PERSPECTIVES

Introducing Point-of-Care Ultrasonography: A Single-Institution Method of Training PHM Faculty

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INTRODUCTION

Point-of-care ultrasonography (POCUS) has the potential to facilitate prompt diagnosis and management at the bedside.[1] Pediatric hospital medicine (PHM)–specific POCUS applications include diagnosing pneumonia, pleural effusions, and cellulitis/abscesses, securing vascular access, and guiding lumbar punctures.[2–7] The Society of Hospital Medicine published a position statement on POCUS that included a general pathway for training and assessment, recommending real-time training and feedback, and attaining competency in specific POCUS applications rather than broad training.[8] Defining a clinician's scope of practice helps determine the required training.[9] However, there are no published clinical competencies nor evidence-based clinical practice guidelines for POCUS within PHM. The broad scope of practice, the dearth of trained clinicians, and the lack of available and longitudinal training opportunities inhibit research and implementation of POCUS within hospital medicine.[10]

The purpose of this article is to propose a model to establish a PHM-specific POCUS program and describe a single-institution experience in piloting a faculty devolvement program focused on POCUS training for PHM faculty.

IDENTIFYING POCUS EDUCATORS AND LEARNERS

Pediatric hospitalists gathered members interested in POCUS as learners. They discussed their needs and vision with the POCUS fellowship director based within emergency medicine (EM). These discussions identified core needs, action items, and steps necessary to developing and implementing a PHM-specific POCUS training program (Table 1). Four POCUS educators were identified within EM and critical care and included the current POCUS fellow. At the time of development, there was no previous standardized POCUS training for pediatric hospitalists. Learners discussed the training flow with educators and POCUS fellowship director. As an initial plan, training included didactics, hands-on ultrasonography scanning sessions, and image interpretation with real-time review to gain appropriate POCUS skills following a practice-based pathway outlined in the Emergency Ultrasound Guideline.[11]

EQUIPMENT AND IMAGE ACQUISITION

Several well-known medical ultrasonography manufacturers are used in the United States that also offer handheld devices, complementing their conventional offerings. Handheld ultrasonography is more affordable and portable, but it has lower image quality and limited access to probes. POCUS training covered all 3 probe types—phased

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TABLE 1. Steps to POCUS Program Development and Implementation

Core Needs	Action Items	Steps
Gather stakeholders	- Identify invested and engaged learners - Onboard educators with a well-defined focus - Engage leadership support to sustain the longevity of the program	- Learners identified were pediatric hospitalists with interest in POCUS - Four POCUS-trained educators were identified within the institution - With increasing interest amongst fellowship applicants, GME was a staunch supporter of enhancing the credibility of the fellowship program

Identify and define	- Identify scope of practice
	- Identify the barriers
	- Define goals to establish competency
	- Establish assessment of competency
		- Since there is no standardized POCUS training curriculum established for pediatric hospitalists, a priority list of needs and potential applications was derived after internal discussions (Table 2)
		- Barriers included:
		  - Funds to support a program with a long lead-time to revenue generation justifying the effort
		  - Access to equipment with a wide range of capabilities
		  - Protected time for learners and educators
		- Utilized ACEP guidelines and collective guidance from practicing POCUS clinicians to establish initial target for proficiently completed case logs
		- Assess competency in the following categories[11]:
		  1. Recognize the indications and contraindications of the POCUS exam
		  2. Acquire adequate images
		  3. Interpret the image
		  4. Integrate POCUS exam findings into patient care and management

Structure	- Build the training contents	- 10-mo program with monthly 4-hour long sessions with educators and 4 h of practice sessions - Coordinated 60-min sessions with calendar holds for each educator 1 mo in advance with target areas (system or procedure) and patient characteristics - Self-directed learning using online resources freely available. - Hands-on learning sessions with educators followed by practice sessions without educators collecting images - Clip review to audit and provide real-time feedback while building up the case repository
Equipment and materials	- Time management - Secure needed equipment	- Coordinate time and place for sessions with each educator - Ultrasonography machines with access to OSP with dedicated IT support - Create account on OSP to store images and generate case-log for feedback
Training	- Identify educational repository for self-directed POCUS learning - Develop guided learning - Review the progress of the learners and training	- Refer and review to ACEP Emergency Ultrasound Education[12] ■ Online learning resources, eg, 5-min Sono - Hands-on sessions with each educator of 1 h/month for 10 mos, providing 4 h per month - Real-time feedback during hands-on sessions - Scheduled review of independently acquired images with an educator - Monthly image review sessions to assess the progress of training - Educator assessment of learners' competency through in person session and OSP worksheets
Sustainability	- Identify the challenges and barriers to future training - Identify national certifications and individual institutional credentialing needs - Next step and future perspectives	- Equipment, protected time for both learners and educators, online educational repository - POCUS certification academy and Radiology Diagnostic Medical Sonography - Institutional credentialing pathways developed with input from multi-disciplinary POCUS committee - Address the funding limitations to become self-sufficient - Expand PHM-specific POCUS applications - Revise the training protocols to fit the ongoing needs, promoting value-adding activity for learners - Credentialing parameters defined by precedence to provide revenue-generating activities - Hospital-accepted image storage portal for documentation and billing - Active pursuit for consistent skill application maintaining proficiency

