JAMA Surgery | Original Investigation

# Association of Same-Day Discharge With Hospital Readmission After Appendectomy in Pediatric Patients

Sarah B. Cairo, MD, MPH; Mehul V. Raval, MD, MS; Marybeth Browne, MD, MS; Holly Meyers, BS; David H. Rothstein, MD, MS

**IMPORTANCE** Appendectomy is the most common abdominal operation performed in pediatric patients in the United States. Studies in adults have suggested that same-day discharge (SDD) after appendectomy is safe and does not result in higher-than-expected hospital readmissions.

**OBJECTIVE** To evaluate the influence of SDD on 30-day readmission rates following appendectomy for acute appendicitis in pediatric patients.

**DESIGN, SETTING, AND PARTICIPANTS** This retrospective cohort study used the American College of Surgeons National Surgical Quality Improvement Program–Pediatric database to evaluate 30-day readmission rates among pediatric patients who underwent an appendectomy for acute, nonperforated appendicitis. The database provides high-quality surgical outcomes data from more than 80 participating US hospitals, including free-standing pediatric facilities, children's hospitals, specialty centers, children's units within adult hospitals, and general acute care hospitals with a pediatric wing. Patients selected for inclusion (n = 22 771) were between ages 0 and 17 years and underwent appendectomy for uncomplicated appendicitis between January 1, 2012, and December 31, 2015. Patients excluded were those discharged more than 2 days after surgery.

**EXPOSURES** Same-day discharge after appendectomy or discharge 1 or 2 days after surgery.

**MAIN OUTCOMES AND MEASURES** The primary outcome was 30-day readmission. Secondary outcomes included surgical-site infections and other wound complications.

**RESULTS** Of the 20 981 patients, 4662 (22.2%) had SDD and 16 319 (77.8%) were discharged within 1 or 2 days after surgery. The patient cohort included 12 860 boys (61.3%) and 8121 girls (38.7%), with a mean (SD) age of 11.0 (3.56) years. There was no difference in the odds of readmission for patients with SDD compared with those discharged within 2 days (adjusted odds ratio [aOR], 0.82; 95% CI, 0.51-1.04; $P = .06$; readmission rate, 1.89% vs 2.33%). There was no significant difference in reason for readmission on the basis of discharge timing. Likewise, there was no difference in wound complication rate between patients with SDD and those discharged 1 or 2 days after surgery (aOR 0.75; 95% CI, 0.56-1.01; $P = .06$).

**CONCLUSIONS AND RELEVANCE** In pediatric patients with acute appendicitis undergoing appendectomy, SDD is not associated with an increase in 30-day hospital readmission rates or wound complications when compared with discharge 1 or 2 days after surgery. Same-day discharge may be an applicable quality metric for the provision of safe and efficient care for pediatric patients with acute, nonperforated appendicitis.

*JAMA Surg*. 2017;152(12):1106-1112. doi:10.1001/jamasurg.2017.2221
Published online July 5, 2017.

CME Quiz at jamanetwork.com/learning

**Author Affiliations:** Pediatric Surgery, Women and Children's Hospital of Buffalo, Buffalo, New York (Cairo, Meyers, Rothstein); Department of Pediatric Surgery, Children's Healthcare of Atlanta, Atlanta, Georgia (Raval); Department of Surgery, Emory University School of Medicine, Atlanta, Georgia (Raval); Department of Pediatric Surgery, Lehigh Valley Children's Hospital, Allentown, Pennsylvania (Browne); Department of Surgery, University at Buffalo, Buffalo, New York (Rothstein).

**Corresponding Author:** Sarah B. Cairo, MD, MPH, Pediatric Surgery, Women and Children's Hospital of Buffalo, 140 Hodge St, Buffalo, NY 14222 (scairo2@gmail.com).

Appendicitis is the most common gastrointestinal disorder in pediatrics that requires an urgent operation.[1] In the United States alone, an estimated 60 000 to 80 000 appendectomies are performed annually in children.[2,3] Both the overall incidence of appendicitis and the use of laparoscopic surgery for appendicitis have increased in the past decade.[4]

The introduction of laparoscopy, although dramatic in prevalence and effect, is only one of a number of changes to the management of acute appendicitis. Additional changes, such as selective administration of postoperative antibiotics, avoidance of nasogastric tubes, and limiting narcotics, have all been implemented to improve patient outcomes and the patient experience with appendectomy.[1,5,6] In the adult population, there has been a movement toward same-day discharge (SDD) after several common surgical procedures, including laparoscopic appendectomy for acute, nonperforated appendicitis.[1,7] Early studies have shown SDD to be a feasible and acceptable pathway in pediatric appendicitis.[6,8-10] To our knowledge, this study is the first to address patient-centered outcomes, including 30-day readmission rates and wound complications, for patients discharged on the same day as the surgery.

