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ORIGINAL CONTRIBUTION

Establishing the international research priorities for pediatric emergency medicine point-of-care ultrasound: A modified Delphi study

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Abstract

Background: The Pediatric Emergency Medicine (PEM) Point-of-care Ultrasound (POCUS) Network (P2Network) was established in 2014 to provide a platform for international collaboration among experts, including multicenter research. The objective of this study was to use expert consensus to identify and prioritize PEM POCUS topics, to inform future collaborative multicenter research.

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Methods: Online surveys were administered in a two-stage, modified Delphi study. A steering committee of 16 PEM POCUS experts was identified within the P2Network, with representation from the United States, Canada, Italy, and Australia. We solicited the participation of international PEM POCUS experts through professional society mailing lists, research networks, social media, and "word of mouth." After each round, responses were refined by the steering committee before being reissued to participants to determine the ranking of all the research questions based on means and to identify the high-level consensus topics. The final stage was a modified Hanlon process of prioritization round (HPP), which emphasized relevance, impact, and feasibility.

Results: Fifty-four eligible participants (16.6%) provided 191 items to Survey 1 (Round 1). These were refined and consolidated into 52 research questions by the steering committee. These were issued for rating in Survey 2 (Round 2), which had 45 participants. At the completion of Round 2, all questions were ranked with six research questions reaching high-level consensus. Thirty-one research questions with mean ratings above neutral were selected for the HPP round. Highly ranked topics included clinical applications of POCUS to evaluate and manage children with shock, cardiac arrest, thoracoabdominal trauma, suspected cardiac failure, atraumatic limp, and intussusception.

Conclusions: This consensus study has established a research agenda to inform future international multicenter PEM POCUS trials. This study has highlighted the ongoing need for high-quality evidence for PEM POCUS applications to guide clinical practice.

INTRODUCTION

Over the past two decades, the use of point-of-care ultrasound (POCUS) in pediatric emergency medicine (PEM) has increased exponentially. Currently there are no mandatory requirements that POCUS should form part of PEM fellowship training, but there are growing recommendations.[1,2] Consequently, an increasing number of articles have been published on PEM POCUS clinical applications, education, and credentialing standards.[1–4] However, despite the increasing use of POCUS, high-quality evidence for PEM POCUS is still lacking. A recent study identified an upward growth and globalization of POCUS-related publications, but almost half of the publications were case-based reports.[5]

Multiple PEM research networks worldwide have identified POCUS as a research priority.[6–10] Most recently, an international group of PEM network research leaders was assembled to develop a list of research priorities for future collaborative endeavors among pediatric emergency research networks using a modified Delphi methodology.[11] They identified the need for more POCUS research within PEM, particularly since indications for its use and application differed between centers. Despite this, to date there has been no dedicated PEM POCUS consensus study for research priorities.

The PEM POCUS Network (P2Network) is a nonprofit, multinational organization that was formed in 2014, with the goal for enabling international collaboration in the emerging field.[12] One of its objectives was to provide a platform for PEM POCUS experts worldwide to collaborate on multicenter research, with the goal of informing clinical practice. To date, the P2Network's research priorities have stemmed from the research interests of individual members.[13,14]

Given the continued growth of POCUS within PEM and recognition of the need for high-quality evidence, there is a need to develop an agenda to guide global research priorities. Establishing a research agenda helps to streamline prioritization and planning of studies, guide allocation of resources, and avoid potential duplication of efforts. It also serves to inform and identify areas of high impact for stakeholders and potential grant funders and importantly aims to provide a high-quality evidence base to inform clinical practice and improve patient care.

The objective of this study was to use expert consensus to identify and prioritize PEM POCUS research topics, to inform future international collaborative multicenter studies or trials. We also aimed to identify evidence gaps for current POCUS applications used in clinical practice.

METHODS

Study design

We conducted a two-stage modified Delphi survey, which included the Delphi method and a modified Hanlon process of prioritization (HPP). This study design was chosen given the large group of geographically dispersed participants and research topics.[15] Additionally, anonymity could be maintained to reduce any effect

of dominant individuals with an iterative process, which included controlled feedback of responses.[15,16] Our methodology was modeled on similar emergency research networks consensus studies.[6,8,9] An ethics waiver for this study was approved by the Gold Coast Hospital and Health Service Human Research Ethics Committee, Queensland, Australia (EX/2021/QGC/76409).

