 (7)	0.212§
Antibiotic at hospital discharge	6.8 (19)	1.5 (4)	0.002§

*Indicates testing performed with an unpaired *t* test.

†Indicates Wilcoxon rank sum test.

‡Indicates testing performed with the Chi-square test.

§Indicates testing performed with the Fisher exact test.

n, number.

demonstrating that the length of stay can be reduced while maintaining opioid stewardship principles.

Based on the preguideline hospital utilization rate, guideline implementation saved 140 hospital days. Due to the incidence of simple appendicitis, efforts to reduce the length of stay can return significant value to health systems. This intervention's value should be considered in terms of days saved for patients and the system and by making beds available in our hospital, which often exceeds 100% occupancy.

Investigation of clinical pathways across medical disciplines, pediatric conditions, and pediatric appendicitis show improved outcomes related to CPG use, including decreased inpatient complications, length of stay, and costs without impacting readmission or in-hospital mortality.^{14,15} Quality improvement projects in pediatric appendicitis have shown a positive impact on outcomes and value, which includes decreased antibiotic usage, reduced hospital stay, mitigation of racial disparities in care, and decrease in overall cost burden.^{3,4,16–19}

Guideline creation does not guarantee a change in outcomes. Guideline nonadherence can mitigate the effects of a well-crafted pathway.²⁰ Day-to-day patient care can conflict with long-term goals when information overload and quality improvement fatigue are present.²¹ There is also evidence that instituting an evidence-based guideline may not provide the desired impact on outcomes.^{22,23} Our team attempted to keep the CPG relatively simple to avoid quality improvement fatigue. Although this project did not have a direct measure of process compliance, we used antibiotics at discharge as a surrogate for compliance, which remained low in the postintervention era.

A 2018 meta-analysis reviewing facilitators and barriers to enhanced recovery pathways identified key facilitating factors: adaptation to the local context, buy-in from direct patient care personnel and hospital leadership, dedicated pathway staff, regular meetings, and early demonstration of pathway effectiveness.²⁴ Primary barriers to enhanced

recovery pathways included resistance from providers at the level of patient care and insufficient resources.²⁴ We believe our pathway implementation had buy-in and inherent local adaptation because the CPG was developed by the clinical users and had a vested interest in its success. Our team included a member dedicated to quality improvement, and outcomes were collected prospectively, which afforded regular updates on progress. The pathway was simple and based on consensus, which limited provider resistance. These factors are consistent with the literature regarding creating measurable and meaningful change in a hospital system through CPG use.

Managing expectations for patient care is important when implementing new practices. The pediatric surgery resident normalizes same-day discharge for simple appendicitis with the patient's family at the time of consultation. The plan is consistent across the care team, which reinforces that the plan is safe. Typical patient flow is from the pediatric ED to either the floor or the perioperative area (PACU) for boarding before going to the OR. Patients who board in the PACU can be discharged from the PACU, whereas patients who initially go to the floor return to the floor postoperatively. Over the study period, the percentage of patients discharged from the PACU increased, improving patient flow and reducing unnecessary patient transfers. Although not intended by the quality improvement team, the authors acknowledge this process change related to discharge from the PACU as a driver that likely contributed to same-day discharge. Total postoperative length of stay decreased following the intervention, including in the PACU, which is evidence that longer stays did not strain the PACU resources to release patients on the day of surgery. Rather, decreasing the length of stay for patients discharged from the PACU and the floor affirms the project's resource reduction mission.

We reduced the length of stay while maintaining careful opioid prescribing and antibiotic stewardship. Published

same-day discharge protocols have included the administration of opioid pain medication.^{3,8} Our team previously demonstrated that general surgery procedures can be performed in children with minimal to no opioid prescribing at discharge.²⁵ Standardizing nonopioid pain control methods preserved length-of-stay goals while minimizing opioid prescribing at discharge. In addition, the low rate of postoperative antibiotic prescribing is concordant with national pediatric appendicitis guidelines.^{26,27} The rate of postoperative antibiotics also acts as a balancing measure, indicating adherence to the CPG and antibiotic stewardship.

The overall increase of same-day discharge from 32% to 75% moved our institution into the positive outlier category in NSQIP-pediatric, demonstrating better performance than most peer institutions for this metric.²⁸ Discharging all children on the same day is likely unrealistic. Factors, such as postoperative pain, postoperative nausea, and time of day, will likely continue to impede same-day discharge.

The authors initially believed that the surgeon-of-the-week model would allow surgeons to complete cases more expeditiously compared with a 24-hour call schedule by limiting scheduled conflicting obligations during an “on” week.^{11,12}

Any positive effect from the surgeon-of-the-week system may have been mitigated by a change in attending practice regarding the management of overnight simple appendicitis consultations. Before the surgeon-of-the-week model and urgent OR availability, surgeons often performed appendectomies as late as midnight to avoid disruptions to the next working day. After implementing a surgeon-of-the-week model, our surgeons generally would not perform appendectomy after 8 P.M. to conserve resources.

There are notable limitations to this study. It is a single-center study based on a quality improvement project composed of personnel at the same institution. Although these processes could yield similar results elsewhere, the exact method and results may not be generalizable since quality improvement efforts typically require modifications based on local processes and culture. We relied on meetings, educational sessions, and physical and electronic distribution of the CPG. We did not embed a specific order set containing the CPG into the electronic medical record, so we cannot know the true adherence rate to the guideline. Additionally, this was a group of interventions rather than an isolated modification made to an existing protocol. Data from this study may not support the success of any one of these changes in isolation or different combinations.

Finally, focusing on day-of-surgery discharges discounts those who undergo a procedure late at night and may be kept until the following day so as not to discharge overnight. These patients may have the same hospitalization hours as others who undergo procedures in the morning and are discharged the same day. Time to OR and total

hospital stay were included to address what same-day discharge does not capture. Time to OR increased, though it was by fewer than 90 minutes on average. Additionally, the median hospital length of stay was reduced by 12 hours, demonstrating that delayed time to OR did not neutralize length-of-stay reduction.

SUMMARY

CPGs can improve care by generating consensus, reducing variability in care, and setting expectations for patients, families, and providers. Implementing a management bundle that included a CPG, surgeon-of-the-week model, and an urgent OR improved same-day discharge after appendectomy for simple appendicitis and decreased length of stay. In addition, improving patient flow through the hospital by utilizing the PACU for preoperative patient boarding and postoperative discharge may enhance same-day discharge. Significant value was returned to our institution and healthcare system as a result of this quality improvement project.

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DISCLOSURE:

Dr. Livingston was associated with the University of Rochester during the inception and implementation of this project. He is now positioned in the Department of Surgery at McMaster University in Hamilton, ON, Canada. Dr. Wakeman has a patent pending unrelated to this manuscript's subject matter. The other authors have no financial interest to declare.

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