### Key Points

**Question** Is same-day discharge following an appendectomy for acute, nonperforated appendicitis safe in the pediatric population?

**Findings** In this cohort study of 22 771 pediatric patients who underwent appendectomy for acute, nonperforated appendicitis, same-day discharge was not associated with an increase in 30-day hospital readmissions compared with discharge 1 or 2 days after surgery.

**Meaning** With appropriate patient selection, same-day discharge after appendectomy may be safe for pediatric patients and may be a valuable quality metric for the provision of safe and efficient surgical care.

## Methods

The study protocol and use of the American College of Surgeons National Surgical Quality Improvement Program-Pediatric (NSQIP-P) database were reviewed by the institutional review board of the University of Buffalo. The study received exemption from formal review, and the need for patient informed consent was waived.

### Data Source

A retrospective review of the NSQIP-P database was performed for January 1, 2012, to December 31, 2015. The NSQIP-P is a multiinstitutional, multispecialty, clinical surgical outcomes database that includes a sampling of cases by most pediatric surgical specialties up to 30 days after a surgical procedure (excluding trauma and transplant cases) in patients younger than 18 years. Data for the NSQIP-P are collected in 8-day cycles for a select group of surgical procedures. These data include preoperative risk factors, *Current Procedural Terminology* codes for the procedure performed, and clinical data such as 30-day outcomes.

### Case Selection

The study population was defined as patients younger than 18 years. Patients were selected for abstraction if they had undergone an appendectomy (*Current Procedural Terminology* codes 44950, 44960, and 44970) during the study period (January 1, 2012, to December 31, 2015). Patients who were diagnosed with perforated or complicated appendicitis were excluded from analysis. For the purposes of this study, *SDD* was defined as zero days between date of appendectomy and date of discharge. Patients with SDD were compared with patients discharged within 1 or 2 days of operation (ie, postoperative day 1 or 2). Patients who were discharged on day 3 or later were excluded (**Figure**).

Data collected or patient variables included age, type of surgery performed (laparoscopic vs open), sex, obesity, race/ethnicity, presence of diabetes, cardiac risk factors, use of steroids, and American Society of Anesthesiology Physical Status classification.[11] *Obesity* was defined according to the Centers for Disease Control and Prevention guidelines as body mass index at the 95th percentile or greater after adjustment for age and sex.[12] Extreme outliers (arbitrarily set at body mass index [calculated as weight in kilograms divided by height in meters squared] less than 10 or more than 100) were excluded as they were thought to represent data errors. *Cardiac risk factors* were defined by the presence of cardiac anomalies and the hemodynamic and clinical significance. Outcomes of interest included hospital readmission within 30 days of operation and wound complications (eg, superficial surgical-site infection [SSI], deep surgical-space infection, deep organ-space infection, and wound disruptions, such as dehiscence).

### Statistical Analysis

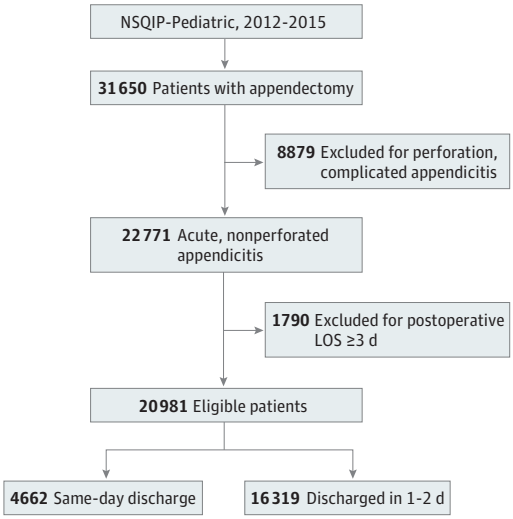
A retrospective descriptive analysis of the data was performed, and the variables were incorporated into a stepwise forward logistic regression model to calculate the adjusted odds ratio (aOR) and 95% CI for readmission and wound complication rates. Categorical variables were compared using the Pearson $\chi^2$ and Fisher exact test, and continuous variables were compared using the paired, 2-tailed *t* test. To account for potential confounding, multivariate and univariate logistic regression analyses were performed to identify risk factors for 30-day postoperative readmission and wound complications. All statistical analyses were performed using Stata Data Analysis and Statistical Software, version 11 (StataCorp LLC). For the multivariable modeling, 2-sided $P < .05$ was considered statistically significant.

