

CAEP POSITION STATEMENT - DÉCLARATION DE L'ACMU

Recommendations for the Use of Point-of-Care

Ultrasound (PoCUS) by Emergency Physicians in Canada

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A. INTRODUCTION

The Canadian Association of Emergency Physicians (CAEP) recognizes the importance of Point-of-Care-Ultrasound (PoCUS) as an adjunct to the delivery of excellent emergency care in all types of emergency settings throughout Canada. Point of Care Ultrasound (PoCUS) is defined as “diagnostic or procedural guidance ultrasound that is performed by a clinician during a patient encounter to help guide the evaluation and management of that patient.” (1).

We recognize that Canadian Emergency Departments are staffed by physicians with a variety of training backgrounds including Emergency Medicine and Family Medicine. In this document we use the term Emergency Physician to describe all physicians with appropriate Emergency Department practice privileges.

The historical progression of the terminology used to describe the use of ultrasound by a clinician at the bedside is worth a brief review, as it continues to be debated and modified even in recent publications (2–4). In Canada, many Emergency Physicians will be familiar with the term ‘*bedside ultrasound*’ or ‘*emergency department echo (EDE)*’. In the USA, ACEP has proposed using the term ‘clinical ultrasound’ to describe an ultrasound performed by any physician in the clinical setting and ‘emergency ultrasound’ to describe essentially the same process when performed by an emergency physician (2). This focus on terminology is to be expected for an emerging area of practice that crosses professional boundaries. However, given the increasing maturity and general acceptance of this practice (across all specialties and in medical schools), the use of multiple definitions to explain the difference between all the various users of ultrasound is no longer required. Throughout this document we have used the term PoCUS, as defined above, which is internationally accepted across all specialties and encompasses all areas of our practice.

There are specific psychomotor skills and knowledge (5) required to competently utilize PoCUS in patient care and specific aspects relating to quality maintenance and machine care that currently require a position statement. The incorporation of PoCUS into medical school curricula and residency training programs is likely to render much of the training and competency section of this document obsolete. However, for at least the next 10 years, there will be a transition period catering to the needs of both these emerging PoCUS-savvy physicians and those mid-to-late career physicians who were not trained to use PoCUS.

The use of PoCUS by Canadian Emergency Physicians is well established (6). Most, if not all, emergency departments have access to an ultrasound machine, and many now have more than one (7). Even small satellite departments and urgent care centres now often have access to portable ultrasound machines and this trend is set to continue with the advent of personal ultrasound devices. The breadth of the scope of practice documented in this position statement reflects the benefit that PoCUS brings to EM specifically. No other specialty has as broad a PoCUS scope of practice. Many PoCUS applications that were first described and investigated by Emergency Physicians have now been adopted by other specialties (8–11). Emergency Physicians continue to provide leadership in PoCUS research and innovation.

With this document, we aim to provide Canadian Emergency Physicians with a framework and a series of recommendations that they can use to advance personal PoCUS development, PoCUS program development and/or maintenance. We recognise that there may be a number of recommendations within this document that some Emergency Physicians and EDs do not currently meet and that some of these recommendations may require investment to achieve. This position statement is not designed to highlight those deficiencies but rather to provide support, in the form of national recommendations, to enable all Canadian Emergency Physicians and their departments to provide the highest standard of care with PoCUS for their patients.

B. OVERVIEW OF CURRENT SITUATION

The Canadian Association of Emergency Physicians (CAEP) Position Statement on Ultrasound in the Emergency Department (ED) was first published in 1999 (12) and updated in 2006 (13) and in 2012 (14). The significant growth in the use of Point-of-Care-Ultrasound (PoCUS) and increased supporting evidence was highlighted in the 2012 update. Over the last 5 years, we have continued to see growth in the number of evidence-based PoCUS applications in Emergency Medicine (EM). The most substantial developments have been in education, curriculum setting, competency and quality of emergency PoCUS. The International Federation for Emergency Medicine (IFEM) published their *Point-of-Care Ultrasound Curriculum Guidelines* in 2014 (3) and the American College of Emergency Physicians (ACEP) updated their policy *Emergency, Point-of-care, and Clinical Ultrasound Guidelines in Medicine* in 2016 (2). Both of these publications reflect the focus on education and quality of PoCUS, that is now an established standard adjunct to the delivery of modern clinical medicine.

Other medical specialties in Canada have looked to EM as they develop their own PoCUS curricula, policies and guidelines (8,9). With the introduction of PoCUS into the curriculum for medical students, many Canadian Medical Schools are looking to Emergency Physicians to provide expertise, teaching and leadership.

In this update, we have expanded the recommendations to provide more guidance in the areas of EM PoCUS training, competency, and program management, for both adult and pediatric EM.

This position statement was developed and written by the CAEP Emergency Ultrasound Committee (EUC) Position Statement Working Group, a subcommittee that included the CAEP EUC executive and invited PoCUS experts including those from both academic and rural practice. The evidence reviewed and included to support these recommendations can be divided into three main categories; test performance, patient oriented outcomes and system efficiency metrics. The evidence appraisal methodology is described in Appendix 3. The manuscript was developed and evolved through consensus of all the authors and benefitted from review and further refinement by the entire CAEP EUC membership at CAEP18 (Calgary, AB). It is based on the most current evidence and reflects both best current practice and a realistically achievable pathway for the next 5 years.

