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# Outcomes and costs of common surgical procedures at children's and nonchildren's hospitals



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## ABSTRACT

**Background:** Variations in the management of pediatric patients at children's hospitals (CHs) and non-CHs (NCHs) have been well described, especially within the trauma literature. However, little is known about the outcomes and costs of common general surgical procedures at NCHs. The purpose of this study was to evaluate the effect of CH designation on the outcomes and costs of appendectomy and cholecystectomy.

**Methods:** The Kids' Inpatient Database (2003-2012) was queried for patients aged under 18 y who underwent appendectomy or cholecystectomy at CHs and NCHs. Outcomes analyzed included disease severity, complications, laparoscopy, length of stay (LOS), and cost.

**Results:** Most of appendectomies and cholecystectomies were performed at NCHs. Overall, CHs cared for younger children were more likely to be teaching hospitals, had higher costs, and longer LOS. On multivariate analysis for appendectomies, CHs were associated with higher rates of perforated appendicitis (OR = 1.53, 95% CI = 1.42-1.66,  $P < 0.001$ ), less complications (OR = 0.68, 95% CI = 0.61-0.75,  $P < 0.001$ ), increased laparoscopy (OR = 2.93, 95% CI = 2.36-3.64,  $P < 0.001$ ), longer LOS (RR = 1.13, 95% CI = 1.09-1.17,  $P < 0.001$ ), and higher costs (exponentiated log \$ = 1.19, 95% CI = 1.13-1.24,  $P < 0.001$ ). Multivariate analysis for cholecystectomies revealed that CHs were associated with less laparoscopy (OR = 0.58, 95% CI = 0.50-0.67,  $P < 0.001$ ), longer LOS (RR = 1.26, 95% CI = 1.19-1.34,  $P < 0.001$ ), and higher costs (exponentiated log \$ = 1.29, 95% CI = 1.22-1.37,  $P < 0.001$ ) with similar complications. Independent predictors of LOS and cost included CH designation, negative appendectomy, perforated appendicitis, complications, younger age, black patients, and public insurance.

**Conclusions:** Variations in surgical management, outcomes, and costs after appendectomy and cholecystectomy exist between CHs and NCHs. CHs excelled in treating complicated

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appendicitis. NCHs effectively performed cholecystectomies. These differences in outcomes require further investigation to identify modifiable factors to optimize care across all hospitals for these common surgical diseases.

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## Introduction

Disparities in the outcomes of pediatric surgical patients nationwide continue to be a driving force for research studies to further characterize the individual and cumulative influences of hospital, surgeon, and patient factors on surgical outcomes.<sup>1,2</sup> Multidisciplinary groups have begun to create evidence-based initiatives with the goal of optimizing the delivery of surgical care to children in the United States.<sup>1</sup> However, children's hospital (CH) designation and its effect on the outcomes and quality of care received by pediatric surgical patients remain to be a controversial subject with many studies reporting worse outcomes and lower quality of care when pediatric patients are treated at non-CHs (NCHs).<sup>1,3-7</sup> Few studies show equivalent outcomes and rarely any studies show improved outcomes at NCHs.<sup>1,8,9</sup> This has been well described in the pediatric trauma literature<sup>3,4</sup> and in select pediatric surgical conditions.<sup>5-9</sup> However, the variations in outcomes and costs of children undergoing common general surgical procedures have not been well studied between CHs and NCHs.

Therefore, the purpose of our study was to use national data to evaluate the effect of CH designation on the outcomes and costs of appendectomies and cholecystectomies performed on pediatric patients. We hypothesized that variations in the management of pediatric patients, as well as differences in resource utilization, at CHs and NCHs would lead to different outcomes and costs for these two common general surgery operations.

## Materials and methods

### Data source

The Kids' Inpatient Database (KID) from the Healthcare Cost and Utilization Project (HCUP) comprises data from pediatric inpatient discharges from community hospitals in the United States for patients below the age of 21 y.<sup>10</sup> The database is released every 3 y and the most recent year, 2012, includes data from 4179 hospitals in 44 states. The KID contains information regarding basic hospital characteristics, teaching hospital status, patient demographics, insurance status, diagnoses, procedures performed, hospital length of stay (LOS), and total charges. The 2012 database stratifies hospital type into freestanding CHs or other hospitals based on data from the Children's Hospital Association. For our study, CHs were defined as freestanding CHs, which admit children only and do not include children's units in general hospitals. Patient transfer data were only available for database years 2009 and 2012 and was thus not included in our analysis. Cost was derived from charges using the charge-to-cost ratio files provided by the HCUP<sup>11</sup> and published medical consumer price

index. The cost was adjusted to represent 2010 dollars to account for inflation.<sup>12</sup> This study was exempted from IRB approval by the Human Subjects Committee at Harbor–UCLA Medical Center.

### Study population

We queried the KID from the years 2003, 2006, 2009, and 2012 for all pediatric patients below the age of 18 y who either underwent nonincidental appendectomy or cholecystectomy as their primary procedure. To identify inpatient hospitalizations for nonincidental appendectomy, we used International Classification of Diseases, Ninth Revision (ICD-9) procedure codes 47.01 (laparoscopic appendectomy) and 47.09 (other appendectomy). To identify inpatient hospitalizations for cholecystectomy, we used ICD-9 procedure codes 51.21 (other partial cholecystectomy), 51.22 (cholecystectomy), 51.23 (laparoscopic cholecystectomy), and 51.24 (laparoscopic partial cholecystectomy). Each patient was then stratified into CH and NCH cohorts based on the hospital where the operation was performed.

### Outcomes

The primary outcomes analyzed in this study included disease severity, complication rates, laparoscopy use, hospital LOS, and cost. Disease severity for nonincidental appendectomies was categorized as negative appendectomy; appendectomy for acute, nonperforated appendicitis; or appendectomy for perforated appendicitis. A negative appendectomy was defined as a nonincidental appendectomy without a diagnosis of appendicitis or an appendectomy where appendicitis was not among the first three diagnoses.<sup>13,14</sup> Acute, nonperforated appendicitis was identified with ICD-9 codes 540.9 (acute appendicitis without mention of peritonitis), 541 (appendicitis, unqualified), and 542 (other appendicitis). Perforated appendicitis was identified by ICD-9 codes 540.0 (acute appendicitis with generalized peritonitis) or 540.1 (acute appendicitis with peritoneal abscess). Diagnosis of cholecystitis was determined using ICD-9 diagnosis codes 575.0 (acute cholecystitis), 575.1 (other cholecystitis), 575.10 (cholecystitis, unspecified), 575.11 (chronic cholecystitis), and 575.12 (acute and chronic cholecystitis). ICD-9 code 575.3 (hydrops of the gallbladder) was used as a marker for disease severity in cholecystectomy patients.

We investigated the common complications associated with appendectomy and cholecystectomy including infectious complications (wound infection, intra-abdominal abscess) and intestinal complications (perforation, *Clostridium difficile* infection, other digestive system complications) using appropriate ICD-9 codes. Other miscellaneous complications included renal failure, postoperative respiratory complications (atelectasis, pneumonia, pneumothorax, acute

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