Abbreviations: ACEP, American College of Emergency Physicians; GME, graduate medical education; OSP, online storage platform; PHM, pediatric hospital medicine; POCUS, point-of-care ultrasonography.

array, curvilinear, and linear—to acquire appropriate images for selected applications. Probes do have overlapping applications, but the most ideal probe was used for each selected application. EM permitted learners to use ultrasonography equipment belonging to EM for training purposes. Equipment was linked to an online storage platform (OSP)—eg, Qpath, Viewpoint—which was used for storing images, managing data entry, reporting, quality assurance, and tracking for training purposes.[13] OSP was used solely

for educational purposes and did not require integration with a medical chart.

CURRICULUM DEVELOPMENT

In PHM, cardiac, lung, abdominal, renal, soft tissues, and specific procedural ultrasonography exams were considered relevant.[7] A list of PHM-specific POCUS applications was solicited from the PHM community. This list was reviewed by the 13-member PHM division from a single institution to define the scope of practice specific to individual PHM needs (Table 2). From the original list, cardiac, lung, and ultrasonography-assisted peripheral intravenous (PIV) catheter placements, and ultrasonography-assisted lumbar puncture (LP) were selected as priority initial applications due to relevance to current clinical practice.

Online resources were used as a didactic tool due to the time constraints.[12] Core Ultrasound's 5-Minute Sono was chosen due to its cost-effectiveness and time efficiency. Learners began with a 5-minute Sono of Basics, Cardiac, Lung, and ultrasonography-assisted LP to acquire fundamental knowledge. Learners then had four 1-hour hands-on sessions per month with educators for 10 months. During these sessions, learners completed ultrasonography exams and received immediate feedback from educators. These sessions were primarily focused on performing the scan on pediatric inpatients after obtaining verbal assent and consent from patients (if able) and parents. Patients were chosen based on clinical diagnosis (pneumonia, bronchiolitis, pleural effusions, obesity, etc), age, and ability to tolerate POCUS.

The use of POCUS for a few patients was only for educational purposes. For example, adolescents assented to cardiac POCUS and the use of ultrasonography to practice identifying spinous processes. Patients admitted with pulmonary exacerbation of cystic fibrosis assented to lung POCUS. Other patients did require POCUS for clinical decision-making. For example, in patients with failed prior LP (multiple attempts without success or in adolescents with obesity in which landmarks were difficult to assess through manual palpation), ultrasonography-assisted LPs were performed with educators. Patients with prior failed PIV catheter placements required PIV placements under ultrasonography guidance. During one of these educational sessions, lung ultrasonography of a patient admitted with worsening respiratory distress was found to have pleural effusion and lobar consolidation. POCUS affected subsequent management steps. Outside of these proctored educational sessions, learners also completed independent scanning sessions for additional practice. Images were stored in OSP, and learners had scheduled image review sessions to assess the quality and interpretations of the images. Learners repeated the learning cycle in 5 Minute Sono, scanning and reviewing images to improve their competency over 10 months (Figure 1).

ASSESSMENT OF COMPETENCY

To assess POCUS competency, the American College of Emergency Physicians Ultrasound Guideline was followed: (1) recognize the indications and contraindications of the POCUS exam; (2) acquire adequate images; (3) interpret the image; and (4) integrate POCUS exam findings into patient care and management.[11] Assessment of

