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Increased pediatric sub-specialization is associated with decreased surgical complication rates for inpatient pediatric urology procedures

R. Tejwani [a], H.-H.S. Wang [a], B.J. Young [a], N.H. Greene [b], S. Wolf [c], J.S. Wiener [a], J.C. Routh [a]

[a]Division of Urologic Surgery, Duke University Medical Center, Durham, NC, USA

[b]Division of Pediatric Anesthesia, Duke University Medical Center, Durham, NC, USA

[c]Department of Biostatistics and Bioinformatics, Duke University Medical Center, Durham, NC, USA

Correspondence to: J.C. Routh, Division of Urologic Surgery, Duke University Medical Center, DUMC 3831, Durham, NC 27710, USA, Tel.: +1 919 684 6994; fax: +919 681 5507

jonathan.routh@duke.edu (J.C. Routh)

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Summary

Introduction
Increased case volumes and training are associated with better surgical outcomes. However, the impact of pediatric urology sub-specialization on perioperative complication rates is unknown.

Objectives
To determine the presence and magnitude of difference in rates of common postoperative complications for elective pediatric urology procedures between specialization levels of urologic surgeons. The Nationwide Inpatient Sample (NIS), a nationally representative administrative database, was used.

Study design
The NIS (1998–2009) was retrospectively reviewed for pediatric (≤18 years) admissions, using ICD-9-CM codes to identify urologic surgeries and National Surgical Quality Improvement Program (NSQIP) inpatient postoperative complications. Degree of pediatric sub-specialization was calculated using a Pediatric Proportion Index (PPI), defined as the ratio of children to total patients operated on by each provider. The providers were grouped into PPI quartiles: Q1, 0–25% specialization; Q2, 25–50%; Q3, 50–75%; Q4, 75–100%. Weighted multivariate analysis was performed to test for associations between PPI and surgical complications.

Results
A total of 71,479 weighted inpatient admissions were identified. Patient age decreased with increasing specialization: Q1, 7.9 vs Q2, 4.8 vs Q3, 4.8 vs Q4, 4.6 years, $P < 0.01$). Specialization was not associated with race ($P > 0.20$), gender ($P > 0.50$), or comorbidity scores ($P = 0.10$). Mortality (1.5% vs 0.2% vs 0.3% vs 0.4%, $P < 0.01$) and complication rates (15.5% vs 11.7% vs 9.6% vs 10.9%, $P < 0.0001$) both decreased with increasing specialization. Patients treated by more highly specialized surgeons incurred slightly higher costs (Q2, +4%; Q3, +1%; Q4 + 2%) but experienced shorter length of hospital stay (Q2, −5%; Q3, −10%; Q4, −3%) compared with the least specialized providers. A greater proportion of patients treated by Q1 and Q3 specialized urologists had CCS ≥2 than those seen by Q2 or Q4 urologists (12.5% and 12.2%, respectively vs 8.4% and 10.9%, respectively, $P = 0.04$). Adjusting for confounding effects, increased pediatric specialization was associated with decreased postoperative complications: Q2 OR 0.78, CI 0.58–1.05; Q3 OR 0.60, CI 0.44–0.84; Q4 OR 0.70, CI 0.58–0.84; $P < 0.01$.

Discussion
Providers with proportionally higher volumes of pediatric patients achieved better postoperative outcomes than their less sub-specialized counterparts. This may have arisen from increased exposure to pediatric anatomy and physiology, and greater familiarity with pediatric techniques.

Limitation
The NIS admission-based retrospective design did not enable assessment of long-term outcomes, repeated admissions, or to track a particular patient across time. The study was similarly limited in evaluating the effect of pre-surgical referral patterns on patient distributions.

Conclusions
Increased pediatric sub-specialization among urologists was associated with a decreased risk of mortality and surgical complications in children undergoing inpatient urologic procedures.

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Introduction

In recent years, professional bodies and policy makers have shown interest in identifying physician and hospital attributes associated with improved patient outcomes. Previous studies have found that increased case volumes, high center operative volumes, and resident training for pediatric surgery are associated with a decreased likelihood of postoperative mortality across several surgical sub-specialties [1–7]. Explanations for these relationships vary, but are believed to stem from greater familiarity with pediatric anatomy, physiology, and surgical techniques better suited for children [8–10]. There may also be effects of the pediatric anesthesiology sub-specialization, which are likely heavily correlated with the surgical sub-specialization [11–13]. However, these studies remain limited; within urology, little is known about the impact of the pediatric sub-specialization on the likelihood of post-operative complications.