## Results

### Univariate Analysis

A total of 31 650 pediatric patients between age 2 years and 18 years were identified as having undergone an appendectomy during the study period of January 1, 2012, to December 31, 2015. A total of 8879 patients were excluded for a diagnosis other than acute, nonperforated or uncomplicated appendicitis (Figure). An additional 1790 patients were excluded for postoperative length

Figure. Patient Selection




LOS indicates length of stay; NSQIP-P, National Surgical Quality Improvement Program–Pediatric database.

of stay of 3 days or longer. Operative and demographic characteristics of the population are described in **Table 1**, which compares patients on the basis of discharge timing. A total of 4662 patients (22.2%) with acute appendicitis admitted for fewer than 3 days had SDD compared with 16 319 (77.8%) discharged on postoperative day 1 or 2. The mean (SD) age of patients with SDD and patients discharged within 2 days did not differ significantly (11.2 [3.48] vs 11.0 [3.59] years; $P > .99$). Most patients underwent laparoscopic appendectomy (19 881 [94.8%]) compared with open appendectomy (1100 [5.2%]), and type of procedure did not differ significantly by discharge timing. Prevalence of diabetes, a comorbidity of interest, did not differ significantly between patients with SDD and patients discharged within 1 or 2 days (0.5% overall; $P = .82$). Similarly, there did not seem to be a difference in rates of obesity between the groups (30.3% among patients with SDD vs 29.8% among patients with 1- or 2-day discharge; $P = .52$). There was no observed difference in race/ethnicity as documented in the NSQIP-P database. Corticosteroid use at the time of operation was reported in 99 patients (0.5%) in the entire original cohort; 9 patients with SDD (0.2%) were receiving corticosteroids compared with 90 patients (0.6%) discharged on day 1 or 2 ($P = .002$).

## Multivariate Analysis

### Primary Outcome

Thirty-day readmission was found in 468 patients (2.2%); 88 (1.9%) were patients with SDD and 380 (2.3%) were patients with a 1- or 2-day discharge ($P = .07$) (**Table 2**). When patients discharged after day 2 were included in the model, they were found to have comparable risk profiles, including American Society of Anesthesiologists Physical Status classification, cardiac risk factors, obesity, and diabetes. Type of operation (laparoscopic vs open), cardiac risk factors, presence of diabetes, and body mass index were not associated with a 30-day readmission. In addition, discharge timing was not associated with increased readmission in multivariate analysis after correction for other significant variables (aOR, 0.82; 95% CI, 0.65-1.04; $P = .06$; **Table 3**). American Society of Anesthesiologists class 3 (severe systemic disease) was associated with an increased risk of readmission (aOR, 1.78; 95% CI, 1.18-2.70; $P = .006$), whereas female sex appeared to have a protective effect against readmission (aOR, 0.81; 95% CI, 0.68-0.98; $P = .03$).

### Secondary Outcome

Wound complications were reported in 318 patients (1.5%) of all 20 981 eligible patients who underwent appendectomy during the study period, which included 57 (1.2%) in the SDD group (Table 2). In the group discharged on day 1 or 2, there were 261 patients (1.6%) diagnosed with a wound-related complication. The overall incidence of wound complication, however, did not differ significantly between the 2 groups ($P = .06$). No association was identified between discharge timing and frequency of wound complications.

When all SSIs were differentiated from organ-space and deep-space SSI, SDD appeared to confer a protective effect (aOR, 0.52; 95% CI, 0.28-0.95; $P = .03$) for organ-space SSI and no change in risk of wound complications overall (aOR, 0.75; 95% CI, 0.56-1.01; $P = .06$). Age of 13 years or older was associated with decreased risk of overall SSI (aOR, 0.61; 95% CI, 0.43-0.87; $P = .006$ for ages 13-15 years vs aOR, 0.62; 95% CI, 0.39-0.98; $P = .04$ for ages 16-18 years). Laparoscopic approach (aOR, 0.50; 95% CI, 0.26-0.96; $P = .04$) was associated with decreased odds of organ-space SSI but no difference overall. Obesity, on the other hand, was associated with increased risk of overall wound complications (aOR, 1.26; 95% CI, 1.00-1.59; $P = .05$) but no difference in organ-space infection (**Table 4**). Minor cardiac risk factors were associated with increased risk of organ-space infection in multivariate modeling but not overall wound complications (aOR, 7.70; 95% CI, 1.02-58.18; $P = .05$). Non-white race was associated with a decreased risk in overall wound complications but no difference in organ-space SSI (aOR, 0.76; 95% CI, 0.57-1.00; $P = .05$).