Study setting and population

This was an international study, with experts in PEM POCUS tasked with identifying and ranking priority research topics.

Steering committee selection

A steering committee of 16 PEM POCUS experts was identified within the P2Network, with representation from the United States, Canada, Italy, and Australia. Within this group, four lead authors acted as conveners (PJS, AES, MMM, SHFL), responsible for coordinating the study. The steering committee members were not precluded from taking part in the survey rounds, provided they fulfilled the expert criteria.

Participant selection

Although more fellowship training positions are becoming available, no data currently exists for the number of PEM POCUS-trained physicians internationally.[17,18] Therefore, the P2Network was used as a surrogate starting point, with 315 members from North America, South America, Europe, and Asia at the time of this study.[12] The survey link was distributed via email to all P2Network members on September 6, 2021. Additional participants were further solicited by advertisement via professional society mailing lists, research networks, social media, and "word of mouth."

Survey participants self-identified as meeting all the following eligibility criteria, consistent with prior literature that defined a PEM POCUS expert[4]: (1) Completion of formal PEM training (including a fellowship or equivalent training) *and* (2) completion of more than 1500 POCUS scans *and* (3) have PEM POCUS leadership positions or training. PEM POCUS leadership or training was defined as meeting one of the following criteria: (a) completion of a PEM POCUS/emergency ultrasound (EUS) fellowship *or* (b) has served as a PEM POCUS lead or director *or* (c) has served as a PEM POCUS fellowship director *or* (d) has served as a general emergency medicine (EM) POCUS fellowship director and teaches PEM POCUS skills as a part of this role. Consent was implied when a participant responded to the survey.

Study protocol

The modified Delphi method consisted of two survey rounds and a HPP round. Surveys were administered via email using REDCap (Research Electronic Data Capture), a secure, Web-based platform for data collection.

In the survey rounds, participants were initially asked to identify topics under the broad categories of "clinical application," "education," "administration," or "other," with no requirement for a prerequisite number in each category. Participants were then asked to rate these research questions using a 5-point Likert scale. High-level consensus for a research question was defined as having >80% proportion of high priority rating scores (4s and 5s) from participants. Within each of these rounds, refinement of responses was conducted by the steering committee before being reissued to participants. The HPP round was then conducted using the research questions that had a mean rating greater than neutral (i.e., >3.0).

Round 1 (Part A): Survey 1

In this initial survey, eligible participants were asked the open-ended question, "What are the most important research questions in PEM POCUS that need addressing, which may include clinical applications, education, administration, or other aspects?" Participants were tasked to submit up to 10 research topics, preferably worded in the PICO (population, intervention, comparison, outcome) format, with an example provided that illustrated this structure. Non-PICO questions were still reviewed for suitability. Participants were also asked to sort the topic into the best related category for the research question, which included "clinical application," "education," "administration," or "other."

Survey 1 was open for 4 weeks beginning September 6, 2021, during which additional participants could be invited. Invited participants who had not already responded were sent reminder emails at weekly intervals and then at 48 hours remaining, to improve completion rates. Participants were also asked to provide baseline demographic data including geographical location, hospital/practice description, specialist qualifications, and POCUS experience.

Round 1 (Part B): Refinement of research topics

All research questions generated from Survey 1 were collated and then grouped into one of the predetermined categories (clinical application, education, administration, other) by members of the steering committee. These members then independently reviewed each question in relation to the eligibility criteria with the following actions taken: (1) Duplications of research questions were removed. (2) Topics only relevant to single-center studies were removed. (3) Research questions were excluded if they had already been adequately answered through current existing evidence. (4) Research topics were removed if deemed they did not have sufficient detail to be answered in a study or trial. Following review of responses by the steering committee digitally, and then via teleconference, eligible research questions were collated into a list, grouped into the categories.

Round 2 (Part A): Survey 2

The refined list of proposed research questions compiled at the completion of Round 1 formed the basis of Survey 2. Participants were asked, "Thinking about the field of PEM POCUS, how important are the following questions to you in terms of the need for future multicenter research?" Participants from Round 1 were asked to rate each research question on a 5-point Likert scale (1 = not a priority, 2 = low priority, 3 = neutral, 4 = high priority, 5 = essential priority). "Survey fatigue," the assumption that early questions are better answered than later questions, was addressed using the allocation of five different random orders of the research questions.