Understanding the degree to which the pediatric sub-specialization affects patient outcomes is particularly salient to urology, given the variability in training, practice environment, and case-mix amongst urologists operating on children. Despite growth in the number of pediatric urology fellowship programs, the nationwide number of urologists with certificates in the added qualification of pediatric urology remains relatively small [14]. A significant number of pediatric urologic surgeries are currently performed by general urologists. Rhee et al. previously demonstrated that a surgeon's degree of sub-specialization might be represented using a provider's Pediatric Proportion Index (PPI) (i.e. the relative proportion of pediatric versus total surgeries by a given surgeon) [1]. However, they did not find a mortality difference among high-volume and low-volume urologists. It is suspected that this null outcome was at least in part due to the fact that very few pediatric urologic surgeries were associated with a high mortality rate. However, complications do occur in pediatric urologic surgeries, and it was hypothesized that complications might differ depending on each urologist's degree of pediatric specialization.

The present study sought to determine the presence of well-defined postoperative complications for elective pediatric urology procedures between pediatric urologic surgeons across a range of pediatric sub-specializations using the Nationwide Inpatient Sample (NIS), which is a contemporary, nationally representative administrative database.

Methods

Data source

The NIS is an all-payer database managed by the Healthcare Cost and Utilization Project (HCUP), and sponsored by the Agency for Healthcare Research and Quality (AHRQ). The NIS is derived from a 20% stratified probability sample of hospitals in the USA, including both children's and adult hospitals, based on five hospital characteristics, including: ownership status, number of beds, teaching status, urban/rural location, and geographic region. The NIS includes post-stratification discharge weights that may be used to calculate national estimates [15]. This data set also includes individual surgeon identifiers, allowing for provider-specific analyses.

Selection of patients

All inpatient hospital encounters occurring between 1998 and 2009 for pediatric patients (<18 years old) were identified with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code for elective, inpatient pediatric urologic procedures, including: ureteral reimplantation, uretero-ureterostomy, pyeloplasty, radical nephrectomy, partial nephrectomy, bladder exstrophy repair, appendicovesicostomy, bladder augmentation, vesicostomy, bladder neck sling, and percutaneous nephrolithotomy (see Appendix 1 for ICD-9-CM codes). Patients were excluded if they did not have an identified urologist or if their urologist did not qualify to receive a PPI.

Calculation of Pediatric Proportion Index

The PPI was calculated, on an annual basis for each surgeon, as the ratio of children to all patients operated on in a given year, in order to account for year-to-year case-mix changes and variation in patient population and training during the period surveyed [1]. A urologist must have performed at least 21 surgeries in a given year to receive a PPI. Urologists were classified into four categories of specialization, as determined by quartiles: Q1, 0–25% specialization; Q2, 25–50%; Q3, 50–75%; Q4, 75–100%.

Outcome selection

The primary outcome was immediate postoperative complications during the operative admission; these were identified by the ICD-9-CM code (Appendix 2) that most closely corresponded to the complications described by the National Surgical Quality Improvement Program (NSQIP) [16]. Included were: superficial or deep surgical site infection (SSI), peritoneal abscess, acute renal failure (ARF), UTI, postoperative urinary complications, postoperative respiratory complications, pneumonia, postoperative respiratory insufficiency, acute respiratory distress syndrome, systemic sepsis, pulmonary embolism, mechanical ventilation >96 h, cerebrovascular accident, postoperative cardiac complications, myocardial infarction (MI), cardiac arrest, bleeding, and deep vein thrombosis (DVT). The probability of at least one complication occurring postoperatively was modeled. Also examined were: in-hospital mortality, cost, and length of stay (LOS) for each admission; however, due to the inpatient nature of the database used, any complications occurring after discharge (including death) would not be captured by this analysis. The NIS cost-to-charge files were used to convert hospital charges to costs. Due to a lack of conversion file availability, cost analyses were only analyzed from 2001 onward. Rare complications ($n \leq 15$) were not reported, as per AHRQ requirements in order to preserve anonymity.