



Point-of-Care Ultrasonography by Pediatric Emergency Medicine Physicians

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Emergency physicians have used point-of-care ultrasonography since the 1990s. Pediatric emergency medicine physicians have more recently adopted this technology. Point-of-care ultrasonography is used for various scenarios, particularly the evaluation of soft tissue infections or blunt abdominal trauma and procedural guidance. To date, there are no published statements from national organizations specifically for pediatric emergency physicians describing the incorporation of point-of-care ultrasonography into their practice. This document outlines how pediatric emergency departments may establish a formal point-of-care ultrasonography program. This task includes appointing leaders with expertise in point-of-care ultrasonography, effectively training and credentialing physicians in the department, and providing ongoing quality assurance reviews.

abstract

Point-of-care ultrasonography (US) is a bedside technology that enables clinicians to integrate clinical examination findings with real-time sonographic imaging. General emergency physicians and other specialists have used point-of-care US for many years, and more recently, pediatric emergency medicine (PEM) physicians have adopted point-of-care US as a diagnostic and procedural adjunct. This technical report and accompanying policy statement¹ provide a framework for point-of-care US training and point-of-care US integration into pediatric care by PEM physicians.

HISTORY OF EMERGENCY PHYSICIAN POINT-OF-CARE US

In 1990, the American College of Emergency Physicians (ACEP) published a position statement supporting the performance of US by appropriately trained emergency physicians.² The next year, the Society for Academic Emergency Medicine endorsed that statement and called for a training curriculum, which Mateer and colleagues published in 1994.^{3,4} By 1996, the published emergency medicine core content included point-of-care

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US for residency graduates.⁵ With the passage of the American Medical Association Resolution 802 and policy H-230.960 in 1999, “recommending hospital [privileging] committees recognize specialty-specific guidelines for US credentialing decisions,”⁶ emergency physicians were given full responsibility for developing the guidelines of their field. By 2001, the Accreditation Council for Graduate Medical Education mandated that all emergency medicine residents attain competency in the use of point-of-care US,⁷ and the ACEP published the first emergency US guidelines.⁸ In 2008, the ACEP published an update to the original guidelines, thereby establishing the most comprehensive specialty-specific training and practice to date.⁹ Subsequently, the Society for Academic Emergency Medicine, the Council of Emergency Medicine Residency Directors, and the American Institute of Ultrasound in Medicine officially recognized that document.^{10,11} Currently, guidelines from the Council of Emergency Medicine Residency Directors consensus documents from 2009 and 2012 are a mainstay for residency education.^{10,12} In addition, competency assessment tools for the evaluation of emergency medicine residents are being considered.¹²

POINT-OF-CARE US IN PEDIATRIC EMERGENCY MEDICINE

More recently, PEM physicians have been using point-of-care US for patient care. According to a survey from 2011, 95% of emergency departments (EDs) with a PEM fellowship program use point-of-care US in some manner, and 88% of programs provide training in point-of-care US for their fellows.¹³ This is a dramatic increase, because only 57% of programs reported the use of point-of-care US in 2006, and only 65% at that time incorporated training for their fellows.¹⁴ Despite the growing use of point-of-care US by pediatric emergency physicians, there have been no published

guidelines specific to pediatric emergency providers. The indications set forth in existing policy statements are written for emergency physicians who predominantly care for adult patients.

DIAGNOSTIC AND PROCEDURAL INDICATIONS

To date, numerous diagnostic and procedural applications for point-of-care US have been described. The literature supports the ability of general emergency physicians to use point-of-care US to improve the care of adult patients by accurately diagnosing time-sensitive and common ED conditions,^{15–38} decreasing patient lengths of stay,^{15,39–41} and reducing complications.^{15,42–45} Furthermore, emergency physicians are able to achieve competency in performing point-of-care US for various indications after completing adequate training.^{20,26,46–48}

Point-of-care US in pediatric patients by PEM providers has recently been adopted into practice, and the literature is still evolving. Nonetheless, there are numerous studies demonstrating the accuracy of point-of-care US by PEM physicians^{49–58} and the ability of PEM physicians to become proficient in point-of-care US after adequate training.^{55,56,59} Although the point-of-care US examinations performed should be specific to the needs of the department, the most common indications for which point-of-care US is being used in PEM are for focused assessment with sonography in trauma, soft tissue evaluation, and vascular access.¹³

Physicians should be aware that examinations in children and adolescents with disabilities and chronic medical problems may be more challenging to perform and integrate. As always, interpretations should be made carefully in the context of the clinical scenario (eg, the focused assessment with

sonography in trauma examination may demonstrate free peritoneal fluid at baseline in a patient with a ventriculoperitoneal shunt).