TABLE 2. PHM-Specific POCUS Applications in Order of Priority

	Number of Exams for Proficiency/Credentialing[a]
A. Exams[b]	
1. Thorax/lung (pneumothorax, consolidation, pleural effusion)	25
2. Basic cardiac (gross assessment of left ventricular function, pericardial effusion)	25
3. Musculoskeletal (drainable fluid collection, cellulitis, abscess, joint effusion)	10
4. Renal and bladder (hydronephrosis, bladder volume)	10
5. Gall bladder and other abdominal (cholecystitis, choledocholithiasis, free fluid, intussusception)	10
6. Ocular (optic nerve sheath diameter)	10
7. Deep vein thrombosis (large lymph nodes, soft tissue swelling, superficial thrombophlebitis, DVT, Baker cyst)	
8. Gynecology (IUD position, endometrial thickness)	
B. Procedures[b]	
1. PIV catheter placement	5
2. Ultrasonography-assisted LP	5
3. Knee/joint aspiration (optional)	5
4. Arterial puncture	5

Abbreviations: DVT, deep vein thrombosis; IUD, intrauterine device; LP, lumbar puncture; PIV, peripheral intravenous.
[a] Number of exams needed for credentialing were based on recommendations given by the institution's POCUS committee.
[b] The curriculum focused on lung, cardiac, peripheral IV placement, and ultrasound-assisted lumbar puncture—applications identified as priority areas for initial learner proficiency.

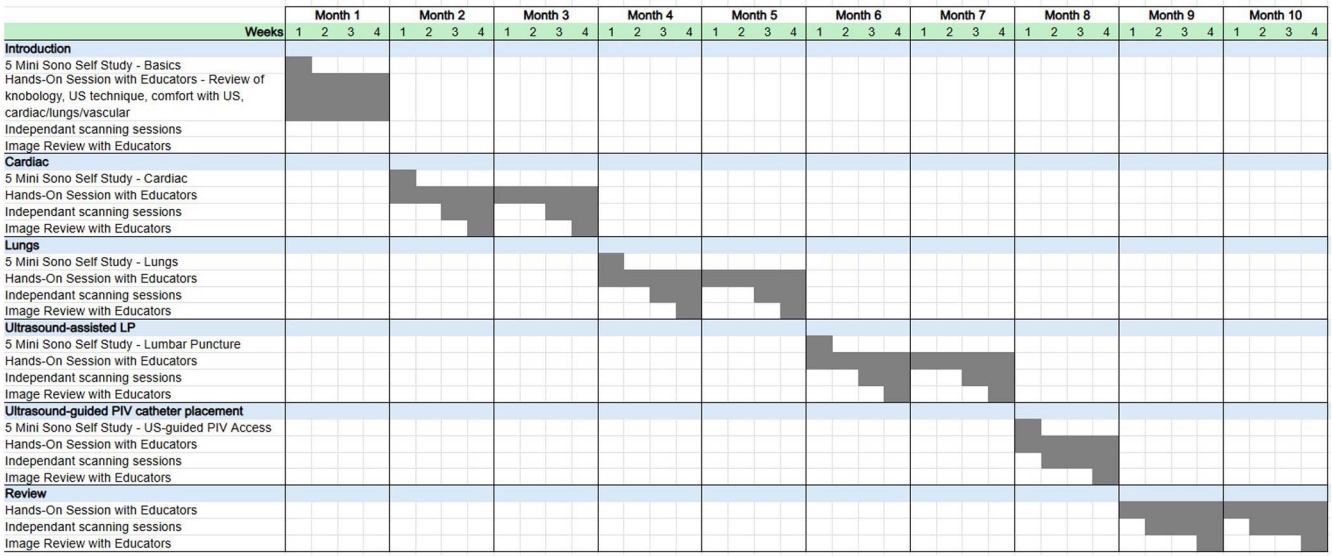

FIGURE 1. Education timeline illustrating the amount of time learners dedicated to each system (cardiac, lungs, US-assisted LP, etc) and the weekly breakdown of the content covered. At the start of a new system, learners completed independent self-study with the relevant 5 Min Sono videos, weekly proctored hands-on sessions, independent practice scanning sessions during weeks 3–4, and monthly image reviews with educators.
Abbreviations: LP, lumbar puncture; US, ultrasonography.

