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Assessing quality in pediatric surgery — the limited role of appendectomy as the optimal target

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Abstract

Background: Appendectomy is one of the highest volume procedures in children performed across a variety of hospital types in the U.S. potentially making it the ideal procedure to target when assessing hospital and surgeon quality. Though appendiceal perforation rate has been identified as a potential quality target reflecting primary care access, perforation rates have little association with hospital or surgeon quality. The utility and reliability of appendectomy as a target procedure to judge hospital quality based on outcomes beyond perforation rates are unknown.

Methods: Using the 2008 Nationwide Inpatient Sample, hospital pediatric appendectomy volumes were determined. Based on literature review, a variety of complication rate thresholds to identify hospital outlier status were determined using sample size calculations. The percent of U.S. hospitals that could exceed volume thresholds in order to be reliably compared was determined.

Results: Several complication rates of interest were identified ranging from mortality at 0.19% to a composite overall morbidity at 6.44%. Minimum hospital caseloads required to detect a doubling of complication rates included 127 cases for a composite overall morbidity, 276 cases for wound infection, 285 cases for negative appendectomy, 335 cases for intra-abdominal abscess, 438 cases for postoperative ileus, and 4,729 cases for mortality. Based on annual volumes, only 22% of hospitals met the minimum volume thresholds for a composite overall morbidity. In order to use other outcomes to assess quality, multiple year aggregate data are needed in order to generate volumes sufficient for comparison. Even with 5 year aggregate data less than 2% of hospitals could be compared based on mortality.

Conclusions: For the vast majority of complications very few hospitals accrue enough procedure specific volume with appendectomy to judge quality even with multiple years of data collection. In order to best assess hospital quality in children's surgery alternate targets beyond procedure specific traditional outcomes warrant exploration.

Patients, payor groups, policy makers, and health care providers are searching for methods to improve the quality of surgical care being delivered in the United States (U.S.) and

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the realm of children's surgery is no exception [1–4]. Almost 3 million children undergo surgical procedures in the U.S. annually with very little knowledge of the incidence and nature of complications. Beyond the efforts of specialty groups such as congenital heart surgery [5–7], children's trauma management [8–10], and children's surgical oncology [11–13], hospital-level assessment of children's surgical quality has been difficult to assess. Efforts have been initiated to prospectively collect outcome data for children undergoing surgical procedures but these programs remain in early phases of development [14]. Sample size is a fundamental limitation to identifying surgical procedures to target for quality improvement in children. Across all pediatric procedures event rates related to surgical morbidity and mortality are exceedingly low. Even at the busiest pediatric referral centers, the procedures for which complications are higher are rare. The ideal quality target procedure must be one that is frequently performed, has a measurable incidence of postoperative outcomes, and entails variation in practice management patterns on which to focus quality improvement efforts. Finally, the outcomes used to define quality should be mutable allowing for continued assessment and improvement efforts to be of significant benefit.

There are over 80,000 appendectomies performed in children annually in the U.S. [15]. Variations in practice patterns for appendicitis from diagnosis to timing of surgery and postoperative management are well documented [16–18]. Furthermore, outcomes after appendicitis have been correlated to hospital volume as well as socioeconomic factors [19–21]. Rate of perforated appendicitis in children has been identified as a target for quality assessment for primary care access by the Agency for Healthcare Research and Quality (AHRQ) [22]. Though appendiceal perforations are common in children and this outcome may serve as an effective measure of regional access, it has been challenged in terms of being an appropriate measure at the surgeon or hospital level [19,21,23]. Several potential appendectomy outcomes of interest other than perforation rate have been suggested but the feasibility of these outcomes to be used to assess hospital quality remains unknown. Based on the volume of appendectomies performed and the variety of hospital types that perform appendectomies in children, appendectomy is often heralded as the ideal children's surgical procedure to use a quality metric and may serve as a barometer of surgical quality at the hospital level.

This study was designed to assess if appendectomy could be used to assess hospital-level surgical quality using outcomes other than appendiceal perforation rates. Complication rates following appendectomy were determined using available literature. We then estimated the minimum sample size needed to identify a poorly performing hospital as significantly different. Using the AHRQ National Inpatient Sample (NIS), we determined the proportion of U.S. hospitals that exceeded this minimum case load requirement and for which a quality outcome measure could be applied.

1. Methods

1.1. Data source

Using the AHRQ sponsored Healthcare Cost and Utilization Project (HCUP) NIS data on patient encounters were analyzed. The NIS is designed to approximate a sample of U.S. community hospitals, including public and/or academic adult as well as pediatric institutions [24]. NIS hospital level sampling is based on five hospital characteristics: geographic region, public versus private status, urban or rural location, teaching status, and bed size. Ultimately, the 20% sampling provided serves as a direct reflection of hospitalizations at various hospital types or strata in the U.S. during a given year. The 2008 version of NIS contains discharge data on 8,158,381 encounters from 1056 hospitals representing 42 States. NIS does not provide linkage from year to year based on hospital specific variables and different hospitals are purposefully selected for inclusion from one year to the next. Thus, we assumed hospital caseloads are stable over time and estimated multiyear models using NIS 2008 hospital volumes.

1.2. Case selection

All NIS discharges from 2008 were searched for *International Classification of Diseases*, *Ninth Revision* (ICD-9) procedure codes for appendectomy. Codes utilized included 47.0 (appendectomy), 47.01 (laparoscopic appendectomy), or 47.09 (other appendectomy). We purposefully omitted patients undergoing incidental appendectomy. The cohort was limited to patients ranging from 1 to 18 years of life. Case volumes were tabulated for each hospital and descriptive statistics were generated.

1.3. Literature review and analytics

Appendectomy represents one of the most studied procedures in all of pediatric surgery. Based on the availability of numerous large retrospective studies of hospital-level and administrative data, several prospective randomized controlled trials, as well as several meta-analyses of outcomes after appendectomy, the complication rates for various outcomes of interest after appendectomy have been well established. We performed a literature review and selected studies that provide benchmarks for complications rates based on the best available data from contemporary studies. A variety of outcomes of interest were selected and Table 1 provides a brief overview of studies used as the primary sources for various complication rates [17,19,25–27].

In order to identify outliers, the benchmark complication rates established from the literature review were doubled. Sample size calculations were performed using one-sample, one-sided tests (alpha set to 0.05) with a power of 80% [28]. One-sample tests provide insight as to whether a single hospital is an outlier compared to the benchmarks established from the literature review. One-sided tests allow for identification of a