Survey 2 was open for 4 weeks beginning October 25, 2021. As in Round 1, participants who had not already responded were sent reminder emails at weekly intervals then at 48 hours remaining, to improve completion rates.

Round 2 (Part B): Survey 2 reevaluation

Survey 2 results were collated, and Likert scores for each question in Survey 2 were combined. Mean scores were used to rank the list of research questions. Additionally, high-level consensus for a research question was determined.

Survey 2 was revisited, with the goal to reevaluate the number of high-level consensus questions. Participants of the original Survey 2 were provided with the list of research questions with mean rating scores, along with the definition for a high-level consensus rating. These participants were invited to rerate topics using the identical Likert scale as before, for questions that had not already met high-level consensus, for an additional 4-week period beginning November 29, 2021. The list of priority research questions, with ranking by mean and high-level consensus, was then finalized at the closure of Round 2.

Modified HPP

Questions at the end of Round 2 with a mean rating score > 3.0 (i.e., greater than neutral rating) were further prioritized using a modified HPP.[6,7,9,19] Typically, the HPP weighs the prevalence, seriousness, and feasibility of a given research question. However, this was adapted by the steering committee to suit PEM POCUS. The existing HPP questions were circulated to the steering committee, who put forward the three main elements of feasibility of performing POCUS research, were discussed and then ratified by the steering committee. Therefore, participants were asked to independently rate each research question on a scale of 1–10 in relation to three domains: (A) relevance—"How likely will you adopt this in your everyday practice?"; (B) impact factor—"How likely will this improve the care of children internationally?"; and (C) feasibility—"Considering your setting, costs involved, and training required, how feasible is this topic for international multicenter research?"

Participants from Round 2 were invited to participate electronically in the HPP for a 4-week period beginning January 10, 2022. Again, reminder emails were sent at weekly intervals then at 48 hours remaining, to improve completion rates.

Key outcome measures

The Delphi ranking was based on the mean rating score for each question from Round 2. Additionally, research questions with >80% proportion of scores being 4 or 5 were identified as being high-level consensus topics. Final HPP scores were calculated using the formula HPP = (A + 2B) x C.[6,7,9,19] This weighed the HPP toward feasibility, with a final ranking based on the overall score for each research question. Although high-level consensus topics were identified in the modified Delphi rounds, the final overall ranking was based on the HPP, in keeping with other consensus studies.[6,9]

Data analysis

Aggregate data were downloaded from REDCap in a spreadsheet format at completion of the study. Answers to survey questions were expressed as frequencies and proportions for categorical variables. Means and medians were then calculated for these variables. Statistical analyses and HPP score calculations were performed using Microsoft Excel.

RESULTS

Survey 1 was distributed via email to 326 potentially eligible individuals, obtained from the initial solicitation process. There were 54 participants (16.6%) who met eligibility criteria and completed Round 1. Participant demographics are summarized in Table 1. The majority were based in North America (49, 90.1%), worked in a pediatric ED (46, 85.2%), and worked in an academic setting (50, 92.6%). Almost all were PEM qualified (52, 96.3%). Most had completed either a general EM POCUS/EUS fellowship (20, 37.0%) or PEM POCUS fellowship (18, 33.3%). Almost two-thirds (35, 64.8%) had greater than 5 years of POCUS experience. Figure 1 illustrates the stages and outcomes of the study.

A total of 191 items were submitted by Survey 1 participants. These were refined and consolidated into 52 research questions, with exclusions of 86 (61.2%) duplicates, 24 (17.3%) lacking detail, 18 (12.9%) not amenable to multicenter research, and 11 (7.9%) with adequate existing evidence. Forty-five (83.3%) participants completed Round 2. Mean scores for the 52 research questions in the Delphi process ranged from 2.82 to 4.43 in Round 2 (Part A; Table S1). Only six of the research questions reached high-level consensus at the completion of Round 2 (Table 2). These included topics of shock (undifferentiated and septic), cardiac arrest, thoracoabdominal trauma, and cardiac failure.

