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Subspecialization in pediatric surgery: Results of a survey to the American Pediatric Surgical Association

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ABSTRACT

Background: Current practice patterns and opinions regarding subspecialization within pediatric surgery are not well known. We aimed to characterize the prevalence of and attitudes surrounding subspecialization within pediatric surgery.
Methods: An anonymous survey regarding subspecialization was distributed to all nonresident members of the American Pediatric Surgical Association.
Results: Of 1118 surveys, we received 458 responses (41%). A majority of respondents labeled themselves 'general pediatric surgeons' (63%), while 34% considered themselves general surgeons with a specific clinical focus, and 3% reported practicing solely within a specific niche. Subspecialists commonly serve as consultants for relevant cases (52%). Common niches included oncology (10%) and anorectal malformations (9%). Subspecialists felt to be necessary included transplant (79%) and fetal (78%) surgeons. Opinions about subspecialization were variable: 41% felt subspecialization improves patient care while 39% believe it is detrimental to surgeon well-roundedness. Only 10% felt subspecialists should practice solely within their subspecialty. Practicing at an academic hospital or fellowship program correlated with subspecialization, while length of time in practice did not.
Conclusion: While pediatric surgeons report that subspecialization may benefit patient care, concerns exist regarding the unfavorable effect it may have on the individual surgeon. A better understanding of how subspecialization affects quality and outcomes would help clarify its utility.
Type of study: Review article.
Level of evidence: Level V.

Contents

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The increasing number of pediatric surgery training programs and graduated pediatric surgeons has led to a sharp decline in exposure to index cases among practicing pediatric surgeons [1,2]. Extrapolating from largely adult data on volume–outcome relationships, a growing number of pediatric surgeons have asked if subspecialization within the field is both a natural evolution thereof and perhaps a change necessary to ensure that rare cases are being performed by experienced surgeons and teams. On the other hand, many surgeons in the pediatric surgery community have expressed a desire to remain "general pediatric surgeons" with a broad scope of practice.

In 2016, Langer et al. [3] reported on the wide variability seen in subspecialization in pediatric surgery in North America. However, current practice patterns regarding subspecialization within pediatric surgery are not well characterized. The dichotomy of opinions on the pros and cons of subspecialization is similarly undefined. Similarly, the attitudes of pediatric surgeons toward the evolving nature of the specialty and the growing number of surgeons with a stable population rate of index cases remain unclear.

The aim of this study was to further clarify and characterize current practice patterns and opinions toward subspecialization within the field of pediatric surgery.

1. Materials and methods

After obtaining Institutional Review Board approval, an anonymous survey was sent to all nonresident members of the American Pediatric Surgery Association. The survey was initially sent September 4, 2018. A reminder was sent September 25, 2018 and the survey was closed September 30, 2018. The survey was created by the Delivery of Surgical Care Committee of the American Association of Pediatrics. It consisted of questions regarding the nature of one's practice, in addition to questions regarding opinions regarding subspecialization. Additionally, there was an open-ended section for free text responses. The survey is shown in Supplemental Fig. 1.

Descriptive statistics (*e.g.* frequencies and proportions for categorical variables) were calculated for the full list of respondents as well as for each surgeon type. Surgeon type was described using both a 3-level variable (general pediatric surgeon, general pediatric surgeon who has a focus within a specific niche, or pediatric surgeon that only practices within a specified niche) and a binary variable (self-identified generalists *vs.* generalists with a niche or specialists). Years in practice was analyzed as a 5-level categorical variable (<5 years, 10– <15 years, 15–<20 years, >20 years).

Additionally, a multilevel breakdown of subgroups of respondents was described within each self-classified type whose responses to other survey questions strongly suggest self-misclassification of the true type of surgeon. These 8 categories were as follows:

1. General pediatric surgeons who appear to be "true" generalists
2. Respondents who self-identify as a general pediatric surgeon but indicated some specialization/niche (may be a specialist)
3. Respondents who self-identified as a general pediatric surgeon but checks off >5 specialties
4. Respondents who self-identified as general with a niche, but no niche specified
5. Respondents who self-identified as general pediatric surgeons who practice within a niche(s)
6. General with a niche but too many niches specified (probably a general pediatric surgeon)
7. "True" specialists
8. Respondents who self-identified as a specialist but stated they do not specialize in other survey questions.

