The Unmet Demand for Point-of-Care Ultrasound Among General Pediatricians: A Needs Assessment

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Abstract

Background: Point-of-care ultrasound (POCUS) is a noninvasive bedside tool with many pediatric applications but is not currently a formal part of pediatric training and practice. Formal needs assessments of general pediatricians regarding POCUS training are lacking. We aimed to quantify the baseline ultrasound experience and training needs of general pediatricians and pediatric residents across different practice settings.

Methods: In 2020, we sent an online survey to 485 current faculty, residents, and graduates from an urban pediatric academic medical center in Northern California. Pediatric subspecialists were excluded. Survey questions about baseline experience, comfort, and perceived usefulness of 20 common POCUS applications were developed by two POCUS experts using existing literature. Chi-squared analysis was used to compare residents versus attendings and to compare attendings practicing in inpatient versus outpatient versus mixed settings.

Results: Response rate was 20% (98/485). Compared to attendings (n=73), residents (n=25) endorsed more exposure to POCUS in medical school (32% vs 5%, $p=0.003$) and residency (12% vs 5%, $p=0.003$). Respondents endorsed low comfort with POCUS (mean 1.3 out of 5 on Likert scale). Of 20 procedural and diagnostic applications, respondents identified abscess drainage, bladder catheterization, soft tissue, neck, advanced abdominal, and constipation as most useful. Overall, 50% of pediatricians (and 70% of pediatric residents) responded that there were opportunities to use POCUS multiple times a week or more in their clinical practice.

Conclusions: There is an unmet demand for POCUS training among general pediatricians and trainees in our study. Our results could guide design of ultrasound curricula for general pediatricians.

Background

Point-of-care ultrasound (POCUS) is a portable, increasingly affordable, non-invasive tool with many evidence-based pediatric applications(1), which has been shown to improve diagnostic accuracy, aid in procedural guidance, decrease length of stay, as well as assist in other patient centered outcomes (2, 3). The diagnostic information obtained by POCUS can be used to reduce the need for other imaging modalities and other more invasive tests, aiding in radiological stewardship and high value care(4, 5). Compared to adults, small children offer the additional advantage of often being easier to scan, as their size facilitates easy penetration by ultrasound waves with high-frequency transducers, producing superior resolution images(6). Yet in spite of these advantages for pediatric use, bedside ultrasound is not currently a standard part of pediatric training or practice.

POCUS is no longer a tool only for pioneers and early adopters. As of 2014, 62% of medical schools reported integrating POCUS into their curricula(7). At the pediatric fellowship level, POCUS has become a standard part of pediatric emergency medicine training(8, 9). POCUS is also becoming increasingly utilized in pediatric critical care(10, 11) and neonatology(12, 13) fellowships. Compared to pediatric subspecialty and adult counterparts, POCUS remains underutilized in general pediatric training. In a 2019 survey by Reaume et al, 37.5% of internal medicine programs and 43.5% of combined medicine-pediatric programs reported formal POCUS curricula while only 12.4% pediatric programs reported offering a formal ultrasound curriculum(14). Furthermore, the authors note that this may represent an overestimate due to potential response-bias, as those with ultrasound programs may have been more likely to respond to a survey about ultrasound curricula.

Various authors have published recent review articles listing POCUS scans that would be most applicable to the practice of a general pediatrician in the acute care setting based on extrapolation from internal medicine, emergency medicine, and pediatric emergency medicine(1, 11, 15–17). However, little is known regarding general pediatricians' baseline POCUS training, their perceptions of POCUS, and which specific applications would be most useful in daily clinical practice from the perspective of a general pediatrician. Internal medicine programs and family medicine programs have conducted focused needs assessments creating roadmaps for POCUS curricula based on responses from their own residents and faculty(18–23). Corresponding needs assessments among pediatricians to guide the development of pediatric POCUS curricula are lacking.

We hypothesized that general pediatricians would identify a variety of specific areas of practice where they could apply POCUS, that trainees have more exposure to POCUS training than attendings, and that the ultrasound applications perceived to be useful by pediatricians would differ from their adult or emergency medicine counterparts. We performed a needs assessment asking pediatric residents and general pediatric attendings across the inpatient and outpatient settings about their exposure to ultrasound training, their baseline comfort with specific ultrasound applications, and their perceived usefulness of specific ultrasound scans in their clinical practice.