TABLE 1 Participant baseline demographics

Age (years)	41.2 (32–52)
Sex	
Male	32 (59.3)
Female	22 (40.7)
Country of practice	
United States	45 (83.3)
Canada	4 (7.4)
Australia	1 (1.9)
Italy	1 (1.9)
United Kingdom	1 (1.9)
Israel	1 (1.9)
Mexico	1 (1.9)
Board certifications[a]	
PEM	53 (98.1)
EM	5 (9.3)
Pediatrics	14 (25.9)
Ultrasound training/qualifications[a]	
EM POCUS/EUS fellowship	20 (37.0)
Pediatric POCUS fellowship	18 (33.3)
RDMS	4 (7.4)
DDU	1 (1.9)
Other (courses, certificates, etc.)	23 (42.6)
PEM POCUS roles[a]	
Director	32 (59.3)
Fellowship director	14 (25.9)
Administration	32 (59.3)
Education	41 (75.9)
Research	35 (64.8)
Organizational leadership	20 (37.0)
Years of POCUS practice	
0–2	1 (1.9)
3–5	17 (31.5)
6–10	22 (40.7)
11–20	14 (25.9)

Note: Data are reported as mean (range) or *n* (%).

Abbreviations: DDU, diploma of diagnostic ultrasound; EUS, emergency ultrasound; PEM, pediatric emergency medicine; POCUS, point-of-care ultrasound; RDMS, registered diagnostic medical sonographer.

[a]Participants could indicate more than one response.

Thirty-one research questions were selected for HPP rating. Thirty-nine participants (72.2% from Round 1, 86.7% from Round 2) provided valid responses for this round. Mean scores using the HPP ranged from 132.2 to 197.0 (Table S2). The top 20 ranked research questions are provided in Table 2. Top ranked priorities included shock (undifferentiated and septic), atraumatic limp, intussusception, thoracoabdominal trauma, lung pathology, PEM POCUS competency, and peripheral intravenous access.

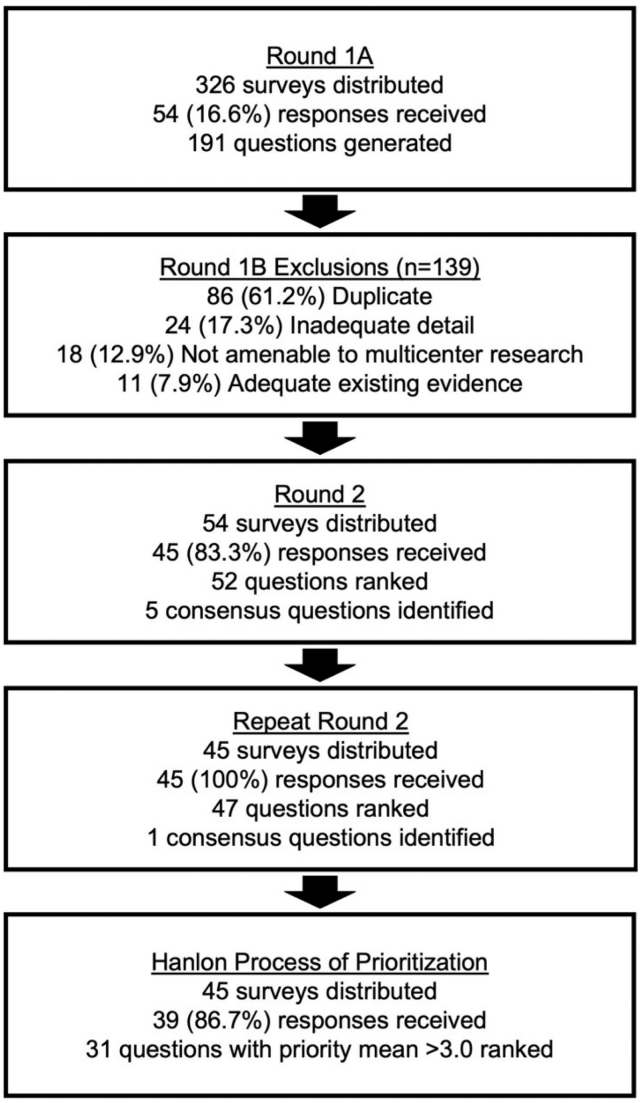

FIGURE 1 Study stages and outcomes

DISCUSSION

This study identified and prioritized PEM POCUS research topics by international expert consensus. The list of research questions was ranked via modified Delphi and HPP processes, which provided both a desired list of topics as well as a pragmatic list weighted toward feasibility. The generated lists provide an agenda for future international collaborative multicenter research. Top ranking consensus topics in this study included clinical applications of POCUS to evaluate and manage children with shock, cardiac arrest, thoracoabdominal trauma, suspected cardiac failure, atraumatic limp, and intussusception. Notably, no educational or administrative POCUS research topics were identified as high consensus, with only even questions from these categories featuring in the HPP.