This 8-level variable was used for descriptive purposes only.

For inferential analyses, only a binary classification of self-identified generalists *vs.* all others (generalists with a niche or specialists) was utilized. Furthermore, inferential analysis excluded two subjects who did not provide a response to the type of surgeon. To assess potential factors that may correlate with surgeon classification type (generalist *vs.* generalist with a niche or specialist), chi-square tests of association were performed. For all aims, a result was considered significant at the $p < 0.05$ level of significance. All analyses of non-open-ended questions were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC).

The responses to an open-ended opinion section of the survey were coded using NVivo (Melbourne, Australia, Version 12) software. The text was scanned in its entirety to develop a set of codes to capture how respondents articulated their feelings regarding subspecialization. Thematic analysis was then conducted to group the final codes into themes.

2. Results

Of 1118 members surveyed, there were 458 responses (41%). Of these, 456 responses met inclusion criteria and were used for analysis. Demographics of respondents are listed in Table 1. Respondents typically worked in large academic hospitals (62%) and a plurality had been in practice for more than 20 years (37.2%).

A majority of respondents labeled themselves as generalists ($n = 286$ or 62.7%), while 34.4% considered themselves generalists with a niche ($n = 157$), and 2.9% reported being a specialist ($n = 13$). Using the 8-level classification system, 10.7% of respondents were estimated to be misclassified. There were 257 general surgeons who appear to be "true" generalists (89.8% of those that self-identified as a generalist, 56.3% of the total cohort). 25 respondents self-identified as a generalist, but indicated some areas of specialization/ niche (may be a specialist). 4 respondents self-identified as generalists and designated >5 areas of specialty, implying they may not in fact be generalists. There were 138 "true" generalists with a niche (87.9% of those that self-identified as a generalist with a niche, 30.2% of the total cohort). Seventeen respondents self-identified as a generalist with a niche but no area of a niche was specified (may be a generalist), and 2 self-identified generalists with a niche, but had multiple niches specified (may be a generalist). There were 12 "true" specialists. One respondent self-identified as a specialist, but stated they do not specialize in all other relevant survey questions. These data are depicted in Table 2.

Almost 40% of respondents reported that they have partners that designate themselves as specialists. Of those, only a small number of respondents (<5%) say that all partners have a clinical niche. Forty percent of respondents indicated at least one specialty or niche of which they practice. Of these, 57.1% indicated more than one specialty. The most common niches included oncology (9.9%), complex anorectal malformations (8.8%), and chest wall deformities (7.9%). Fig. 1 demonstrates the frequency of each clinical niche.

Table 1
Demographics of respondents ($n = 456$).

Type of Hospital ($n = 455$)	Large academic: 62.0%	Small/medium academic: 22.4%	Urban/Suburban: 10.1%	Private Practice: 4.4%	Rural: 1.1%
Country of Practice ($n = 450$)	US: 96%	Canada: 1.3%	Iraq: 0.7%	Israel: 0.4%	Other: 1.6% (Brazil, Germany, India, Peru, Qatar, Rwanda, Tanzania)
Years in Practice ($n = 454$)	>20 years: 37.2%	15–<20 years: 14.3%	10–<15 years: 14.5%	5–<10 years:16.7%	<5 years:17.2%
Fellowship Training Program ($n = 454$)	Yes: 48.2%	No: 51.8%			

Table 2
Categorization of self-identified surgeon type.

Generalist (n=286)	Generalist with a niche (n=157)	Specialist (n=13)
• 257 "true" generalists • 25 with desingated niche(s) (may be specialists) • 4 with > 5 designated niches (probably generalists)	• 138 "true" generalists witha niche • 17 with no niche designated • 2 with > 5 niches identified (may be generalists)	• 12 "true" specialists • 1 responding they do not specialize in other survey questions (may be a generalist)

When asked to clarify the role of specialty surgeons in a practice among the subset who indicated that their group consists of specialists ($n = 226$), 14.2% responded that specialists are the sole providers that perform cases regarding that specialty, 34.1% of specialists are involved in some capacity with every case within that specialty, while the majority (51.8%) are not necessarily involved with each case, but are available for consultation regarding complex cases within that specialty. Referral patterns for specialists mainly consist of hospital consultants who are aware of the specialist, pediatricians specializing in the same niche, and partners who specialize in another niche.

