Disparities in Pediatric Operative Experience during Urology Residency Training

Jason Silvestre, Jade M Hernandez, and David I. Lee

OBJECTIVE
To understand trends in pediatric cases performed during urology residency including intraresident variability and cases performed relative to required minimums.

MATERIALS AND METHODS
Case logs of urology residents graduating from 2010 to 2018 were analyzed. Temporal trends in reported pediatric case volume were assessed via ANOVA tests and calculation of compound annual growth rates (CAGRs). Percent differences between the 90th and 10th percentiles of residents were calculated to assess intraresident variability. Reported case volumes were compared with minimum requirements with t tests.

RESULTS
1072 residents from 306 urology residency programs were represented in this study. Minor pediatric cases increased from 2010 to 2018 (105.4 ± 54 vs 124.6 ± 65, P = .004, CAGR = 2.1%) while major pediatric cases decreased (83.9 ± 40 vs 60.8 ± 30, P < .001, CAGR = -3.9%). Orchiopexy (range, 23%-27%), hypospadias (range, 19%-21%), and hydrocele / hernia (range, 15%-19%) were the highest volume case categories. Mean intraresident variability in reported case volumes was 338% for minor pediatric (CAGR = 0%) and 382% for major pediatric (CAGR = 1.8%). Mean reported case volumes exceeded the minimum requirement for each case category by several fold (P < .001, range, percent difference 232-675%). All urology residents reported minimum pediatric case requirements in 2018.

CONCLUSION
Urology residents report more cases than minimum requirements for pediatric urology by several folds. Future research is needed to understand the implications of increasing intraresident case volume variabilities on residency training in pediatric urology. UROLOGY 127: 24−29, 2019. © 2019 Elsevier Inc.

To achieve Accreditation Council for Graduate Medical Education (ACGME) accreditation, urology residency programs must demonstrate the ability to provide sufficient pediatric operative experiences to graduating residents.1−3 Many programs accomplish this competency through dedicated rotations at affiliated pediatric hospitals. The ACGME requires every graduating urology resident to have performed a certain number of pediatric cases — termed the “minimum case requirement.” These minimum requirements serve, in part, to help define certain resident ACGME defined core competencies like “patient care.”2 While not necessary for successful graduation, final assessment of competency is left to the discretion of the urology residency program director.

While imperfect, minimum case requirements provide a quantitative benchmark for resident experience to perform key urologic procedures encountered during independent clinical practice.3 However, one critique may be that this benchmark is not high enough and greater exposure to pediatric urology especially is especially needed.4 Inadequate operative training during residency may present a complex issue for surgical educators and residents. Furthermore, large variabilities in operative case performed by urology residents present a challenging issue for the standardization of competency-based training.

This study analyzes temporal trends in case volumes and variabilities in reported pediatric case volumes of graduating urology residents. Given the identified need for greater exposure to pediatric urology during residency,4 we hypothesized that reported pediatric case volumes would increase and intraresident variabilities would decrease over time. Ultimately, this study may highlight several opportunities to improve pediatric operative training of urology residents.

MATERIALS AND METHODS
The institutional review board granted formal review exemption due to the public availability of ACGME resident case logs.5

Conflict of Interest: The authors have no conflicts of interest.

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Submitted: January 2, 2019, accepted (with revisions): February 4, 2019

https://doi.org/10.1016/j.urology.2019.02.002
0090-4295
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UROLOGY 127, 2019

The ACGME prospectively collects data on cases performed during surgical residency programs. The data are self-reported and reviewed by residency faculty on a semi-annual basis to assess attainment of minimum case requirements at the completion of residency. Each year, the ACGME publishes summative statistics from these case logs for all graduating residents in a surgical specialty. Case volumes represent cumulative operative experience at the completion of residency training. Means, standard deviations, and percentiles are available for operative experience in specific case categories.

Urology resident case logs were analyzed for pediatric operative experience across 9 consecutive national cohorts (2010 – 2018). There were 2 major categories: ‘Pediatric – Minor’ and ‘Pediatric – Major’; and 5 sub-categories. Under “Pediatric – Minor” there was “Endoscopy,” “Hydrocele / hernia,” and “Orchiopexy.” Under “Pediatric – Major” there was “Hypopadias” and “Ureter.” Each pediatric case category is an aggregation of common procedural terminology codes as defined by the ACGME (Supplemental Table 1).

