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Shifts towards pediatric specialists in the treatment of appendicitis and pyloric stenosis: Trends and outcomes

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ABSTRACT

Background: Little data exists on temporal changes in the care of children with common surgical conditions. We hypothesized that an increasing proportion of procedures are performed at pediatric hospitals over time, and that outcomes are superior at these centers.

Methods: We conducted a retrospective cohort study using Washington State discharge records for children 0–17 years old undergoing appendectomy (n = 39,472) or pyloromyotomy (n = 3,500). Pediatric hospitals were defined as centers with full-time pediatric surgeons. Outcomes were examined for two time periods (1987–2000, 2001–2009).

Results: From 1987 to 2009, the proportion of procedures performed at pediatric hospitals steadily increased. The percentage for appendectomies increased from 17% to 32%, and that for pyloromyotomies increased from 57% to 99%. For pyloromyotomy, care at a pediatric hospital was associated with decreased risk of postoperative complications (OR = 0.36, $p < 0.001$) for both time periods. Appendectomy outcomes did not differ significantly in the early time period, but in the later time period specialist care was associated with lower risk of complications in children <5 years (OR = 0.54, $p = 0.03$).

Conclusion: There has been a shift towards pediatric hospitals for certain procedures, with a widening disparity in outcomes for younger children. These results suggest that procedures in younger patients may best be performed by providers familiar with these patient populations.

Hospital and provider characteristics have been implicated as key factors that may influence post-operative outcomes in surgical patients. In adult surgery, operative volume is one such factor that has been widely studied [1,2]. Although many of the intricacies of the relationship between provider experience and outcomes remain undefined, the strength of evidence has led to changes in policy directed at regionalization of care in adult surgery, with some indications of improved outcomes following such measures [3,4].

Recent research efforts have also sought to determine the influence of surgeon and hospital factors on outcomes in children with surgical illness. While there is a relatively large body of evidence supporting a link between provider characteristics (e.g. operative volume, surgeon specialty training, hospital designation) and outcomes in pediatric surgery, the quality of these data are highly variable, and results depend greatly upon the complexity of the procedure of interest [5]. In order to simplify comparisons, many studies in this area have focused on common, low-complexity procedures (e.g. appendectomy, pyloromyotomy), and many have shown improved outcomes for children treated at specialty centers and by fellowship-trained pediatric surgeons [6–12]. Based on such findings, recommendations have been put forth urging referral of younger children with surgical needs to pediatric specialists [13]. The extent to which such changes in practice have occurred, and the extent to which post-operative outcomes have changed over time, have not been investigated.

In order to identify the temporal changes in practice with regard to where children with surgical diseases are treated, and to compare post-operative outcomes for children treated at pediatric versus non-pediatric hospitals during two different time periods, we conducted a population-based retrospective cohort study on children undergoing non-incidental appendectomy and pyloromyotomy in Washington State over a 23 year period. We hypothesized that an increasing proportion of procedures would be performed at hospitals with pediatric surgeons over time, and that the risk of post-operative complications at pediatric hospitals relative to non-pediatric hospitals would change over time.

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1. Methods

1.1. Study design

We performed a population-based retrospective cohort study using the Washington State Comprehensive Hospital Abstract Reporting System (CHARS), a statewide inpatient hospital discharge database that provides de-identified patient data regarding age, gender, payer status, diagnoses, procedures, length of stay, and discharge disposition. The study was approved by the University of Washington Institutional Review Board (IRB #39105).

1.2. Study subjects

Using hospital discharge records from January 1, 1987 to December 31, 2009, we identified all patients <18 years of age who underwent non-incidental appendectomy or pyloromyotomy. Appendectomy patients were defined as those with a procedure code for appendectomy (ICD-9 procedure code 47.0, 47.01, 47.09) in the absence of a code for incidental appendectomy. Patients with benign GI neoplasms or malignant neoplasms, and those with inflammatory bowel disease were excluded. Pyloromyotomy patients were defined as those with both a procedure code for pyloromyotomy (43.3) and a diagnostic code for infantile pyloric stenosis (750.5). Pyloromyotomy patients ≥1 year of age were excluded (these data do not record age in months).