The most common specialties felt to be necessary included transplant (79%), fetal interventions (78%), and bariatrics (52%). Only 10.2% ($n = 45$) of respondents felt that specialists should practice solely within their subspecialty, while 89.8% ($n = 396$) felt that specialists should act as content experts in the field, participate in centers of excellence, and consult on relevant cases, but continue to perform procedures outside of that niche. Half of the respondents responded that additional specialization training is necessary (50.8%). Most self-identified generalists with a niche or specialists did report receiving additional training (72.4%, $n = 110/152$). This most likely took the form of informal training with individual experts within that specialty (34.7%), followed by at least one year in a certified fellowship program (14.7%), at least one year in a noncertified fellowship program (13.1%), and specialty courses (5.2%). Approximately 1 in 5 respondents would only consider a new job within a particular subspecialization. Almost 19% percent of respondents indicated that subspecialization should be linked to reimbursement. With regards to who should be the governing body regarding subspecialization, 55% felt it should be the American Pediatric Surgical Association, 30.5% responded the American Board of Surgery, 30.5% responded the individual surgeon/group, 14.5% responded the American College of Surgeons, 6.1% responded the American Academy of Pediatrics, and 1.9% responded insurance companies. Several free text responses to this question implied there should be no governing body ($n = 19$).

The vast majority of self-identified generalists with a niche and specialists came from large academic hospitals (82%) compared with only 50% of the generalist group ($p < 0.0001$). Fourteen percent of generalists came from urban/suburban hospitals compared with 3.6% of generalists with a niche or specialists. No generalist with a niche or specialist came from a rural practice and very few came from private practice (1.2%) compared with 1.8% and 6.3% of generalists who came from rural or private practice, respectively. Twenty-two percent of generalists practiced in a nonacademic hospital *versus* 5% of generalists with a niche and specialists ($p < 0.0001$). More than 70% of pediatric surgeons who self-identified as a generalist with a niche or specialist practice at a fellowship training program compared with only 35% of generalists ($p < 0.0001$). There was no significant association between being a generalist with a niche or a specialist and years in practice ($p = 0.3$). Interestingly, about 40% of respondents who identified as a generalist with a niche or a specialist thought that in order to specialize one must complete additional training compared with 57% of generalists ($p < 0.001$).

Opinions about subspecialization ($n = 452$) were variable: 41.2% of respondents felt that subspecialization improves patient care while 39.2% considered it to be detrimental to the well-roundedness of pediatric surgeons. Approximately one-quarter of respondents felt it is necessary given the growing number of pediatric surgeons and the rarity of pediatric surgical conditions. Approximately one third thought subspecialization should be limited to quaternary academic centers but is otherwise unnecessary. Less than 5% of subjects felt it should be required by insurance companies in the future.

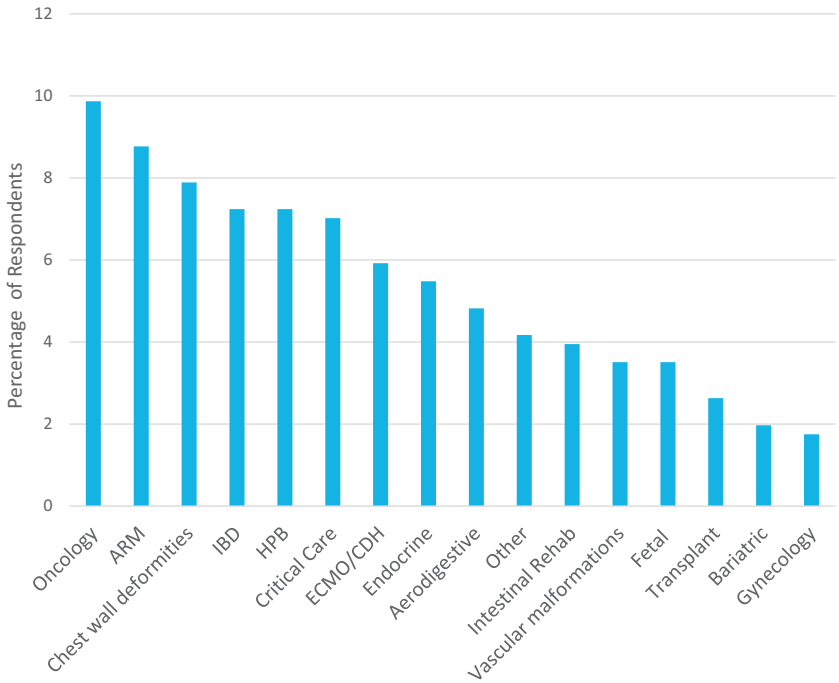

Fig. 1. Frequency of specialties within pediatric surgery. ARM: Anorectal malformations; HPB: hepatobiliary; IBD: inflammatory bowel disease; ECMO: extracorporeal membranous oxygenation; CDH: congenital diaphragmatic hernia.