Methods

Study Population

In September 2020, we sent an online survey to a total of 485 pediatric residents, pediatric urgent care faculty, pediatric hospitalist faculty, primary care pediatric faculty, and recent graduates (graduating classes of 2010 - 2019) from an urban, community-based, pediatric academic medical center in Northern California. Fellows and attendings practicing in pediatric subspecialties were excluded. We included those who had completed a hospitalist or adolescent medicine fellowship.

Survey and Data Collection

An electronic survey was distributed via email, social media, and fliers with a quick response (QR) code that linked to the survey. The survey was created in Qualtrics (Qualtrics, Provo, UT) based on prior needs assessments designed for family medicine and internal medicine(18-21) Specific pediatric POCUS applications were selected based on published reviews describing the scans most pertinent to pediatric POCUS (1, 11, 15) and based on input from 2 of the authors (AS, MLM), who are experts in pediatric POCUS. The survey was then reviewed by medical education experts from a variety of specialties for clarity and breadth. We asked participants to score their baseline comfort (from 1 = extremely uncomfortable to 5 = extremely comfortable) and the perceived usefulness (from 1 = I would never use this to 5 = extremely useful) of 8 procedural and 12 diagnostic pediatric POCUS applications on 5-point Likert-type scale. The survey instrument is available in supplemental material, [additional file 1].

Data Analysis

Descriptive statistics were tabulated in Microsoft Excel (Version 16.50) from survey results to determine characteristics of respondents and their mean responses to survey questions. Differences in mean self-reported usefulness or comfort scores were assessed with ANOVA and Chi-squared tests or Fisher's exact test were used to compare categorical response variables, as appropriate. All statistical analysis were performed using R version 3.6 (R Core Team, 2020). In subgroup analyses, we compared attendings (n=72) vs residents (n=25), and we compared inpatient attendings (n=15) vs outpatient attendings (n=30) vs attendings who practice in both the inpatient and outpatient setting ("mixed", n=22). We included urgent care attendings who practice in the hospital setting in the "mixed" category.

This study was deemed exempt by the University of California, San Francisco Institutional Review Board. Each participant provided informed consent prior to starting the survey.

Results

Respondent Practice Setting and POCUS Utilization

A total of 25 residents and 73 attendings completed our survey, with a total response rate of 20% (98 of 485). Of the attendings and recent graduates who responded, the majority practiced in an urban setting (73%), did not have access to a POCUS machine (82%), and did not use POCUS for clinical decisions (94%). The anticipated future

Table 1
Participant Characteristics

<u>Level of Training.</u>	<u>% (n).</u>
Pediatric Resident	26% (25)
Attending/Faculty	74% (73)
Total	100% (98)
<u>Attending/Faculty characteristics (n = 73).</u>	<u>% (n).</u>
Pediatric hospitalist medicine (inpatient general pediatrics)	40% (29)
Pediatric primary care (outpatient general pediatrics)	56% (41)
Adolescent medicine	5% (4)
Urgent care	26% (19)
Solo or two physician practice	5% (4)
Academic medical center	42% (31)
Community hospital	23% (17)
Federally Qualified Health Center	26% (19)
Group practice or HMO	41% (30)
Rural	4% (3)
Suburban	26% (19)
Urban	70% (51)
Access to POCUS machine - No	82% (58)
Bill for POCUS - Yes	0% (0)
Use POCUS for clinical decisions - Yes	6% (4)
POCUS training in medical school – Yes	5% (4)
POCUS training in residency - Yes	5% (4)
<u>Residents (n = 25).</u>	<u>% (n).</u>
Pediatric hospitalist medicine (inpatient general pediatrics)	44% (11)
Pediatric primary care (outpatient general pediatrics)	56% (14)
Procedural pediatric sub-specialty	8% (2)
Adolescent medicine	4% (1)

Urgent care	36% (9)
Non-procedural pediatric sub-specialty	4% (1)
Use POCUS for clinical decisions - Yes	52% (13)
POCUS training in medical school – Yes	32% (8)
POCUS training in residency - Yes	12% (3)

practice settings for the 25 residents who responded (Table 1) were similar to the attendings, with the majority (88%) planning to practice in outpatient pediatrics. A higher proportion of residents (52%) than attendings (6%) reported using POCUS for clinical decisions during their residency ($p<0.0001$, Table 1). Of the four pediatric attendings in our sample who endorsed using POCUS for clinical decisions, all of them practiced either fulltime or part time in the inpatient setting. Two of these four endorsed no formal training. Of the two who used POCUS but endorsed no formal training, one worked in rural setting, and one worked in both an academic center and a community hospital. The other two endorsed receiving formal training longitudinally in fellowship (hospital medicine) and in an ultrasound bootcamp/conference, respectively.