DEVELOPMENT OF A POINT-OF-CARE US PROGRAM

The development of a point-of-care US program begins with a clinical need for these services. It is not necessary that all relevant applications be introduced at the same time. In fact, it is most effective to identify the applications that will be the most important in emergent scenarios or most commonly used. The program may then be extended as PEM physicians become more proficient. Point-of-care US has become more prevalent in medicine,⁶⁰ and consequently more physicians are using this bedside technology. Preparing the workforce of the future for point-of-care US means embedding training strategies in the infrastructure of residency and fellowship training.

Point-of-Care US Leadership

A point-of-care US director or core group of leaders is established to facilitate and manage the educational and administrative tasks of coordinating a point-of-care US program within a division or department. Overall, responsibilities for developing a program include education for the clinician operators and administrative processes and procedures for credentialing and quality assurance (QA).

The point-of-care US director (or several directors) has significant US experience encompassing the breadth of pediatric point-of-care US applications. As more PEM point-of-care US fellowships become available, it is likely that US directors will be fellowship-trained.

The director works with the departmental leaders to define a vision and goals for the program. These include equipment accrual,

training guideline development, QA program development, payment strategies, workflow solution implementation for image storage, and creation of credentialing and privileging documents.

Equipment

Selecting the appropriate equipment depends on a number of factors, including image quality, number of users, breadth of use, ease of use, storage space, connectivity options, memory storage needs, budget, and local contracts with manufacturers at each institution.

According to the American Institute of Ultrasound in Medicine's "Routine Quality Assurance for Diagnostic Ultrasound Equipment," there are 2 types of QA needs: cleanliness and safety, and image display and performance.⁶¹ The regular cleaning and daily maintenance of the machinery may be performed by users, biomedical engineering staff, or environmental service staff and should follow guidelines of the Joint Commission. The technical performance of the machine may be maintained by the manufacturer if the machine is under a service contract, and those in the ED may be responsible for QA.

Many departments with established programs have, at a minimum, a low-frequency and a high-frequency transducer. The high-frequency linear transducer can be used in pediatrics for the soft tissues, abdomen, lung, and spine and for procedural guidance. For the evaluation of deeper structures and evaluation of the chest and abdomen, a lower-frequency transducer will provide improved visualization. The phased-array transducer, with its smaller footprint, is attractive for use in children, given the smaller size of pediatric patients. A curvilinear transducer may be suitable for some applications despite the larger footprint. Other transducers, such as a "hockey stick" linear transducer

or endocavitary transducer, which can be used for applications including pelvic imaging and peritonsillar abscesses, may be useful depending on the patient population and physician practice patterns. Obtaining service agreements and warranties with equipment purchasing are important because the equipment undergoes more physical deterioration than similar equipment in an isolated suite used by fewer technicians.

Education and Training

When developing a US program, it is important to consider the spectrum of learners, their willingness to accept new innovations, and their learning styles. Each learner needs special educational attention, and several options for US education may be used. As an introduction to US, physicians may use asynchronous online learning material through Web sites, podcasts, or blogs, for example. Synchronized time through an 8- to 16-hour course with education and hands-on experience is a standard foundation for introductory US training and has been recommended in the ACEP 2008 "Emergency Ultrasound Guidelines" and other publications.^{9,62,63} Additionally, simulation centers may provide a learning environment to teach and demonstrate the practice of point-of-care ultrasound. Finally, bedside teaching of US on patients is an important part of any educational paradigm, including instruction in acquiring high-quality images, interpreting these images, and incorporating these data into bedside medical decision-making. Evidence suggests this is the best method for learners to understand this modality.⁶⁴

Most novice learners report time constraints as the major hurdle toward learning US and obtaining proficiency.¹³ The point-of-care US director is challenged to help integrate various types of US education into the practice

patterns of the division or department to meet the needs of all learners. Alternatively, the director may choose to highlight a specific group, such as attending physicians, and develop a focused plan to train them and use their skills in providing training to the other members of the division or department. Another option is to develop US fellows as educators and to have them train attending physicians in turn. Regardless of the approach, it is important to understand and appreciate that learning point-of-care US at any level is time intensive. Overall, it is important to provide a spectrum of didactic and hands-on opportunities that will assist the learner in mastering this technical and interpretive skill.