Table 3
Opinions about specialization based on type of surgeon.

Response	Percentage of General Pediatric Surgeons	Percentage of Specialists (generalist with a niche or specialist)	P-value
"It is necessary given the growing number of pediatric surgeons and rarity of particular anomalies in pediatric surgery"	16%	38%	$p < 0.0001$
"It is better for patient care and quality to have a surgeon who specializes"	28%	63%	$p < 0.0001$
"It is only beneficial at quaternary academic centers, but otherwise is unnecessary"	39%	22%	$p = 0.0002$
"It is detrimental to the well-roundedness of pediatric surgeons"	48%	24%	$p < 0.0001$
"Should be required by insurance companies/CMMS in the future"	2%	7%	$p = 0.004$
"It is not necessary, but beneficial to the individual surgeon and his/her outcomes"	23%	27%	$p = 0.27$

How one self-identified as a surgeon was significantly associated with opinions about subspecialization. Those that specialize tended to have more favorable opinions about subspecialization. Table 3 summarizes these results. This is comparable to the opinions of those with specialists within their practice *vs.* those who do not (Table 4). Similarly, those that work at academic centers were more likely than those that do not work at academic centers to feel that subspecialization is better for patient care and quality (44% *vs.* 24%, $p = 0.002$). Those that do not work in an academic center were more likely to opine that subspecialization is detrimental to the well-roundedness of pediatric surgeons compared to those who do work in academic centers (50% *vs.* 37%, $p = 0.039$). Years in practice was not found to be significantly associated with any opinion regarding subspecialization ($p \geq 0.5$). Practice in a fellowship training program was significantly associated with more positive opinions about subspecialization. Specifically, those not in fellowship training programs were more likely than those at fellowship programs to believe subspecialization is detrimental to the well-roundedness of pediatric surgeons (44.6% *vs.* 33.0%, $p = 0.01$), and less likely to believe it is better for patient care and quality (28.8% *vs.* 53.7%, $p < 0.0001$) and less likely to opine that it is necessary given the growing number of pediatric surgeons and rarity of particular anomalies in pediatric surgery (15.9% *vs.* 33.5%, $p < 0.001$). More respondents who were not in a fellowship training program felt that it is only beneficial at quaternary academic centers, but otherwise is unnecessary (40.8% *vs.* 24.8%, $p = 0.003$).

Respondents were asked to provide any additional information or opinions about subspecialization in pediatric surgery in an open-ended format. There were 125 responses (27.3%). Fig. 2 summarizes these responses. The majority of comments were designated against subspecialization with the most common reasons being that all pediatric surgeons should be competent in all aspects of pediatric surgery, the diminished attractiveness of the field and its inapplicability to small hospitals or private practices. The most common reasons cited among the prospecialization comments were regarding the improvement of quality and safety with subspecialization.

3. Discussion

In a survey of nearly 500 practicing pediatric surgeons, it was found that true generalists continue to comprise the majority of practicing pediatric surgeons. Specialists more frequently take the form of a generalist who is a content expert of one or more clinical niches, and only very few pediatric surgeons solely practice within the field of their expertise, foregoing all other aspects of general pediatric surgery. Not surprisingly, specialists are more commonly found in large academic hospitals and within divisions with fellowship training programs. There does not seem to be any standard with regards to subspecialty training. Most self-identified specialists did partake in formal training within their clinical niche, but the type and extent of training were quite variable. While pediatric surgeons comprehend the potential benefit of subspecialization for patient outcomes given the rarity of which they see certain pathology, the majority of pediatric surgeons perceive subspecialization to be disadvantageous to the field.