POCUS competency is limited by educators' subjectivity.[14] Therefore, through discussions with institutional POCUS committee leaders, educators set the goal image numbers needed for credentialing in each application based on previous literature and other specialties guidelines (cardiac: 25 scans; lung: 25 scans; and ultrasonography-assisted LP: 5 scans).[15–17] Learners received real-time feedback during hands-on sessions with educators and periodic clip review sessions, which assessed learners' interpretation of images from online resources or images acquired by a third person. Additionally, learners were required to complete worksheets within OSP for each obtained image. "Yes/No" questions were answered that addressed the indications and interpretations of POCUS so that learners' understanding of the indications of the POCUS study, skills of acquiring images, and interpretation could be assessed by educators. Each worksheet was specific to the application. For example, a cardiac exam addressed cardiac function, ventricular or atrial size, and the presence of pericardial effusions. The lung exam worksheet addressed the presence of lung sliding, B-lines, consolidations, and effusions, whereas the ultrasonography-assisted LP worksheet focused on marking the appropriate location and measuring the depth from skin to cerebrospinal fluid space. During the training, educators assessed the learners' POCUS competency on each application in person and through OSP.

WHAT WORKED WELL

Local POCUS experts and educators were eager to share their knowledge and expertise. Four POCUS educators were easily identified, and each educator was gracious with their time, agreeing to monthly 1-hour sessions. POCUS educators made ultrasonography equipment available for learners during these training sessions. The ultrasonography equipment was already connected to OSP, which was essential for workflow and quality assurance purposes. Educators, equipment, and image archives were accessible due to an already existing robust POCUS fellowship program and a burgeoning POCUS committee represented by multiple specialties (family medicine, internal medicine, obstetrics/gynecology, intensive care [ICU], EM, pediatric emergency medicine [PEM]).

The POCUS applications' most high yield for PHM faculty (ie, those that provide the most information, address immediate clinical questions, and are used frequently) were selected. They were then organized by systems, and each system was the focus of study for 2 months. This educational structure narrowed learners' scope of practice and allowed learners ample time to learn and review image acquisition techniques and acquired images with educators.

Using free online resources was both cost-effective and time effective. Both educators and learners continued to have regular work schedules without additional protected time. Online reviews of POCUS techniques prior to educational sessions helped maximize in-person education with educators.

CHALLENGES

Coordinating educational sessions was challenging. Learner and educator schedules were irregular, and each educational session was at a different time and place. Neither educators nor learners had protected time for implementing this curriculum. For the hands-on training portion, educators brought their own ultrasonography equipment already connected to OSP and associated with their

individual departments (EM, ICU, or PEM). Learners did not have access to equipment outside of these sessions. Existing ultrasonography equipment available to PHM was limited to linear probes and not connected to OSP. Additional probes could not be added due to machine limitations and cost. Time allotted for independent practice sessions and limited access to ultrasonography machines connected to OSP hindered learners from acquiring additional images for review with educators to fulfill proposed credentialing parameters. For example, some POCUS exams (eg, lung and ultrasonography-assisted LP) were completed using ultrasonography equipment without OSP connectivity. Once the program was well under way, the POCUS fellow, who was also a PEM physician, was most instrumental in bridging POCUS applications across the spectrum to target PHM specific applications and related challenges, but this required an increased time commitment from a single educator.

NEXT STEPS

POCUS is an important skillset that can support PHM clinicians with real-time answers at bedside. Next steps require establishing a PHM POCUS training pathway. This same pathway can eventually be made available to pediatric trainees, who have had increasing interest for POCUS opportunities within training.[18] Based on the implementation of this curriculum, possible future limitations to expanding POCUS to additional members were lack of protected time for educators and learners, consistent access to equipment outside of training sessions, and access to budgeted OSP available to the pediatric department. To address these limitations, local funding has been secured to purchase a pediatric-specific spoke with OSP and handheld ultrasonography machines. Handheld ultrasonography was chosen due to cost limitations. At the time of writing, training will consist of first addressing PHM faculty interest: ultrasonography-assisted lumbar punctures. POCUS educators have agreed to continue education with future cohorts, which include additional interested PHM faculty and PHM fellows. Eventually, the ideal is for learners who have completed POCUS training to become POCUS educators. The long-term goal would be to establish a credentialing pathway for PHM clincians within the institution, allowing for real-time patient care using POCUS.

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ABBREVIATIONS

POCUS: point-of-care ultrasonography
US: ultrasonography
SSTIs: soft-tissue skin infections
AAP: American Academy of Pediatrics
ESPNIC: European Society of Pediatric and Neonatal Intensive Care
PIV: peripheral intravenous
PHM: pediatric hospital medicine
UNM: University of New Mexico
EM: emergency medicine
QA: quality assurance
PBL: practice-based learning
PIMs: Pediatric Hospitalist POCUS Interest Members
LP: lumbar puncture
CSF: cerebrospinal fluid
OSP: online storage platform
ICU: intensive care
PEM: pediatric emergency medicine

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