Interdepartmental Considerations

Working with other medical specialty departments may be useful when beginning a point-of-care US program. Specifically, the point-of-care US directors may find that their US efforts parallel an undeveloped desire of physicians in other disciplines who seek to incorporate US into their practice. Because specialties such as radiology and cardiology have a long history with US use, early collaboration with these departments may enhance the development of a PEM point-of-care US program. In addition, the general emergency medicine community has developed a robust national and international presence to advocate for point-of-care US. They have established guidelines and policy statements regarding the use of point-of-care US in the ED.^{9,10} Collaboration with neighboring or affiliated general EDs may also prove beneficial.

POINT-OF-CARE US TRAINING AND CREDENTIALING

Point-of-care US is a multifaceted skill including image acquisition, interpretation, and clinical knowledge. To be considered proficient in point-of-care US, PEM

physicians need the skills to acquire technically adequate images and the ability to interpret these studies to inform clinical decision-making. Additionally, physicians should be aware of the relevant point-of-care US applications and how they apply to the patient population.

Many practicing PEM physicians received little or no point-of-care US education during their training. This section includes suggestions for a PEM trainee pathway (“Training-Based Pathway”) and a PEM practicing physician training pathway (“Practice-Based Pathway”). Both pathways require a combination of teaching and hands-on training and include standards for determining proficiency.

Training-Based Pathway

In general, point-of-care US education programs provide trainees with a comprehensive understanding of point-of-care US principles and a skill set that allows them to incorporate point-of-care US into their daily practice. Trainees gain proficiency in the applications most relevant to their practice environment, as determined by the training program. They also develop and understand the advantages and limitations of point-of-care US in their patient population and practice setting. They identify strategies for staying informed of the newest and best evidence-based practices and recommendations.

A point-of-care US education program, adapted from published consensus guidelines for PEM fellow US training⁶⁵ and the ACEP policy statement on point-of-care US,⁹ is summarized here.

Introductory Instruction

Trainees receive an introduction to point-of-care US early in the course of their training. The introduction incorporates didactics and hands-on instruction and covers important topics such as a brief history of

point-of-care US, indications and limitations, and relevant fundamental physics. Practical instruction focuses on machine basics (commonly referred to as “knobology”) and image acquisition.

Rotation Components

A dedicated point-of-care US rotation is considered necessary by many US instructors for trainees who will use point-of-care US in their field. In some institutions, this rotation may be coordinated with radiology, cardiology, or subspecialty-specific point-of-care US-trained physician members. During this rotation, trainees have adequate allocated time free from other clinical responsibilities. The rotation is structured in a manner that incorporates the following features:

- **Didactic sessions and hands-on instruction** related to relevant applications. Hands-on training should include live or simulation models.
- **Scheduled scanning sessions** without simultaneous patient care responsibilities, with a majority proctored by the point-of-care US director or qualified clinicians (ie, those who have been trained and credentialed to perform US for that indication).
- **Image review** of exemplary or departmental scans. Review of imaging from other subspecialties (eg, radiology, cardiology) should be incorporated when appropriate.
- **Timely review of individual scans** with feedback on image quality and interpretation throughout the rotation.
- **Required reading** from selected textbooks and journals.
- **Access to educational resources** including point-of-care US textbooks, online resources, image banks, question banks, and electronic educational materials.

If providing a structured quality point-of-care US rotation is not

feasible given the resources of a particular program, the point-of-care US directors may arrange for trainees to enroll in an outside, comprehensive continuing medical education (CME) course that includes basic and advanced applications. Alternatively, trainees may arrange for a rotation at another institution with an established rotation to receive adequate training. A pediatric subspecialty-specific point-of-care US course or rotation at an institution with a pediatric focus is preferred.

Longitudinal Experience

Beyond the point-of-care US rotation, longitudinal point-of-care US education is important to maintain skills. This includes ongoing didactics, hands-on instruction, image review, and feedback on individual scans throughout the training. Whenever possible and with patient permission, trainees may scan during their clinical shifts. These practice or “educational” scans are not used for medical decision-making.

It is important for physicians to obtain verbal consent from patients and families before performing an educational scan. Specifically, patients and families are informed that the examination would not be used to inform clinical decision-making, and there would not be a charge incurred for the examination. Timely feedback may be provided on the quality and accuracy of the studies, with attention to improvement and maintenance of skills over time. In many institutions, longitudinal trainee point-of-care US educational opportunities can be combined with physician development efforts.