Equal credit is conferred to the resident for 3 unique roles during an operation: surgeon, assistant, teaching surgeon. To achieve surgeon designation, the resident must be present for all critical portions of a case and perform critical steps of the procedure. An assistant is present for all critical portions of a case and assists the surgeon during the procedure. A teaching surgeon supervises the case, while overseeing the junior colleague during major portions of the procedure. The compound annual growth rate (CAGR) formula was then applied to case volumes to understand temporal trends in case categories. Chi square test for trend was used to understand trends in intraresident variability over the study period.

Mean reported case volumes were compared with minimum case requirements with student’s t test using Welch’s correction. Fold differences were calculated between the 90th percentile of reported cases and minimum case requirements to understand historical performance relative to graduation requirements. Fold differences were calculated between the 90th and 10th percentiles of reported case volumes for graduation year. Statistics were calculated using GraphPad Prism 6.02 Software (GraphPad, La Jolla, CA) and figures were created using Think-Cell 9 (GmbH & Co, Berlin, Germany).

RESULTS

Case statistics from 1,072 urology residents at 306 residency programs were analyzed in this study (Table 1). Trends in pediatric case volumes were mixed. “Pediatrics – Minor” case volume increased over the study period from 105.4 ± 54 to 124.6 ± 65 (P = .004, CAGR = 2.1%), with a true peak in 2015 (129.3 ± 70) and subsequent plateau. “Pediatrics – Major” case volume decreased over the study period from 83.9 ± 40 to 60.8 ± 30
The largest decrease in case volume was observed for “Ureter” from 31.9 ± 19 to 17.3 ± 12 (P < .001, CAGR = −8.3%) while the largest increase in case volume was observed for “Endoscopy” from 20.9 ± 27 to 37.4 ± 28 (P = .059, CAGR = 7.5%).

Pediatric urology cases were performed in the role of surgeon (range, 83.5% - 91.4%), assistant surgeon (range, 7.8%-15.6%), and teaching surgeon (range, 0.4%-1.1%). There was relative growth in the teaching surgeon (P = .039, CAGR = 11.0%) and assistant surgeon (P = .026, CAGR = 2.0%) roles with declines in the surgeon role (P = .019, CAGR = −0.3%) over the study period.

Figure 1 demonstrates the intraresident variability of reported pediatric case volume. For each case category, the mean reported case volume exceeded the minimum requirement by several fold (range, 2.3x to 6.8x, P < .001). Mean fold differences between the 90th and 10th percentiles of reported case volumes ranged from a low of 3.4x for “Pediatrics − Minor” to a high of 6.8x for “Endoscopy” (Table 2). Analysis of CAGRs for intraresident case volume variability demonstrated flat to negative growth rates for “Pediatrics − Minor” case categories (range, −6.8%-0%) and positive growth rates for “Pediatrics − Major” case categories (range, 1.8%-2.2%).

In 2018, all urology residents reported case volumes at or exceeding the minimum case requirements (Table 3). Between 2010 and 2017, urology residents consistently achieved minimum requirements for “Pediatrics − Major” and “Hypospadias.” Urology residents did not achieve case requirements in “Pediatrics − Minor” for 3 years, “Endoscopy” for 4 years, “Hydrocele/hernia” for 7 years, “Orchiopexy” for 1 year, and “Ureter” for 5 years.