The modified HPP was effective in identifying POCUS research topics that were relevant, impactful, and feasible to research in the PEM department. Although the topics of cardiac failure and cardiac

TABLE 2 Summary of the top 20 ranked PEM POCUS research questions

HPP priority (HPP score)	Research question	Delphi priority (Delphi score)
1 (197.0)	What is the role of POCUS (cardiac/IVC/lungs/other) in children with undifferentiated shock, in terms of diagnosis and management?[a]	4 (4.32[b])
2 (196.5)	In children presenting to the ED with atraumatic limp, is POCUS noninferior to RADUS for the detection of hip effusion and can it expedite their disposition and/or management (e.g., arthrocentesis)?	19 (3.40)
3 (195.2)	In children presenting to the ED with suspected intussusception, is POCUS noninferior to RADUS for the diagnosis of clinically important intussusception (randomized controlled trial)?	22 (3.36)
4 (193.1)	In children presenting to the ED with atraumatic limp, can POCUS findings be incorporated into a diagnostic algorithm, in conjunction with clinical findings/investigations, to improve diagnosis and management?	11 (3.62)
5 (187.1)	What is the role of POCUS (cardiac/IVC/lungs/other) in children with septic shock, in terms of guiding resuscitation and management?[a]	1 (4.47)
6 (186.1)	In children with shock, can POCUS (cardiac/IVC/lungs) guide fluid resuscitation and administration of inotropes/vasopressors, compared with standard assessment, with improvement of patient-centered outcomes?[a]	2 (4.43[b])
7 (184.3)	In children presenting with thoracoabdominal trauma, can e-FAST performed by expert/trained sonologists: (a) Decrease the utilization of CT imaging without missing any clinically important injuries? (b) Expedite the care of children with clinically important injuries? (c) Be integrated with clinical features and other investigations into an algorithm that benefits patients?[a]	4 (4.32[b])
8 (182.3)	In children, is a dedicated pediatric lung ultrasound diagnostic protocol noninferior to conventional radiography for the diagnosis of pulmonary pathology?	16 (3.49)
9 (180.3)	What are the current consensus guidelines for attaining and maintaining competency in PEM POCUS?	9 (3.69)
10 (178.6)	In children with difficult peripheral intravenous access, does POCUS improve rates of successful insertion and avoidance of central access (intraosseous, central venous line, etc.)?	19 (3.4)
11 (174.8)	In children with suspected cardiac failure, can POCUS accurately diagnose cardiac failure compared to echocardiography, and what is the best measure (EPSS vs. visual estimation, etc.)?[a]	6 (4.25[b])
12 (171.9)	How does POCUS compare to validated scores for diagnosis of appendicitis and can POCUS findings be incorporated into a decision-making algorithm/score, along with clinical findings and other investigations (e.g., pathology)?	19 (3.40)
13 (168.3)	In pediatric sickle cell patients who present with suspected acute chest crisis, what is the role of lung POCUS for the detection of infiltrates compared with x-ray imaging?	24 (3.33)
14 (167.8)	In pediatric patients presenting to the ED with clinical suspicion of lower respiratory tract infection, can POCUS differentiate bacterial from viral pneumonia to guide management? Can it reduce x-ray imaging and length of stay, without missing any clinically important infections?	9 (3.69)
15 (162.9)	In children requiring cardiac evaluation, is POCUS noninferior to echocardiography for the diagnosis of clinically important cardiac pathology (e.g., pericardial effusions, HOCM)?	7 (3.91)
16 (161.3)	In children who present to the ED with suspected appendicitis, does POCUS: (a) Accurately diagnose clinically important appendicitis? (b) Predict the need for operative management? (c) Expedite disposition?	18 (3.44)
17 (159.4)	In children with cardiac arrest, can POCUS guide management (e.g., identification of reversible causes, improve pulse checks) and prognosticate outcomes (e.g., ROSC/survival)?[a]	3 (4.36[b])
18 (157.9)	What training (number of studies/evaluation tools) is required to achieve and maintain competence in PEM POCUS applications and how does it differ for various levels of training/experience?	12 (3.60)
19 (156.2)	What are the perceptions and attitudes of subspecialists/inpatient teams toward POCUS being performed for children in the ED, and what factors might influence their acceptance of images over RADUS for clinical decisions and informing management?	31 (3.04)
20 (154.7)	What should comprise the standard curriculum for PEM POCUS education (applications, delivery, evaluation) for various levels of learners?	12 (3.60)