## Discussion

Using a clinically validated, multicenter registry, we found that SDD after appendectomy in pediatric patients appears to be safe and is not associated with an increased rate of 30-day hospital readmission when compared with discharge on postoperative day 1 or 2. To our knowledge, this study is the first to address these quality measures following appendectomy in the pediatric patient. The findings of this study are significant both in describing the patient population and assessing the safety of SDD in pediatric patients. The characteristics of pediatric patients and the demands of the health care system are evolving such that there is a call for enhanced efficiency and safety of the existing system. Same-day discharge after appendectomy has become commonplace in the adult population and is rising in popularity among pediatric surgeons. With an estimated cost of $9000 per appendectomy and an estimated incidence of 1 appendectomy per 1000 pediatric patients in the United States, the

Table 1. Patient Demographics

| Variable | No. (%) | | | *P* for Pearson $\chi^2$ |
|---|---|---|---|---|
| | Same-Day Discharge | Day 1 or Day 2 Discharge | Total | |
| Total | 4662 (22.2) | 16 319 (77.8) | 20 981 | |
| Sex | | | | |
| Male | 2916 (62.6) | 9944 (60.9) | 12 860 (61.3) | .05 |
| Female | 1746 (37.5) | 6375 (39.1) | 8121 (38.7) | |
| Age, y | | | | |
| Mean (SD) | 11.2 (3.48) | 11.0 (3.59) | 11.0 (3.56) | |
| <7 | 452 (9.7) | 1939 (11.9) | 2391 (11.4) | |
| 8-12 | 1987 (42.6) | 6892 (42.2) | 8879 (42.3) | >.99[a] |
| 13-15 | 1655 (35.5) | 5632 (34.5) | 7287 (34.7) | |
| 16-18 | 568 (12.2) | 1856 (11.4) | 2424 (11.6) | |
| Cardiac risk factors[b] | | | | |
| None | 4615 (99.0) | 16 100 (98.7) | 20 715 (98.7) | NA |
| Minor | 38 (0.8) | 143 (0.9) | 181 (0.9) | |
| Major | 7 (0.2) | 55 (0.3) | 62 (0.3) | |
| Severe | 2 (0.0) | 21 (0.1) | 23 (0.1) | |
| Body mass index[c] | | | | |
| Obese[d] | 1413 (30.3) | 4867 (29.8) | 6280 (29.9) | .52 |
| Not obese | 3249 (69.7) | 11 452 (70.2) | 14 701 (70.1) | |
| Ethnicity | | | | |
| Hispanic | 1076 (23.1) | 3587 (22.0) | 4663 (22.2) | .11 |
| Non-Hispanic | 3586 (76.9) | 12 732 (78.0) | 16 318 (77.8) | |
| Race | | | | |
| White | 3790 (81.3) | 12 093 (74.1) | 15 883 (75.7) | <.001 |
| Non-white | 872 (18.7) | 4226 (25.9) | 5098 (24.3) | |
| Type of operation | | | | |
| Laparoscopic appendectomy | 4510 (96.7) | 15 371 (94.2) | 19 881 (94.8) | <.001 |
| Open appendectomy | 152 (3.3) | 948 (5.8) | 1100 (5.2) | |
| Corticosteroid use | | | | |
| Yes | 9 (0.2) | 90 (0.6) | 99 (0.5) | .002 |
| No | 4653 (99.8) | 16 229 (99.5) | 20 882 (99.5) | |
| ASA Physical Status classification[e] | | | | |
| ASA class 1 | 2575 (55.2) | 8539 (52.3) | 11 114 (53.0) | <.001 |
| ASA class 2 | 1936 (41.5) | 7198 (49.7) | 9134 (43.5) | |
| ASA class 3 | 149 (3.2) | 573 (3.5) | 722 (3.4) | |
| ASA class 4 | 2 (0.04) | 9 (0.06) | 11 (0.05) | |
| ASA class 5 | 0 | 0 | 0 | |
| Diabetes | | | | |
| Yes | 23 (0.5) | 85 (0.5) | 108 (0.5) | .82 |
| No | 4639 (99.5) | 16 234 (99.5) | 20 873 (99.5) | |

Abbreviations: ASA, American Society of Anesthesiologists; NA, not available.

[a] Calculated using 2-sample *t* test with equal variances.

[b] Cardiac risk factors are classified as 0, indicating no risk factors; 1, minor risk factors, such as atrial septal defect, small to moderate ventricular septal defect without symptoms, or patent ductus arteriosus or status post repair of congenital heart defect not receiving treatment; 2, major risk factors, such as congenital heart defect with residual hemodynamic abnormality with or without medications; and 3, severe risk factors, such as uncorrected cyanotic heart disease, documented pulmonary hypertension, or ventricular dysfunction requiring medications.

[c] Calculated as weight in kilograms divided by height in meters squared.

[d] Defined by the Centers for Disease Control and Prevention guidelines[12] as a body mass index at the 95th percentile or greater after adjustment for age and sex.