1.3. Covariates of interest

We defined "pediatric hospital" as any hospital employing full-time, fellowship-trained pediatric surgeons who were available 24/7, as our goal was to have treatment at a pediatric hospital represent treatment by a pediatric surgeon. Of 5 hospitals that met these criteria, 3 were freestanding children's hospitals employing only pediatric surgeons. Excluding the other 2 hospitals (designated children's units in adult hospitals) from the analysis did not substantively change our results, so all five were included in the analysis. All other hospitals were considered "non-pediatric hospitals". One hospital in our study had part-time pediatric surgeon coverage from 1988–1996, and thus did not meet criteria as a pediatric hospital. Neither excluding this hospital nor treating it as a pediatric hospital for the years 1988–1996 substantively changed our results, so we left it as a non-pediatric hospital in our analysis. Demographic factors were extracted including gender, age, Medicaid insurance status, and perforation status (for appendectomy patients). Chronic comorbid conditions were identified using a set of ICD-9 codes selected a priori, as these variables are commonly considered as potential confounding factors in pediatric outcomes research (Appendix A) [14]. Post-operative complications were defined using ICD-9 codes indicating complications attributed to medical or procedural treatment (Appendix B). Duodenal perforation in pyloromyotomy patients was defined as a code for accidental perforation during procedure (998.2) [12]. Negative appendectomy was defined as appendectomy in the absence of a diagnosis of appendicitis [15,16]. There were no missing data for the covariates considered in the study.

1.4. Statistical analysis

Descriptive statistics were used to compare characteristics according to hospital type for both appendectomy and pyloromyotomy patients. The proportion of all procedures in the state that were performed at a pediatric hospital was determined for each procedure for each year of the study. Multivariate logistic regression was used to quantify the odds of treatment at a pediatric hospital according to each successive year in the study. The odds of post-operative outcomes (complications, negative appendectomy) according to hospital type were quantified using multivariate logistic regression models. Post-operative outcomes were analyzed separately for the time periods 1987–2000 and 2001–2009. We chose this time period breakdown because in 2001 the American Academy of Pediatrics released a position statement urging referral of certain childhood surgical cases to pediatric specialists[13]. Outcomes in appendectomy patients were analyzed in the full cohort and stratified by age group. $P < 0.05$ was considered statistically significant. Regression models were adjusted for clustering at the hospital level using a random-effects model in order to account for the non-independence of sampling.

Statistical analysis was performed using Stata 12 (College Station, TX).

2. Results

2.1. Appendectomy

Over the course of the study period, 39,472 patients underwent non-incidental appendectomy. The majority of patients were older than 10 years (62.5%), and 26.8% were perforated (Table 1). The negative appendectomy proportion was 8.9%. Overall, 22.0% of patients received treatment at a pediatric hospital.

The proportion of appendectomies performed at pediatric hospitals increased over time, from 17% in 1987 to 32% in 2009. The change was greatest for children younger than 5 years (Fig. 1). In a multivariate logistic regression model, the odds of receiving care at a pediatric hospital increased by 4% each successive year (OR = 1.04, 95% CI 1.03–1.04), with the greatest increase noted in patients younger than 5 years (OR = 1.05, 95% CI 1.04–1.06). Given that such results could be related to a relative increase in the population near pediatric relative to non-pediatric hospitals (rather than from a conscious treatment decision) we used state census data to look at the change in population in the three counties with pediatric hospitals. Rather than increasing, the total proportion of the state population in these counties decreased over the study (50.8% in 1980, 50.4% in 1990, 48.5% in 2000, and 47.6% in 2010, data not shown).

In comparing children treated in 1987–2000 to those treated in 2001–2009, 19.5% of children in the earlier period received care at a pediatric hospital, versus 25.3% in the later period. The change was greatest for children <5 years (37.5% to 51.5%). Perforation was more common at pediatric hospitals in both time periods, as were comorbid conditions and post-operative complications (Table 2). The negative appendectomy rate decreased from the earlier to the later time period for both groups, but to a greater degree at pediatric hospitals.

After multivariate adjustment, the odds of post-operative complications from 1987–2000 was similar at both hospitals types across all age groups (Table 4). Similar results were observed with regard to the odds of negative appendectomy. In the later time period, however, the odds of post-operative complications for children <5 years was significantly

Table 1
Characteristics of appendectomy and pyloromyotomy patients.

	Appendectomy (n = 39,472)	Pyloromyotomy (n = 3,500)
	n (%)	n (%)
Male	22,722 (57.6)	2,885 (82.4)
Age (years)		
<5	1,778 (4.5)	N/A
5–10	13,012 (33.0)	N/A
11–17	24,682 (62.5)	N/A
Perforated	10,560 (26.8)	N/A
Medicaid	10,079 (25.5)	1,629 (46.5)
Comorbid conditions	1,664 (4.2)	174 (5.0)
Any postop complication	1,713 (4.3)	101 (2.9)
Negative appendectomy	3,511 (8.9)	N/A
Duodenal perforation	N/A	54 (1.5)
Treated at pediatric hospital	8,701 (22.0)	2,383 (68.1)