Abbreviations: eFAST, extended focused assessment with sonography for trauma; EPSS, E-point septal separation; HPP, Hanlon process of prioritization; HOCM, hypertrophic obstructive cardiomyopathy; IVC, inferior vena cava; PEM, pediatric emergency medicine; POCUS, point-of-care ultrasound; RADUS, radiology ultrasound.

[a]High-level consensus-rated questions.

[b]Ranking as per Round 2A mean score.

arrest were ranked as high-level consensus priority topics in the Delphi, these ranked far lower in the HPP, likely due to being rare presentations and being less feasible to study. This is a key distinction, which relates to the FINER (feasible, interesting, novel, ethical, and relevant) framework used for formulating research questions, rather than simply choosing topics of importance alone.[20]

The role of POCUS in children with undifferentiated shock and sepsis ranked highly in both the Delphi and the HPP. The use of POCUS for undifferentiated shock in adults has been established[21,22] but high-quality evidence in pediatrics is still lacking.[23,24] The pathophysiology of shock in children is different from that of adults, which can lead to difficulties with early recognition and management.[25] POCUS holds great potential in aiding the recognition of shock, defining the etiology, and guiding management, such as fluid resuscitation, administration of vasoactive medications, or procedural intervention.[23,26,27]

Cardiac failure in children is an infrequent presentation but can be mistaken for other pathologies, such as bronchiolitis or sepsis, given that it can be difficult to distinguish clinically.[28] POCUS is a way to directly visualize cardiac structure and function and has been demonstrated to be useful in diagnosing cardiac failure in the emergency department (ED) but large-scale studies are still required.[29] Cardiac arrest in children is uncommon but generally has poor outcomes.[30] The etiology of cardiac arrest in children is usually secondary to respiratory failure but other reversible causes, albeit rarer, may be identifiable using POCUS, such as cardiac tamponade,[31] tension pneumothorax,[32] and pulmonary embolism.[33] Although there is growing evidence in the adult population supporting the routine use of POCUS in cardiac arrest,[34] its utility in children remains unclear.

The use of POCUS in thoracoabdominal trauma has come under scrutiny, particularly given that children with visceral injury do not always have free fluid and rarely require operative management.[35] However, many of these studies were conducted in single institutes on stable children with blunt abdominal trauma with an emphasis on POCUS findings in isolation.[36,37] No large multicenter international studies have been performed to date, particularly with expert PEM POCUS sonologists and the incorporation of clinical findings into a pragmatic algorithm, with the inclusion of cardiothoracic injuries.[38] Under these conditions, POCUS may have a defined role in the reduction of unnecessary CT imaging or to rapidly delineate injuries in an unstable patient to aid critical decision making. Furthermore, the use of contrast-enhanced ultrasound holds great promise in pediatric blunt abdominal trauma, but access in the ED remains a barrier.[39]

Atraumatic limp is a frequent presentation to the pediatric ED, often due to hip effusion. POCUS is superior to x-ray in detecting a hip effusion and can guide arthrocentesis but cannot readily determine etiology.[40–42] Therefore, larger trials are required to validate an algorithm incorporating POCUS with clinical and laboratory findings to differentiate transient synovitis from septic arthritis.[43]

Ileocolic intussusception can be a life-threatening condition in infants and young children that can be elusive to diagnose on clinical grounds alone.[44] POCUS has been demonstrated to be noninferior to radiology performed ultrasound in a large multicenter prospective trial but was limited by convenience sampling, which could be mitigated by consecutive recruitment in a randomized controlled trial.[13]