Pediatric surgeons have historically taken pride in the fact that their field allows for surgeons taking care of children to remain true "general surgeons," continuing to operate within all of the fields in which our adult colleagues are specializing, such as surgical oncology, minimally invasive surgery, transplantation, thoracic, head and neck, hepatobiliary and colorectal. Despite this, there seems to be increased discussions surrounding the idea of subspecialization within the field of pediatric surgery. Subspecialization for children's surgery began decades ago with the advent of pediatric urologists, otolaryngologists, cardiothoracic surgeons, and gynecologists. Over time, further fractionation has occurred and at the present time, specialty surgeons and centers of excellence are increasing within subcategories of pediatric surgery. This survey sought to clarify practice patterns and attitudes regarding the idea of subspecialization within the field of pediatric surgery.

The most prevalent arguments in favor of subspecialization pertain to the idea that it permits a number of pediatric surgeons to be experts in certain aspects within their field, thereby increasing the relative caseload of rare entities and allowing for the maintenance of surgical competency. It is then often extrapolated that this would ultimately benefit patient care. Other positive opinions regarding subspecialization are that it encourages collaboration, it is beneficial for pooling of resources, and it is in line with the trends that are occurring in other fields of medicine. In some settings, patients may demand subspecialists and reimbursement may eventually be linked to this degree of expertise.

In spite of this, the majority of opinions in the free text section of our survey were against subspecialization. The most common cited arguments were that all pediatric surgeons should remain competent in all pediatric surgical conditions that subspecialization would diminish the attractiveness of the field for upcoming surgical residents, and that subspecialization is not sustainable in small hospitals or private practices. Once a surgeon specializes, there is concern about his or her ability

Table 4
Opinions about specialization based on if specialists are present within a practice.

Response	Specialists present within the practice	Specialists not present within the practice	p-value
"It is necessary given the growing number of pediatric surgeons and rarity of particular anomalies in pediatric surgery"	43%	12%	$p < 0.0001$
"It is better for patient care and quality to have a surgeon who specializes"	63%	26%	$p < 0.0001$
"It is only beneficial at quaternary academic centers, but otherwise is unnecessary"	22%	40%	$p = 0.0001$
"It is detrimental to the well-roundedness of pediatric surgeons"	26%	47%	$p < 0.0001$
"Should be required by insurance companies/CMMS in the future"	7%	2%	$p = 0.007$
"It is not necessary, but beneficial to the individual surgeon and his/her outcomes"	22%	26%	$p = 0.46$

Fig. 2. Opinions about specialization utilizing free text results. This sunburst plot uses thematic analysis to group the comments into themes. Each theme is presented in a separate segment and the size of the segment represents how frequent that theme was identified.

to obtain future positions, and should a specialized surgeon leave a practice, it potentially leaves a void in the care of certain patients. Furthermore, it is felt that subspecialization would lead to increased fragmentation of care and difficulties for patients with increased travel burdens.

This survey identified that approximately 40% of respondents consider themselves a specialist. Interestingly, only 3% of respondents (representing 0.2% of those who consider themselves a specialist) solely practice within that specialty. The remainder considers themselves content experts within a specific niche or niches, but continue to practice general pediatric surgery. A model of practicing general surgery but specializing in one or more specific fields may counteract some of the negative opinions about subspecialization. This idea of a generalist with a niche would allow a surgeon to take part (in varying degrees) in all cases involving a certain niche at his/her center, while not necessarily acting as the primary surgeon on the case but rather as a consultant. The degree of involvement can be variable and may help maintain exposure of pediatric surgeons to rare cases while increasing proficiency and expertise for generalists with a niche. This paradigm may also counteract other deleterious opinions about subspecialization, as generalists with a niche continue to practice general pediatric surgery and therefore can also retain competency in all aspects of pediatric surgery.