**DISCUSSION**

From 2010 to 2018, operative case volumes increased for “Pediatrics − Minor” cases and decreased for “Pediatrics − Major” cases. The decrease is “Pediatrics − Major” cases was driven primarily by the decrease in “Ureter” cases (CAGR = −8.3%). Overall, some of this decrease may be attributable to a greater share of pediatrics cases going to subspecialized fellowship training or increasing work-hour restrictions for urology residents. Specific decreases in “Ureter” cases may also be driven by wider adoption of Deflux administration techniques and changes to vesicoureteral reflux treatment guidelines by the American Urological Association. On average, urology residents report more pediatrics cases than minimum requirements by several fold. In 2018, all urology residents achieved minimum requirements in pediatrics. However, while intraresident variabilities in reported pediatric case volumes stayed flat or decreased for most “Pediatrics − Minor” case sub-categories, the disparities increased for all “Pediatrics − Major” case categories. Thus, our hypotheses that reported pediatric case volumes would increase
### Table 2. Analysis of pediatric case volume variability between the 90th and 10th percentiles of residents, 2010-2018

<table>
<thead>
<tr>
<th>Case Category</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>Mean</th>
<th>CAGR of 90th / 10th Percentiles, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatrics — Minor</td>
<td>3.4x</td>
<td>2.9x</td>
<td>3.9x</td>
<td>3.3x</td>
<td>3.3x</td>
<td>3.6x</td>
<td>3.5x</td>
<td>3.2x</td>
<td>3.4x</td>
<td>3.4x</td>
<td>0%</td>
</tr>
<tr>
<td>Endoscopy</td>
<td>N/A</td>
<td>9.0x</td>
<td>7.4x</td>
<td>6.5x</td>
<td>6.2x</td>
<td>6.7x</td>
<td>6.0x</td>
<td>7.0x</td>
<td>5.5x</td>
<td>6.8x</td>
<td>−6.8%*</td>
</tr>
<tr>
<td>Hydrocele/hernia</td>
<td>5.6x</td>
<td>4.5x</td>
<td>4.8x</td>
<td>4.6x</td>
<td>4.3x</td>
<td>5.0x</td>
<td>3.9x</td>
<td>3.9x</td>
<td>4.0x</td>
<td>4.5x</td>
<td>−4.2%</td>
</tr>
<tr>
<td>Orchiopexy</td>
<td>3.7x</td>
<td>3.6x</td>
<td>3.9x</td>
<td>4.0x</td>
<td>4.3x</td>
<td>4.3x</td>
<td>3.7x</td>
<td>3.6x</td>
<td>4.2x</td>
<td>3.9x</td>
<td>1.6%</td>
</tr>
<tr>
<td>Pediatrics — Major</td>
<td>3.5x</td>
<td>3.7x</td>
<td>4.0x</td>
<td>3.9x</td>
<td>4.1x</td>
<td>4.0x</td>
<td>3.7x</td>
<td>3.6x</td>
<td>4.0x</td>
<td>3.9x</td>
<td>1.8%</td>
</tr>
<tr>
<td>Hypospadias</td>
<td>4.4x</td>
<td>4.9x</td>
<td>5.4x</td>
<td>4.6x</td>
<td>4.8x</td>
<td>5.2x</td>
<td>5.3x</td>
<td>4.6x</td>
<td>5.3x</td>
<td>4.9x</td>
<td>2.2%</td>
</tr>
<tr>
<td>Ureter</td>
<td>4.3x</td>
<td>5.7x</td>
<td>5.6x</td>
<td>5.9x</td>
<td>5.4x</td>
<td>4.4x</td>
<td>4.6x</td>
<td>4.4x</td>
<td>5.0x</td>
<td>5.0x</td>
<td>1.9%</td>
</tr>
</tbody>
</table>

Fold difference defined as 90th / 10th case volumes. CAGR, compound annual growth rate.

* CAGR for “Endoscopy” was calculated for 2011-2018 due to no value for 10th Percentile in 2010.

### Table 3. Analysis of urology residents reporting pediatric case volumes below minimum requirements, 2010-2018

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatrics — Minor</td>
<td>30</td>
<td>27</td>
<td>23</td>
<td>38</td>
<td>30</td>
<td>31</td>
<td>26</td>
<td>33</td>
<td>32</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>Endoscopy</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Hydrocele/hernia</td>
<td>10</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>10</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Orchiopexy</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Pediatrics — Major</td>
<td>15</td>
<td>19</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>11</td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Hypospadias</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Ureter</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Bold indicates that at least one resident did not achieve the minimum requirement.
and intraresident variabilities would decrease over time proved mostly false.