[e] The ASA Physical Status classification system uses 1 for normal healthy patient; 2, mild systemic disease; 3, severe systemic disease; 4, severe systemic disease that is a constant threat to life; and 5, moribund patient who is not expected to survive without the operation.

benefits of SDD, assuming equivalent or improved outcomes, may be substantial.[5,13,14]

The finding of this study—that SDD is not associated with an increased rate of wound complications and 30-day readmissions—is consistent with other recently published studies evaluating SDD pathways for uncomplicated appendicitis in pediatric patients.[1,9,13,15,16] Both prospective and retrospective studies have described pathways for enhanced patient recovery and evaluation for discharge readiness. These studies show high family satisfaction as well as a significant reduction in postoperative admission and hospital charges of more than $4000 per patient.[10,13,15,17] Patients who were discharged on or after day 3 following surgery were specifically excluded from the study given the presumed differences in underlying patient conditions and factors unrelated to the surgical process that lead to prolonged admission.

Regarding the evaluation of discharge timing as an independent variable, this study differs from previous reports on the use of outpatient vs inpatient appendectomy in pediatric patients. Previous studies have compared inpatient and outpatient appendectomy, where *outpatient* is defined by NSQIP-P as same-day surgery or 23 hours or less for the in-hospital stay before discharge regardless of discharge timing.[6-8,10] Similarly, the term *ambulatory surgery* has been applied to surgical procedures in which the patient may be reasonably expected to go home on the same day and not require an overnight

Table 2. Complications in Pediatric Patients Undergoing Appendectomy

| Complication | No. (%) | | | *P* for Pearson $\chi^2$ |
|---|---|---|---|---|
| | Same-Day Discharge (n = 4662) | Day 1 or Day 2 Discharge (n = 16 319) | Total (N = 20 981) | |
| 30-d Readmissions | | | | |
| Yes | 88 (1.9) | 380 (2.3) | 468 (2.2) | .07 |
| No | 4574 (98.1) | 15 939 (97.7) | 20 513 (97.8) | |
| Wound complications | | | | |
| Overall wound complication | 57 (1.2) | 261 (1.6) | 318 (1.5) | .06 |
| Deep surgical-site infection | 3 (0.1) | 16 (0.1) | 19 (0.1) | .50 |
| Superficial surgical-site infection | 42 (0.9) | 162 (1.0) | 204 (1.0) | .57 |
| Deep organ-space infection | 12 (0.3) | 83 (0.5) | 95 (0.5) | .02 |
| Other wound disruption | 0 | 4 (0.02) | 4 (0.02) | .29 |

Table 3. Stepwise Regression for Factors Affecting Readmission Rates Following Appendectomy

| Factor | aOR (95% CI)[a] | *P* Value |
|---|---|---|
| Day of discharge | | |
| Discharge on day 1 or day 2 | 1 [Reference] | |
| Same-day discharge | 0.82 (0.65-1.04) | .06 |
| Age, y | | |
| <7 | 1 [Reference] | |
| 8-12 | 0.56 (0.44-0.72) | <.001 |
| 13-15 | 0.45 (0.34-0.59) | <.001 |
| 16-18 | 0.56 (0.68-0.98) | <.001 |
| ASA Physical Status classification[b] | 1 [Reference] | |
| ASA class 1 | 1 [Reference] | |
| ASA class 2 | 1.14 (0.94-1.38) | .18 |
| ASA class 3 | 1.78 (1.18-2.70) | .006 |
| ASA class 4 | NA | |
| ASA class 5 | NA | |
| Sex | | |
| Male | 1 [Reference] | |
| Female | 0.81 (0.68-0.98) | .03 |
| Race | | |
| White | 1 [Reference] | |
| Non-white | 0.82 (0.65-1.03) | .08 |
| Ethnicity | | |
| Non-Hispanic | 1 [Reference] | |
| Hispanic | 0.80 (0.63-1.01) | .06 |

Abbreviations: aOR, adjusted odds ratio; ASA, American Society of Anesthesiologists; NA, not applicable because result too insignificant for inclusion in stepwise regression.

[a] Stepwise logistic regression with removal of type of operation (laparoscopic vs open), cardiac risk factors, diabetes, and body mass index.

[b] The ASA Physical Status classification is explained in the last footnote to Table 1.

hospital bed. With the increasing cost of health care delivery and constraints imposed on the system, there has been a push, along with bundled payments, for decreased hospital length of stay and heightened emphasis on the use of outpatient surgery. When further defined as SDD, as is done in our study, Scott et al[5] confirmed the comparable rates of readmission and complications for adult patients with SDD compared with inpatients or patients briefly hospitalized at 2% to 7% overall. Patients who were admitted for more than 2 days after surgery (ie, discharged on postoperative day 3 or later) were purposely excluded because they were considered to belong in a different cohort in which comorbidities or other clinical variables were contributing to the increased length of stay.