Baseline Exposure to POCUS Training and Comfort

Compared to attendings, residents endorsed more exposure to POCUS in medical school (32% vs 5%, $p=0.003$) and in residency (12% vs 5%, $p=0.003$, Table 1). On average, pediatricians in our sample endorsed feeling uncomfortable with POCUS – mean 1.2 for diagnostic POCUS and 1.4 out for procedural POCUS on a 5-point Likert scale (Figure 1). More residents than attendings endorsed being at least “4 - somewhat comfortable” with diagnostic POCUS (17% vs 0%, $p = 0.004$). There were no significant differences in comfort with procedural POCUS between residents and attendings. Among attendings, only 1 inpatient attending endorsed feeling at least “4 - somewhat comfortable” with procedural POCUS, but there were no statistically significant differences between inpatient vs outpatient vs mixed attendings in baseline comfort with POCUS.

Perceived Usefulness of POCUS

When asked “how often do you think there is an opportunity to use POCUS in your practice?” 50% of all respondents responded that there were opportunities to use POCUS “multiple times a week” or more in their clinical practice (Figure 2).

Compared to attendings, a higher proportion of residents responded that they would use POCUS “multiple times a week” or more (70% vs 45%, $p=0.08$), although this was not statistically significant. Among attendings, a higher percentage of inpatient attendings responded that they would use POCUS “multiple times a week” or more (60%), followed by mixed attendings (45%), and last by outpatient attendings (37%), although when groups were compared, differences were not statistically significant ($p=0.33$). See [additional file 2] to view subgroup analysis.

Of the 8 procedural applications, abscess drainage and bladder volume measurement prior to catheterization were scored at least “3 - useful” on average by all respondents. Of the 12 diagnostic applications, “skin and soft tissue (cellulitis or abscess)”, “neck (lymphadenopathy vs abscess vs mass)”, “advanced abdominal (appendicitis, intussusception, hypertrophic pyloric stenosis, cholecystitis)”, and “constipation (transrectal diameter to assess rectal stool burden)” were scored as “3 - useful” on average by all respondents. Average scoring of all surveyed applications, from most to least useful, is shown in Figure 3. Subgroup analysis comparing how applications were ranked by various groups is available in [additional file 2]

Compared to attendings, residents overall assigned significantly higher average usefulness scores across procedural POCUS applications (mean 3.53 vs 2.10, $p < 0.001$) and diagnostic POCUS applications (mean 3.77 vs 2.57, $p < 0.001$). Compared to outpatient attendings, those practicing in the inpatient setting or in the mixed setting assigned significantly higher usefulness scores for procedural POCUS (mean usefulness score out of 5 on a Likert scale, 2.71 inpatient vs 2.23 mixed vs 1.69

outpatient, $p < 0.001$) and for diagnostic POCUS (mean score out of 5 on a Likert scale, 2.88 inpatient vs 2.72 mixed vs 2.30 outpatient, $p < 0.001$). See [additional file 2] to view subgroup analysis.

Perceived Barriers to POCUS

A majority of pediatricians in our sample noted the following barriers to use of POCUS in clinical practice: discomfort with image acquisition/technique, discomfort with image interpretation, lack of access to an ultrasound machine (Figure 4).

Discussion

The majority of general pediatricians and pediatric trainees in our study responded that there were frequent opportunities to use POCUS in their clinical practice. However, most did not have the training, comfort, and tools necessary to perform POCUS.

This study represents one of few needs assessments of POCUS utility for general pediatricians both in training and in practice(14, 24). Residents universally scored POCUS more highly in terms of usefulness and, in fact, in subgroup analysis 25% of pediatric residents responded that they could identify opportunities to use POCUS multiple times a day in their clinical practice. Importantly, the majority of pediatric trainees are using POCUS in their clinical practice (52%), though few pediatric attendings are (6%), thus raising questions of supervision, safety and quality assurance. This disparity in POCUS training between trainees and faculty is found similarly in needs assessments of adult specialties (21, 25, 26) and is likely reflective of national trends as medical schools increasingly integrate POCUS into their curricula(7). This also underscores the urgency that pediatric residencies follow the trend led by medical schools and adult specialties in developing ultrasound curricula(26–28). Given the technical skill required for POCUS(29), new practitioners need skilled preceptors to oversee and hone this important clinical skill. We did not ask trainees in our study if they were using POCUS unsupervised, but currently the trainees at our institution only have access to POCUS machines in the emergency department, neonatal intensive care unit, and pediatric intensive care unit – all departments where they have access to trained POCUS preceptors. Currently, trainees in our institution are unable to practice POCUS in outpatient clinics or on the general pediatrics floors where they do not have access to POCUS machines. Although the residents in our study showed more interest in POCUS on average than practicing attendings, it is just as important that continuing medical education and accreditation be developed and made available beyond residency given that the vast majority of pediatric providers did not receive formal training in POCUS and may need to supervise trainees who are already using POCUS in clinical care.