This study had several notable limitations. First, the ACGME publishes national case logs with summative statistics that prohibit specific insight into resident- or program-specific variables. Thus, the effect of program characteristics like pediatrics fellowship presence and program size could not be evaluated. Furthermore, resident characteristics such as gender could not be evaluated with our data. Second, while useful for reporting purposes, ACGME case categories provide limited insights into specific procedure codes. Thus, specific drivers into the “Ureter” case category, for example, could not be investigated. However, reported case categories are useful to both residents and faculty as they are tracked during residency. Third, case logs are self-reported and not all cases provide the same operative experience despite the equivalency of conferred credit. For example, pediatric urology attendings may permit different levels of autonomy during an operative case, yet the result is recorded equivalently on the resident case log. Lastly, the implications of high intraresident case volume variability on surgical proficiency remains unknown.

Reported case volumes ultimately provide a quantitative benchmark for resident evaluation. Ultimately, minimum case requirements should be established in an evidence-based manner and conjoined with the Urology Milestone Project to improve competency-based training in pediatric urology. In its shift towards competency-based training, the ACGME has commissioned the creation of Milestones for surgical training programs including pediatric urology fellowships. Published in July of 2015, the Urology Milestone Project provides specific milestones in a checklist format to determine a resident’s progression from Level 1 (incoming resident) through Level 4 (graduation target). Level 5 exists for a few exceptional residents who demonstrate aspirational goals of someone in practice for several years. Minimum case requirements could help define Level 4 especially for the “Patient Care” domains. Graduated requirements could also help define Levels 1-3 to ensure appropriate tracking for graduation.

Historically, a small number of urology residents do not achieve case minimums for pediatric urology each year. While this observation may warrant further investigation, the fact that urology residents unanimously reported minimum requirements in pediatric urology for 2018 is reassuring. Currently, the ACGME establishes case minimum requirements through expert consensus via recommendations of the residency review committee, for example, Level V evidence. In the future, case minimum requirements may be better informed through outcomes-based clinical research, for example, Level IV evidence and above. For example, a recent study demonstrated that pediatric urology fellows perform robotic assisted pyeloplasty in equivalent times as an attending surgeon after 37 cases. Similar studies could help inform case minimum requirements for core pediatric urology procedures during urology residency training. Evidence-based case minimum requirements could also be informed through studies that leverage resident surveys and faculty evaluations.

Programs that struggle to attain adequate pediatric operative volume could leverage alternative methods for resident education to supplement operative training in pediatric urology including virtual reality and simulation-based training. The effectiveness of trainers for robotic surgery and laparoscopic techniques are well-described. As the paradigm for urology residency training continues to evolve, the importance of simulation training as an adjunct to clinical training will increase. Furthermore, as the surgical literature consistently demonstrates lower complication rates for high volume surgeons, residency programs should reasonably aspire to afford the most robust operative experiences possible. However, competing interests will increasingly undermine this goal including work-hour restrictions and greater subspecialty fellowship training.

Lastly, in the era of hyper-specialization, it can be argued that increasing the pediatric operative experience for non-pediatric fellowship trained urologists has limited value. That is, overwhelmingly urologists with pediatrics training will increase. Furthermore, as robotics and minimally invasive techniques have increasing applications in adult urology, the skills and techniques of open surgery will be increasingly taught through subspecialty training in pediatric urology. Ultimately, however, more research is needed to define optimal environments for residency training in pediatric urology.

CONCLUSION
Reported case volumes for “Pediatrics – Minor” are increasing while those for “Pediatrics – Major” are decreasing. On average, urology residents reported more cases than the minimum requirements for pediatric urology by several fold. Intra-resident variabilities in reported case volumes are increasing for most pediatric urology case categories. Future research is needed to understand the implications of increasing intraresident case volume variabilities on residency training in pediatric urology.

AUTHOR’S PARTICIPATION

ETHICAL APPROVAL
The institutional review board granted formal review exemption due to the public availability of ACGME resident case logs.
Acknowledgment. The authors have no sources of funding to report.

SUPPLEMENTARY MATERIALS
Supplementary material associated with this article can be found in the online version at https://doi:10.1016/j.jurology.2019.02.002.

References