Thirty-day hospital readmission is of particular interest in an evolving, pay-for-performance health care system. Reducing pediatric readmissions has become an area of increased interest to multiple federal agencies, such as Partnership for Patients, which challenged hospitals to reduce pediatric readmission by 20%.[18-20] In 2012, the costs associated with pediatric readmissions were estimated to be at least $1 billion annually.[21] To comply with federal initiatives to reduce readmission rates, both physicians and administrators must understand the risk factors. In a separate study evaluating risk factors for readmission and targets for performance improvement, longer length of stay, presence of chronic medical conditions, and surgical specialty were associated with increased odds of 30-day readmission for pediatric patients.[22] Many of those factors were not addressed here, but SDD was not associated with increased rate of readmission, which is consistent across patients undergoing open or laparoscopic appendectomy. Of the elements evaluated in this study, only sex was found to be associated with increased risk of 30-day hospital readmission. The most frequently identified reasons for readmission, regardless of discharge timing, were superficial wound complications and factors unrelated to the surgical procedure.

In addition to readmission rates, SSIs are another commonly used quality metric for interhospital comparisons with publicly reported results to the Centers for Medicare and Medicaid Services since 2012.[23] The diagnosis of an SSI, however, can vary between institutions and reporting agencies. In one recent publication, an SSI rate of 1.6% was reported for patients with simple appendicitis and increased dramatically for patients with gangrenous and perforated appendicitis, as determined by the surgeons' documentation.[24] In our analysis of the NSQIP-P database, the overall SSI rate was 1.5%, which did not differ significantly by discharge timing.

The literature on the influence of obesity on surgical outcomes yields conflicting results. Several adult studies reported higher rates of wound infection in patients with higher body mass index.[25-28] The correlation between obesity and surgical

Table 4. Stepwise Regression for Factors Affecting Wound Complications Following Appendectomy

| | All Wound Complications | | Organ-Space SSI | |
|---|---|---|---|---|
| Factor | aOR (95% CI)[a] | *P* Value | aOR (95% CI) | *P* Value |
| Sex | | | | |
| Male | 1 [Reference] | | 1 [Reference] | |
| Female | NA | | NA | |
| Discharge timing | | | | |
| Discharge on day 1 or day 2 | 1 [Reference] | | 1 [Reference] | |
| Same-day discharge | 0.75 (0.56-1.01) | .06 | 0.52 (0.28-0.95) | .03 |
| Ethnicity | | | | |
| Non-Hispanic | 1 [Reference] | | 1 [Reference] | |
| Hispanic | NA | | 0.61 (0.35-1.08) | .09 |
| Age, y | | | | |
| <7 | 1 [Reference] | | 1 [Reference] | |
| 8-12 | 0.79 (0.57-1.09) | .15 | 0.48 (0.17-1.32) | .15 |
| 13-15 | 0.61 (0.43-0.87) | .006 | 0.33 (0.10-1.09) | .07 |
| 16-18 | 0.62 (0.39-0.98) | .04 | NA | |
| Cardiac risk factors | | | | |
| No | 1 [Reference] | | 1 [Reference] | |
| Minor | NA | | 7.70 (1.02-58.18) | .05 |
| Major | NA | | NA | |
| Severe | NA | | NA | |
| Type of procedure | | | | |
| Open appendectomy | 1 [Reference] | | 1 [Reference] | |
| Laparoscopic appendectomy | NA | | 0.50 (0.26-0.96) | .04 |
| Body mass index | | | | |
| Not obese | 1 [Reference] | | 1 [Reference] | |
| Obese | 1.26 (1.00-1.59) | .05 | NA | |
| Race | | | | |
| White | 1 [Reference] | | 1 [Reference] | |
| Non-white | 0.76 (0.57-1.00) | .05 | NA | |

Abbreviations: aOR, adjusted odds ratio; ASA, American Society of Anesthesiologists; NA, not applicable because result too insignificant for inclusion in stepwise regression; SSI, surgical-site infection.

[a] Stepwise logistic regression excluding ASA for statistical insignificance.

outcomes, however, is not well borne out in the pediatric literature. In this study, obesity was not associated with an increased rate of wound complications in the SDD group or among patients discharged within 1 or 2 days after surgery. Similarly, the rate of obesity did not differ between the 2 groups, suggesting that clinicians are no more likely to keep a patient overnight after an operation only on the basis of obesity. In the present study, only 6280 patients (29.9%) were identified as obese. The reported obesity rate in this study is higher than others specifically addressing surgical technique but did not seem to affect outcomes. The NSQIP-P database does not yet differentiate between single-incision endosurgery and laparoscopic appendectomy.[29] When this level of detail is determined, a statistically significant difference in the type of procedure performed and potential associations with discharge timing, readmission rates, and wound complications may become apparent.