Outpatient attendings perceived POCUS as less useful, on average, than those practicing in the inpatient setting. However, as seen in prior studies, perceived utility may change with increased exposure(30). Supporting this notion, family medicine is also heavily outpatient and clinical practice overlaps with pediatrics, yet other studies have found that graduates from family medicine programs where POCUS is taught continue to use POCUS in their clinical practice(31). Prior review articles on pediatric POCUS have focused on the role of POCUS in the practice of the pediatric hospitalist (1, 11, 15–17, 32). However, the majority of pediatric residents in our study were interested in POCUS, and over half of them planned to practice outpatient general pediatrics. As more pediatric residencies include ultrasound in their training, the role of POCUS in the pediatric outpatient setting may grow substantially.

The pediatricians in our study ranked the usefulness of specific POCUS applications differently than in prior studies focusing on internal medicine and family medicine. For example, in prior studies of internal medicine physicians, central line placement, paracentesis, and thoracentesis were the most highly ranked procedural POCUS applications(19, 33). However, in our study, central line placement was ranked among the least useful, along with arterial venous access and arthrocentesis. For diagnostic POCUS, cardiac POCUS, lung (particularly pleural effusion), DVT, and abdominal free fluid tend to be ranked most useful in prior surveys of adult practitioners(19, 20, 33), while for the pediatricians in our study, abdominal free fluid and cardiac applications were again ranked least useful. Interestingly, pediatricians ranked neck (lymph node vs abscess), advanced abdominal (appendicitis, intussusception, hypertrophic pyloric stenosis, cholecystitis) among the most useful diagnostic applications. These studies tend to be considered more advanced by POCUS experts (11, 15). While the POCUS

literature for pediatric appendicitis(34, 35) and intussusception(36, 37) is growing, there is currently limited evidence to support the use of POCUS for differentiation of neck masses(3, 38, 39). Constipation was also ranked as a useful diagnostic application by pediatricians; however, there are currently only a handful of studies on the validity of measuring transrectal diameter in the diagnosis of pediatric constipation(40–42). Although these advanced applications may not have as broad support in the literature, their perceived utility in our study provides important insight into research gaps and ways in which POCUS could potentially impact the clinical practice and diagnostic capabilities among general pediatricians in the future. Designs of ultrasound curricula for pediatricians should combine the clinical needs identified by pediatricians with guidance from POCUS educational experts who are well versed in the evidence to support pediatric POCUS.

Limitations

Our study had a number of limitations. Our sample was limited to residents and pediatricians currently working at or trained by one center in one state, limiting generalizability. Our low response rate at 20%, although comparable to other published needs assessments(23, 43), may be a source of bias as it is possible that physicians and trainees with an interest or background in ultrasound may have been more likely to respond to a study about ultrasound, thus overestimating the demand for POCUS training and skewing our results. Indeed, in our barriers question, very few respondents (5%) endorsed a lack of interest in POCUS. There are few prior needs assessments specific to pediatrics, thus although our survey was based on published literature, it was not validated. In our survey, we asked respondents to rate individual applications on a Likert scale by asking what would be “the most useful to you in your clinical practice?”. It is possible that “usefulness” can mean different things to different people. To some it may mean frequency of use, to others it may mean sensitivity/specificity, and to others it may mean the degree to which it changes clinical management. The majority of the physicians in our study did not have formal POCUS training, therefore we were not able to ask more specifically about most used applications or about applications most likely to change management. It is possible, as seen in other studies, that as pediatricians get more exposure to POCUS they may rank POCUS applications differently(30, 31). Similar to prior studies(30) those with more experience with POCUS (residents) also showed more interest in using POCUS and gaining further training in POCUS.