This survey corroborates several findings from the Langer et al. [3] 2016 study in which they surveyed U.S. and Canadian practices to examine group practice patterns and case distribution. Similar to their findings, this survey demonstrates that both subspecialization and feelings about subspecialization vary based on a variety of factors. Our results concur with their findings that those who practice at fellowship programs and at academic centers are more likely to specialize and are more likely to have positive opinions about subspecialization. This is not surprising as academic centers may have higher volumes of rare and complex cases and more referrals of certain rare diagnoses. Furthermore, administration at these centers may champion the idea of centers of excellence, and patient expectations at these institutions may demand this degree of expertise. Furthermore, Langer et al. [3] demonstrated that the highest degree of subspecialization was seen for cases involving transplantation, fetal surgery and bariatric surgery. While this does not correlate with our findings of the most common clinical niches identified (oncology, ARM and chest wall deformities), it does parallel the top three specialties that respondents felt are necessary (transplant, fetal interventions, and bariatrics). This is likely the case for several reasons including the very low volume of these cases at a particular center (and subsequent minimal and not mandatory exposure during pediatric surgery fellowship), the unique surgical techniques utilized within these fields, and the degree of subspecialization of the corresponding medical practitioners within that field. Perhaps it may be determined that certain fields benefit from specialists while others may not.

It has been shown in a variety of fields that surgeon volume and/or center volume for a particular disease process improves outcomes [4–6]. Within pediatric surgery, this has been reported as well. For example, Bucher et al. [7] reported on the impact of hospital volume on outcomes for congenital diaphragmatic hernia. This study demonstrates a range of 1.4 to 17.5 cases per year per hospital and found that medium and high volume hospitals had significant lower mortality. Similarly, Drews et al. [8] described decreased morbidity in 3149 patients identified in the Pediatric Health Information System database after pediatric thyroidectomy performed by higher-volume surgeons. However, in contradistinction, Lal et al. [9] did not find this to be true with esophageal atresia as hospital volume was not associated with postoperative complication rates. It has been shown in the adult literature that not only surgical volume, but surgical specialization (defined as the number of times the surgeon performed the specific procedure divided by his/her total operative volume) was a predictor of operative mortality

[10]. It is interesting to consider if and how each of these data can be extrapolated to the idea of subspecialization, and resultant increased volume, of pediatric surgeons.

Given this often cited volume/outcome relationship, the decreasing volume of critical cases per pediatric surgeon is of concern. It has recently been shown that the rate of growth of pediatric surgeons largely outnumbers the growth in the pediatric population estimated for the year 2030 [1]. In 2016, Abdullah et al. [2] highlighted this matter, citing the limited exposure each pediatric surgeon has to a variety of index cases after fellowship. The authors showed a 278% increase in the number of training programs over 33 years and a 132% increase in the number of pediatric surgeons. 60%, 45% and 42% of surgeons had not performed any operation for biliary atresia/choledochal cyst, spleen, or kidney tumors within the year prior. Furthermore, 39%, 32% and 29% had not performed any operations for lung resections, adnexal procedures or anorectal malformations within one year. The authors conclude that the pediatric surgery workforce exceeds the increase in the number of index cases, questioning the compared competency of future pediatric surgeons. What is not clear from their work is how many of those particular procedures are being performed in each center. While a specialist in each center may allow that particular individual to gain amplified expertise, it is unclear if and how it would ameliorate these concerns.

This survey study has clarified what is occurring with regards to subspecialization in our community and has exposed a variety of opinions about subspecialization. However, it does not take the next step of understanding if subspecialization is in fact linked to improved outcomes. Few studies have attempted to understand this association in the pediatric population. Rhee et al. [11] reported on outcomes of procedures in various specialties, taking into account the proportion of children treated by each surgeon. The authors identified improved mortality rates for general and cardiothoracic surgeons caring preferentially for children. This finding was replicated within pediatric urology as Tejwani et al. [12] reported providers with proportionally higher volumes of pediatric patients achieve improved postoperative outcomes. Specifically relating to pediatric surgery, Jawaid et al. [13] reported on their experience with the creation of an esophageal atresia service. They analyzed all cases both before and after a completed subspecialization program was initiated. After near-complete subspecialization, intensive care unit length of stay and mortality both declined. While this survey was not designed to evaluate the relationship between subspecialization and outcomes, our field would benefit from further data to understand if subspecialization is valuable to the practitioner, the hospital center, and most importantly to the patient.