## Limitations

This study has several limitations, which may influence its generalizability. The cohort we evaluated included outcomes from the NSQIP-P database that consists of selected cases sampled only from participating hospitals and therefore may not necessarily represent a generalizable national estimate. In addition, this study evaluated only patients treated during 3 calendar years for 30-day complications as a convenience sample of NSQIP-P cases.[30] Some patients who were readmitted to a facility other than where their surgical procedure was performed may not be captured, but this factor is minimized by active data collection by NSQIP-P, which includes contacting patients or families to determine 30-day complications, including readmissions, and is not expected to differ by discharge timing. The NSQIP-P database sampling, despite some limitations, is considered to accurately represent the larger pediatric surgical cohort.[31]

One major limitation cited in other studies evaluating the influence of obesity on surgical complications is the lack of differentiation between degrees of obesity. Given the number of patients included in this study and use of Centers for Disease Control and Prevention guidelines for the definition of obesity, it was not practical to further differentiate degrees of obesity. The use of the Centers for Disease Control and Prevention definition may also contribute to slight variability in our results compared with other studies evaluating obesity's effect on pediatric surgical outcomes.

Additional variables of interest for future studies include preoperative length of stay, time of surgical procedure (and therefore actual duration of hospitalization on a more granular level), overall cost to the patient and the health care system, time to postoperative visits, and time of day when the procedure was performed. Clinical indicators that are considered to be associated with wound complications and may

prompt increased length of stay are not included in the NSQIP-P database. We attempted to exclude patients who were considered to be at higher risk for complication by limiting the study to discharge within 1 or 2 days of operation, but increased data granularity may help further differentiate patients at risk of complications.

Despite these limitations, we believe the present study effectively evaluates the risk of wound complications and readmissions for pediatric patients with simple appendicitis who undergo a laparoscopic or open appendectomy and are discharged on the same day as the surgery as opposed to within 1 or 2 days. A major strength of this study is the use of a large database with a sampling of patients from a number of different institutions. Complications in the pediatric population occur infrequently and are better analyzed using large populations, as was done here. Appendicitis and its management are well suited for research in standardization of care and improvements in patient outcomes because of the steadily high prevalence and associated cost to the health care system for adult and pediatric patients.

## Conclusions

When applied to the appropriate patients, SDD is a safe alternative to overnight admission after appendectomy in a pediatric patient. Discharge timing, within 1 to 2 days of surgery, does not appear to influence readmission rates and wound complications, and SDD may be an applicable quality metric in pediatric patients undergoing appendectomy for simple appendicitis.


### ARTICLE INFORMATION

**Accepted for Publication:** April 16, 2017.

**Published Online:** July 5, 2017. doi:10.1001/jamasurg.2017.2221

**Author Contributions:** Dr Rothstein had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
*Study concept and design:* Cairo, Raval, Browne, Rothstein.
*Acquisition, analysis, or interpretation of data:* Cairo, Meyers, Rothstein.
*Drafting of the manuscript:* Cairo.
*Critical revision of the manuscript for important intellectual content:* All authors.
*Statistical analysis:* Cairo, Rothstein.
*Administrative, technical, or material support:* Cairo, Meyers.
*Study supervision:* Raval, Browne, Rothstein.

**Conflict of Interest Disclosures:** None reported.


### REFERENCES


1. Aguayo P, Alemayehu H, Desai AA, Fraser JD, St Peter SD. Initial experience with same day discharge after laparoscopic appendectomy for nonperforated appendicitis. *J Surg Res*. 2014;190(1):93-97.

2. Buckius MT, McGrath B, Monk J, Grim R, Bell T, Ahuja V. Changing epidemiology of acute appendicitis in the United States: study period 1993-2008. *J Surg Res*. 2012;175(2):185-190.

3. Gonzalez DO, Deans KJ, Minneci PC. Role of non-operative management in pediatric appendicitis. *Semin Pediatr Surg*. 2016;25(4):204-207.

4. Masoomi H, Nguyen NT, Dolich MO, Mills S, Carmichael JC, Stamos MJ. Laparoscopic appendectomy trends and outcomes in the United States: data from the Nationwide Inpatient Sample (NIS), 2004-2011. *Am Surg*. 2014;80(10):1074-1077.

5. Scott A, Shekherdimian S, Rouch JD, et al. Same-day discharge in laparoscopic acute non-perforated appendectomy. *J Am Coll Surg*. 2017;224(1):43-48.

6. Putnam LR, Levy SM, Johnson E, et al. Impact of a 24-hour discharge pathway on outcomes of pediatric appendectomy. *Surgery*. 2014;156(2):455-461.

7. Cross W, Chandru Kowdley G. Laparoscopic appendectomy for acute appendicitis: a safe same-day surgery procedure? *Am Surg*. 2013;79(8):802-805.

8. Oyetunji TA, Gonzalez DO, Aguayo P, Nwomeh BC. Variability in same-day discharge for pediatric appendicitis. *J Surg Res*. 2015;199(1):159-163.