Programs without the resources to provide a point-of-care US rotation and longitudinal point-of-care US experience for their trainees may use outside courses or institutions. In addition, PEM fellows may supplement their training and develop administrative and leadership skills in point-of-care

US through additional training in a 1-year PEM-specific or general emergency medicine US fellowship program.

Practice-Based Pathway

For practicing physicians who did not receive point-of-care US training during their residency or fellowship, point-of-care US education may be creatively integrated into the physician development curriculum. Physicians can pursue training off site if their clinical setting does not provide adequate point-of-care US teaching faculty or supervisors. The practice-based pathway can focus on applications that will be of highest yield for the practicing physicians based on their specialty, patient population, and practice environment.

Introductory Instruction

For physicians without US experience, point-of-care US training may begin with an introductory course consisting of both didactics and hands-on instruction. Introduction to point-of-care US concepts and basic clinical applications can be provided with online, video, or in-person presentations. Didactics alone are insufficient. Hands-on training with live or simulation models is essential for successful introductory training.

Experiential Training

After completing an introductory course, physicians are encouraged to practice the point-of-care US skills they have learned during their clinical shifts. These practice or “educational” scans are either reviewed in real time or saved for review by the point-of-care US director or other qualified clinicians. Feedback is best provided in a timely fashion on the quality and accuracy of the studies, with attention to improvement and maintenance of skills over time. As in the training-based pathway described in the previous section, it is important for physicians to obtain verbal consent from patients and families before

performing an educational scan. Specifically, patients and families are informed that the examination would not be used to inform clinical decision-making, and there would not be a charge incurred for the examination. Department leadership establishes well-defined goals for the numbers of required educational scans in the most relevant applications. Repetition will allow physicians to refine their technique and improve their image acquisition abilities. Ideally, hands-on scanning with a point-of-care US faculty member should complement independent scanning. Participation in image review is an important aspect of point-of-care US training and allows physicians to receive feedback on the quality and accuracy of their scans. By participating in online educational activities and attending conferences, physicians can learn about new point-of-care US applications and stay abreast of developments in the field.

Longitudinal Experience

Establishing requirements for competency (as detailed later) will depend on the clinical setting and the complexity of the individual application. Maintenance of point-of-care US competency requires continued use of the skill. Once it has been determined that a physician is competent in a given application, continued review of a percentage of studies by a supervising point-of-care US physician is important to ensure that the quality of scan acquisition and accuracy of scan interpretation does not decline after competency has been achieved. Frequent review of the recent point-of-care US literature related to the applications used by each subspecialty is also a part of maintenance of proficiency.

Credentialing

Credentialing “defines a physician’s scope of practice and the clinical services he or she may provide, and ensures that the physician provides

services within the scope of privileges granted.”⁹ Specifically, the credentialing of physicians to use point-of-care US provides a framework to ensure the appropriate training and implementation of US into clinical practice. Overall, it is important that the credentialing system be a “transparent, high quality, verifiable, and efficient system.”⁹ Credentialing is typically conferred by the hospital and is achieved through education, training, and practice performance, with subsequent evaluation of individual physician data. For hospitals without an established credentialing process whereby hospital privileges are granted for point-of-care US, the US directors may consider creating a document that delineates the expectations for those seeking privileges. Credentialing should be distinguished from certification, which is made possible by documentation from an outside body attesting that a person has the capability to perform and interpret US.⁶⁶ Currently, there is no nationally accepted certification for physician performance and interpretation of point-of-care US. Some physicians may opt to receive the Registered Diagnostic Medical Sonographer certification, but this certification is geared toward US technicians and is not specific to point-of-care US. Accreditation refers to the overall evaluation of a practice, such as an US department at an institution, typically by a national organization.⁶⁶

It is important that the department leaders clearly delineate how point-of-care US will be used in each department, and providers should be skilled in the point-of-care US indications that apply to their practice environment. The ACEP guidelines for emergency physicians suggest physicians should successfully perform 25 to 50 examinations in each application, with a required number of “true positives” with pathologic findings.⁹ Ideally, these scans are performed in the ED during clinical encounters.

However, acceptable alternatives may include scanning with other imaging specialists and approved CME activities.