This study has several limitations. Our study was limited by the response rate of 41%. While this response rate is actually quite good for similar surveys, it certainly raises the question of response bias and generalizability. Additionally, the respondents were designated based on how they self-identified; however, we demonstrated the discrepancies in several surveys and it is unclear if each respondent was categorized accurately and we had no ability to confirm or validate individual responses, thus potentially introducing misclassification. The discrepancies could also be owing to variations in the way questions were asked. Additionally, the survey was sent to members of the American Pediatric Surgical Association and thereby may not incorporate the practice patterns or the opinions representative of the entire cohort of pediatric surgeons. Furthermore, given the reduced proportion of respondents who provided additional feedback using the free-text section, caution should be exercised on extrapolating these opinions to reflect a generalizable portion of pediatric surgeons. Importantly, a definition of subspecialization was not given in the survey in an effort to not bias respondents as well as to comprehend how our field defines specialization. This survey demonstrates the definition of subspecialization is not standardized and it seems respondents had a varying understanding of what it means to be a subspecialist and this may have skewed some of the results. This survey was intended to gain an understanding of practice patterns and opinions regarding the current state of subspecialization within pediatric surgery. It remains unclear if and how this relates to patient outcomes. Given this, along with the wide variety of practicing pediatric surgeons with regards to environment, resources, and patient needs, this work does not intend to make any claims regarding what an ideal practice model may be.

4. Conclusion

While self-reported subspecialization within the field of pediatric surgery is quite common, occurring in approximately 40% of respondents, the majority of pediatric surgeons continue to practice general pediatric surgery. Most that designate themselves as specialists continue to practice general pediatric surgery as well. Specialists more frequently practice in academic centers, rather than private practice or rural centers. The most common specialists are in the fields of oncology, ARM, and chest wall deformities; however, it is commonly felt that specialists are most necessary within the realm of fetal, bariatric and transplantation surgery. While some pediatric surgeons report that subspecialization may benefit patient care, concerns exist regarding the unfavorable effect it may have on the well-roundedness of the individual surgeon. A better understanding of how subspecialization affects both quality of care and patient outcomes would help to clarify its utility.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpedsurg.2020.02.006.

References

[1] Ricketts TC, Adamson WT, Fraher EP, et al. Future supply of pediatric surgeons analytical study of the current and projected supply of pediatric surgeons in the context of a rapidly changing process for specialty and subspecialty training. Ann Surg 2017;265:609–15.
[2] Abdullah F, Salazar JH, Gause CD, et al. Understanding the operative experience of the practicing pediatric surgeon implications for training and maintaining competency. JAMA Surgery 2016;151:735–41.
[3] Langer JC, Gordon JS, Chen LE. Subspecialization within pediatric surgical groups in North America. J Pediatr Surg 2016;51:143–8.
[4] Luft HS, Bunker JP, Enthoven AC. Should operations be regionalized? The empirical relation between surgical volume and mortality. N Engl J Med 1979;301:1364–9.
[5] Birkmeyer JD, Stukel TA, Siewers AE, et al. Surgeon volume and operative mortality in the United States. N Engl J Med 2003;349:2117–27.
[6] Pieper D, Mathes T, Neugebauer E, et al. State of evidence on the relationship between high-volume hospitals and outcomes in surgery: a systematic review of systematic reviews. J Am Coll Surg 2013;216:1015–25.
[7] Bucher BT, Guth RM, Saito JM, et al. Impact of hospital volume on in-hospital mortality of infants undergoing repair of congenital diaphragmatic hernia. Ann Surg 2010;252:635–42.
[8] Drews JD, Cooper JN, Onwuka EA, et al. The relationship of surgeon volume and specialty with outcomes following pediatric thyroidectomy. J Pediatr Surg 2019;54:1226–32.
[9] Lal DR, Gadepalli SK, Downard CD, et al. Challenging surgical dogma in the management of proximal esophageal atresia with distal tracheoesophageal fistula: outcomes from the Midwest Pediatric Surgery Consortium. J Pediatr Surg 2018;53:1267–72.
[10] Sahni NR, Dalton M, Cutler DM, et al. Surgeon specialization and operative mortality in the United States: retrospective analysis. BMJ 2016;21:354.
[11] Rhee D, Papandria D, Yang J, et al. Comparison of pediatric surgical outcomes by the surgeon's degree of specialization in children. J Pediatr Surg 2013;48:1657–63.
[12] Tejwani R, Wang HHS, Young BJ, et al. Increased pediatric sub-specialization is associated with decreased surgical complication rates for inpatient pediatric urology procedures. J Pediatr Urol 2016;12:388.e1.
[13] Jawaid W, Chan B, Jesudason EC, et al. Subspecialization may improve an esophageal atresia service but has not addressed declining trainee experience. J Pediatr Surg 2012;47:1363–8.