9. Alkhoury F, Burnweit C, Malvezzi L, et al. A prospective study of safety and satisfaction with same-day discharge after laparoscopic appendectomy for acute appendicitis. *J Pediatr Surg*. 2012;47(2):313-316.

10. Halter JM, Mallory B, Neilson IR, Langer M. Same-day discharge following laparoscopic appendectomy for uncomplicated acute appendicitis as a measure of quality in the pediatric population. *J Laparoendosc Adv Surg Tech A*. 2016;26(4):309-313.

11. American Society of Anesthesiologists. ASA physical status classification system. https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system. Updated October 15, 2014. Accessed March 2017.

12. Centers for Disease Control and Prevention. Defining childhood obesity. https://www.cdc.gov/obesity/childhood/defining.html. Updated June 19, 2015. Accessed March 2017.

13. Farach SM, Danielson PD, Walford NE, Harmel RP Jr, Chandler NM. Same-day discharge after appendectomy results in cost savings and improved efficiency. *Am Surg*. 2014;80(8):787-791.

14. Rentea RM, Peter SD, Snyder CL. Pediatric appendicitis: state of the art review. *Pediatr Surg Int*. 2017;33(3):269-283.

15. Skarda DE, Rollins M, Andrews S, et al. One hospital, one appendectomy: the cost effectiveness of a standardized doctor's preference card. *J Pediatr Surg*. 2015;50(6):919-922.

16. Akkoyun I. Outpatient laparoscopic appendectomy in children: a single center experience with 92 cases. *Surg Laparosc Endosc Percutan Tech*. 2013;23(1):49-50.

17. Yu YR, Abbas PI, Smith CM, et al. Time-driven activity-based costing to identify opportunities for cost reduction in pediatric appendectomy. *J Pediatr Surg*. 2016;51(12):1962-1966.

18. Conway PH. Partnership for patients: Innovation and leadership for safer healthcare. *J Healthc Manag*. 2017;62(3):166-170.

19. Hackbarth AD, Munier WB, Eldridge N, et al. An overview of measurement activities in the partnership for patients. *J Patient Saf*. 2014;10(3):125-132.

20. Polites SF, Potter DD, Glasgow AE, et al. Rates and risk factors of unplanned 30-day readmission following general and thoracic pediatric surgical procedures [published online December 9, 2016]. *J Pediatr Surg*. doi:10.1016/j.jpedsurg.2016.11.043

21. Bardach NS, Vittinghoff E, Asteria-Peñaloza R, et al. Measuring hospital quality using pediatric readmission and revisit rates. *Pediatrics*. 2013;132(3):429-436.

22. Brown EG, Anderson JE, Burgess D, Bold RJ, Farmer DL. Pediatric surgical readmissions: are they truly preventable? *J Pediatr Surg*. 2017;52(1):161-165.

23. Kao LS, Ghaferi AA, Ko CY, Dimick JB. Reliability of superficial surgical site infections as a hospital quality measure. *J Am Coll Surg*. 2011;213(2):231-235.

24. Putnam LR, Ostovar-Kermani TG, Le Blanc A, et al. Surgical site infection reporting: more than meets the agar. *J Pediatr Surg*. 2017;52(1):156-160.

25. Choban PS, Flancbaum L. The impact of obesity on surgical outcomes: a review. *J Am Coll Surg*. 1997;185(6):593-603.

26. Pemberton LB, Manax WG. Relationship of obesity to postoperative complications after cholecystectomy. *Am J Surg*. 1971;121(1):87-90.

27. Galyfos G, Geropapas GI, Kerasidis S, Sianou A, Sigala F, Filis K. The effect of body mass index on major outcomes after vascular surgery. *J Vasc Surg*. 2017;65(4):1193-1207.

28. Onyekwelu I, Glassman SD, Asher AL, Shaffrey CI, Mummaneni PV, Carreon LY. Impact of obesity on complications and outcomes: a comparison of fusion and nonfusion lumbar spine surgery. *J Neurosurg Spine*. 2017;26(2):158-162.

29. Yannam GR, Griffin R, Anderson SA, Beierle EA, Chen MK, Harmon CM. Single incision pediatric endosurgery (SIPES) appendectomy—is obesity a contraindication? *J Pediatr Surg*. 2013;48(6):1399-1404.

30. Sood A, Abdollah F, Sammon JD, et al. The effect of body mass index on perioperative outcomes after major surgery: results from the National Surgical Quality Improvement Program (ACS-NSQIP) 2005-2011. *World J Surg*. 2015;39(10):2376-2385.

31. Zhang JX, Song D, Bedford J, Bucevska M, Courtemanche DJ, Arneja JS. What is the best way to measure surgical quality? comparing the American College of Surgeons National Quality Improvement Program versus Traditional Morbidity and Mortality Conferences. *Plast Reconstr Surg*. 2016;137(4):1242-1250.