Finally, unsurprisingly many of the identified PEM POCUS research topics in this consensus study align with those identified in international PEM research network consensus studies.[6–10] The Pediatric Emergency Care Applied Research Network (PECARN; United States) group listed respiratory illness and pain management as priority topics, which relates to lung ultrasound and nerve blocks identified in our priority list.[6] The Pediatric Emergency Research in the United Kingdom and Ireland (PERUKI) group identified the need for further research into children with atraumatic limp, imaging in trauma, and management of sepsis, which interface with several of our POCUS priority research questions.[8] The Research in Pediatric Emergency Medicine (REPEM; Europe) and the Pediatric Emergency Research Canada (PERC; Canada) networks both identified POCUS as a priority theme and general topics that relate to our priority list, including trauma, respiratory illness, sepsis, and cardiopulmonary resuscitation.[7,10] The Pediatric Research in Emergency Departments International Collaborative (PREDICT; Australia and New Zealand) network specifically listed POCUS for intussusception, pneumonia, appendicitis, or hip pain in their agenda.[9] Finally, an international PEM research network study identified the need to investigate the impact of POCUS on clinical outcomes of specific diseases, such as blunt abdominal trauma and resuscitation for intravascular volume status, with the overall general top clinical conditions listing sepsis, trauma, and respiratory conditions, all of which are relevant to POCUS as identified in our consensus study.[11]

LIMITATIONS

Although we solicited PEM POCUS experts worldwide as broadly as possible, there was underrepresentation from multiple countries. The participant group likely reflects where PEM POCUS training and research are more embedded, but we only solicited in the English language, which limited its reach. The majority of participants were from North America, which may limit generalizability of the findings.

Our response rate was lower than other PEM research network Delphi studies but our strict criteria of a PEM POCUS expert would have precluded many from participating, and an overall number of eligible participants remains unknown to determine an accurate proportion.[6–10] The benefit of restricting the study to PEM POCUS experts is that they arguably have the best knowledge and experience to guide research. However, the identified topics may not be relatable to general users of POCUS.

Only six questions reached high-level consensus, which may have been reflected both by the definition used and by having international participants, with heterogeneity in settings and resources. This was in part mitigated by the HPP round. There was also a trend toward repeat surveys yielding lower scores, such as one participant scoring all topics as 2s in Round 2 (Part B), likely due to survey fatigue. Although, we did attempt to control for survey fatigue

effects on individual questions by having different random ordering of questions.

Although the HPP identifies topics that are feasible, this consensus study did not specifically address the logistics or barriers associated with conducting multicenter research, including funding, approvals, or collaboration with other specialty teams and stakeholders. Although the research questions were framed around patient-centered outcomes, the actual design of high-quality studies or trials to answer these was not covered. This international PEM POCUS consensus study provides a starting point to start to try and address these issues.

Finally, education and administration topics did not feature strongly, with clinical applications overshadowing the priority list. This may have been due to the majority participants being interested in or more familiar with researching clinical applications or being already highly trained or that the topics were overlooked due to having overlap with a previous study.[4] Many of the high-ranking topics were applications for unstable patients with high risk diagnoses that cannot be readily transported from the ED. Future studies could include a broader cohort of participants, such as the participation of nonexpert users, and separate ranking of topics within main categories, such as education.

CONCLUSIONS

This was the first research consensus study conducted by pediatric emergency medicine point-of-care ultrasound experts worldwide. With the use of a modified Delphi and Hanlon process of prioritization methodology, a ranked list of priority pediatric emergency medicine point-of-care ultrasound research topics was generated and could be used to inform future international multicenter studies and trials. Key research areas included the use of point-of-care ultrasound to evaluate and inform management for shock, thoracoabdominal trauma, cardiac pathology, atraumatic limp, and intussusception. High-quality evidence is currently lacking for pediatric emergency medicine point-of-care ultrasound and the results of this study would hopefully guide future endeavors with the design and implementation of high-quality multicenter international research studies and trials.

AUTHOR CONTRIBUTIONS

Concept and design: all authors. Acquisition of the data: all authors. Analysis and interpretation of the data: all authors. Drafting of the manuscript: Peter J. Snelling (initial), Allan E. Shefrin, Matthew M. Moake, Samuel H. F. Lam. Critical revision of the manuscript for important intellectual content: all authors. Statistical expertise: Matthew M. Moake, Samuel H. F. Lam. Database construction and management: Matthew M. Moake.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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