With regard to US-guided procedures, the number of scans needed to define competency varies depending on the procedure and the clinician's experience and comfort with the procedure without US guidance. For most simple procedures with which the clinician is already familiar, previous statements on point-of-care US recommend performing 10 scans. For other applications, the clinician may require additional scans (25–50).⁹

Maintenance of Competency

Hospitals typically reappoint physicians and renew their clinical privileges at regular intervals. To renew hospital privileges, a physician must “demonstrate current clinical competence, skill, judgment, and technique.”⁹ This includes performing services as specified in their clinical privileges on a regular basis and keeping up to date on the current literature. In addition to the minimum number of hours of CME didactics, clinicians perform a certain number of scans per year to maintain privileges, with monitoring of their accuracy and remediation when necessary.⁶⁷

Point-of-care US is an acquired skill requiring training and practice. Accordingly, ongoing maintenance of proficiency through CME is important. This may be accomplished in a number of different formats, including departmental US conferences, regional courses, image review sessions, online educational activities, morbidity and mortality conferences that have a specific point-of-care US component, in-service examinations, textbook and journal readings, and research. Hands-on sessions are preferred for physicians who use point-of-care US less frequently. The number of CME hours required per CME cycle

(every 2 years) to maintain competency may vary, but in general they should be relevant and proportional to the number of credentialed applications. The ACEP recommends 5 hours of CME for general practitioners and 10 hours for US directors to maintain credentialing.⁹ However, particularly when point-of-care US practitioners do not have the opportunity to use certain examination skills on a routine basis, additional CME hours should be considered to maintain an appropriate knowledge base and skill level (eg, 10–15 hours per year).

POINT-OF-CARE US QUALITY ASSURANCE AND QUALITY IMPROVEMENT

Examinations are reviewed and evaluated on a regular basis as part of the overall QA and improvement program at each institution. The purpose of the QA process is to evaluate for maintenance of a minimum standard quality of image acquisition and accurate interpretation. An integral component to point-of-care US is the identification of a person (or people) who will be responsible for ongoing monitoring and QA. This may consist of the US director or an equivalent person with requisite knowledge and experience. Assistance in this capacity may be obtained from physicians with requisite US experience who work outside the pediatric ED (eg, critical care, general emergency medicine, radiology).

In general, the person responsible for QA regularly reviews images and provides timely feedback to physicians performing point-of-care US. Images are assessed for technical components (eg, gain, depth, orientation, labeling, and focus) and interpretative accuracy, comparing the point-of-care US findings with comprehensive or consultant imaging in all cases in which these are obtained, as well as medical or

surgical outcomes when available. Discordant findings are monitored and periodically reviewed with the sonologist and through the departmental morbidity and mortality process to identify opportunities to improve patient care. The QA records are regularly maintained and available for review.

It is important to put a process in place to address imaging or interpretive errors of clinical significance in a timely fashion so that potential patient harm is avoided. This includes instances of misinterpretation and the omission of necessary views. The treating physician, QA director, US director, or equivalent ensures that proper follow-up is established, including a return to care if necessary, and documentation of communication is reflected in the patient's charting.

Documentation and Archiving

The manner of documentation for the point-of-care US (eg, hand-written, templated on a computer, or other) depends on the medical record system of the institution. Communication with individual insurance companies and regulators may assist with clarifying the exact wording and level of detail for additional purposes of payment. Elements to include in the documentation are^{68,69} indications for the examination; name of sonologists or certified physician performing imaging; views and findings, including incidental findings; limitations and recommendations for additional studies; impression and medical decision-making; and permanently recorded images as part of the medical record. Maintaining standardized documentation ensures that all relevant information for a given examination is included for easier review, data inquiries, retrieval for research, and inclusion of all necessary elements for billing compliance.⁷⁰ Images may be archived in a variety of formats. The types of imaging may

include printed thermal images, digital still images, or video clips. Archiving solutions may include CDs, digital video discs, hard drives, local servers, third-party proprietary digital archival servers, or picture archiving and communication system programs. The solution should comply with relevant regulatory and individual institutional risk management policies.

CONCLUSIONS

The evidence in support of point-of-care US as an adjunct to the clinical effectiveness of PEM physicians is growing. Over time, more pediatric EDs will develop point-of-care US programs. By establishing training, credentialing, and QA programs, a director or core group of leaders can ensure that this technology is implemented in a safe and effective manner. Ultimately, this will improve the care of pediatric patients. As stated in a "Perspectives" article in *Pediatrics*, "as much as it is our responsibility to understand the limitations and challenges associated with integrating point-of-care US into pediatrics, it is our responsibility to our patients to stay abreast of the most current advances in medicine and provide the safest, most efficient, state-of-the-art care. Point-of-care US can help us meet this goal."⁷¹

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