Future Directions

We hope that our survey can serve as a starting point for additional focused needs assessments, either on a larger scale, or for use by other pediatric hospital groups who are trying to develop POCUS curricula for their pediatric practitioners. Future needs assessments focusing on general pediatric attendings who are already using POCUS in their clinical practice may provide valuable perspective on which applications are most useful, although given how few there are (6% of our sample) such a study may need to be national in scope. Further assessment of pediatricians and pediatric resident ultrasound experience and training needs on a national level are warranted to determine the extent to which POCUS should be a standard part of pediatric residency curricula and which applications should be prioritized.

Conclusions

There is an unmet demand for point-of-care ultrasound training for the pediatricians in our study. Pediatric residents had more experience using POCUS and perceived POCUS as more useful than attendings. General pediatricians who worked full or part time in the inpatient setting, including urgent care, were more significantly likely to view POCUS as useful than outpatient attendings. Given the tools and the training, general pediatricians can identify frequent opportunities to use POCUS in their clinical practice.

Abbreviations

POCUS – Point-of-care ultrasound

DVT – Deep Venous Thrombosis

FAST – Focused assessment with sonography in trauma

QR code – Quick response code

Declarations

Ethics approval and consent to participate

This study was deemed exempt by the University of California, San Francisco Institutional Review Board number 20-30653, study reference number 288836. All methods were performed in accordance with The Revised Common Rule 2018.(44) All participants provided informed consent to participate in this study prior to survey initiation.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AM and AS conceived and designed the study survey. AM distributed the survey, cleaned the data, performed data analysis, and prepared all figures. NA performed analysis and/or interpretation of data. MLM, AS, and AM drafted the work and substantially revised it. All authors read and approved the final manuscript.

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Authors' information

Dr. Anelah McGinness is a general pediatrician. Dr. Ashkon-Shaahinfar and Dr. Margaret Lin-Martore are faculty in the departments of emergency medicine and pediatrics and are experts on pediatric point-of-care ultrasound.

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Figures

How would you rate your overall comfort in using POCUS?

Figure 1

Overall self-rated pediatrician comfort with diagnostic and procedural POCUS. Providers responded to the question “How would you rate your overall comfort in using procedural/diagnostic POCUS” (Rated on a Likert scale where 1 = extremely uncomfortable 2 = somewhat uncomfortable 3 = neither comfortable nor uncomfortable 4 = somewhat comfortable 5 = extremely comfortable)

How often do you think there is an opportunity to use POCUS in your clinical practice?

Figure 2

Perceived opportunities for use of POCUS by general pediatricians. Providers responded to the question “How often do you think there is an opportunity to use POCUS in your clinical practice?” (Percentages were calculated as number of responses divided by total n = 98)

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Figure 3

3a. Procedural POCUS applications and their perceived utility to general pediatricians. Pediatricians were asked the question “Which of the following procedural applications would be the most useful to you in your clinical practice?” They rated the following procedural applications on a 5 point Likert scale, (where 1= I would never use this 2 = somewhat useful 3 = useful 4 = very useful 5 = extremely useful): abscess drainage, bladder volume measurement (i.e. prior to cath), peripheral vascular access, foreign body removal, lumbar puncture (including post-LP hematoma), arterial vascular access, Central vascular access, arthrocentesis. 3b. Diagnostic POCUS applications and their perceived utility to general pediatricians. Pediatricians were asked the question “Which of the following diagnostic applications would be the most useful to you in your clinical practice?” They rated the following diagnostic POCUS applications on a 5-point Likert scale (where 1= I would never use this 2 =

= somewhat useful 3 = useful 4 = very useful 5 = extremely useful): skin and soft tissue (cellulitis or abscess), neck (lymphadenopathy vs abscess vs mass), advanced abdominal (appendicitis, intussusception, hypertrophic pyloric stenosis, cholecystitis), constipation (transrectal diameter to assess rectal stool burden), lung (pneumothorax, pneumonia, bronchiolitis, pleural effusion/empyema), genitourinary (bladder volume, hydronephrosis), foreign bodies (soft tissue), basic abdominal (abdominal free fluid), musculoskeletal (long bone and clavicle fractures, skull fractures, joint effusion), transabdominal pelvic (early pregnancy detection, IUD placement confirmation), focused cardiac exam (pericardial effusions, global cardiac function), optic nerve measurement (papilledema).

Figure 4

Perceived barriers to POCUS use by pediatricians. Pediatricians were asked the question “What are some barriers to use of POCUS in your clinical practice?” Respondents were allowed to select more than one response. (Percentages calculated as number of responses divided by total n = 98)

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