C. RECOMMENDATIONS

1. Clinical Scope of Practice
2. Training and Competency
3. Emergency PoCUS Program Management
4. Pediatric Emergency PoCUS
5. Research

1. CLINICAL SCOPE OF PRACTICE

When listing emergency applications of PoCUS, it has previously been the practice to divide this list into basic and advanced applications. This approach may be problematic as it may misrepresent the level of skill required to learn the given applications (historically, lung PoCUS was labelled an advanced application, but likely represents one of the easiest PoCUS skills to learn). In this position statement we have included the core PoCUS applications (mirroring the core set recommended by CAEP for residency training) and then separately listed all other applications that may fall within the scope of practice for an Emergency Physician. See appendix 1 and 2 for a more detailed description of each application, its relevance to EM and supportive referenced evidence.

A. CORE APPLICATIONS

The following POCUS applications have been recommended by the CAEP EUC as essential to the practice of Emergency Medicine in Canada. These applications are considered emergent and potentially life-saving, their prioritization is also mirrored by other major instructional bodies in EM. It is therefore recommended that all practicing Emergency Physicians have (or are actively working towards attaining) these core PoCUS skills.

- ***Extended Focused Assessment with Sonography for Trauma (eFAST includes thorax and abdomen)***
- ***Identification of Abdominal Aortic Aneurysm (AAA)***
- ***Identification of First Trimester Intrauterine Pregnancy (IUP)***
- ***Thoracic Ultrasound*** (including identification of pneumothorax, hemothorax, pleural effusion, and interstitial lung syndrome)
- ***Focused Cardiac Ultrasound*** (including assessment of global cardiac activity, gross left ventricular systolic function, right ventricular size, presence of pericardial effusion and inferior vena cava (IVC) calibre).
- ***Ultrasound-Guided Vascular Access*** (including peripheral and central vascular access).

The above applications have also been recommended by the CAEP Emergency Ultrasound Committee (EUC) as a core curriculum for EM residency training (15).

B. SCOPE OF PRACTICE

PoCUS can be indicated in a number of clinical scenarios: it can be used as an adjunct to the resuscitation of a critically ill or injured patient, as an adjunct to history and physical examination in helping to narrow the differential diagnosis, and as an adjunct to improve safety and efficacy of common procedures. The following list of applications is divided into Resuscitative, Diagnostic, Procedural Guidance, and Therapeutic Monitoring categories. They include, but are not limited to, the common PoCUS indications with associated referenced evidence (See appendix 1 and 2 for a more detailed description). It is not expected that all Emergency Physicians acquire the skills to perform all of these applications. Emergency Physicians can use this list as a guide to acquiring PoCUS skills that provide benefit to their particular area of practice.

1. **Resuscitative:** PoCUS used as directly related to resuscitation and critical care. This includes the use of ultrasound to determine the etiology of shock or hypotension, as well as to assist with identifying the cause of respiratory distress and to guide cardiac arrest management. Generally, resuscitative PoCUS includes, but is not limited to, assessment of left ventricular (LV) systolic function, right ventricular (RV) size, assessment for pericardial effusion and tamponade, IVC size and respiratory variability, thoracic PoCUS for the identification of pneumothorax, hemothorax, pleural effusion and interstitial lung syndrome, and abdominal PoCUS for the identification of a AAA or free fluid
2. **Diagnostic:** PoCUS used in an emergent diagnostic imaging capacity. These applications have a positive impact by expediting patient care and improving departmental flow. As an example, PoCUS can rapidly detect ureteric obstruction in a patient presenting with renal colic, or the presence of gallstones and signs of cholecystitis in a patient presenting with right upper quadrant pain. Diagnostic PoCUS includes, but is not limited to, focused assessment of the hepatobiliary system, genito-urinary tract, abdominal aorta, deep venous system of the lower limbs, the large and small bowel, the eyes, joints, soft tissues, and musculoskeletal system for fractures, effusions, dislocations and identification of cutaneous foreign bodies.
3. **Procedural Guidance:** PoCUS used as an aid to guide a procedure. Generally, procedural guidance includes, but is not limited to, vascular access, paracentesis, thoracentesis, pericardiocentesis, suprapubic catheterisation, regional anesthesia, joint aspiration and injection, lumbar puncture, cutaneous and peritonsillar abscess drainage, endotracheal intubation, foreign body removal, and reduction of fractures and dislocations.
4. **Therapeutic and Monitoring:** PoCUS used in therapeutics or in physiologic monitoring. This is especially relevant with the growing body of literature highlighting the potential risks of “over-resuscitation” with crystalloids (16). Cardiac output monitoring, fluid tolerance, fluid responsiveness (velocity time integral (VTI), IVC collapsibility, carotid flow), and response to treatment of interstitial lung syndrome (resolution of B-lines) all represent potential monitoring modalities by means of POCUS.

Frequently in clinical practice, selected applications are performed in combination when assessing a patient with an undifferentiated presentation. PoCUS is then used as part of a clinical assessment pathway based on the patient's symptom or signs (e.g. shortness of breath, abdominal pain, chest pain, hypotension, leg swelling). This symptom/sign-based approach to combining applications is a natural progression from the limited focused question approach and is consistent with the hypothesis-driven assessment expected of clinicians. For example, the patient presenting with right upper quadrant pain may be suffering from either biliary or renal colic or may be experiencing referred pain from a lower lobe pneumonia or pleural effusion. Such patients may benefit from a symptom-based approach that includes scans of the above-mentioned structures.

Formal protocols that attempt to define combinations of applications for particular presentations have been described and studied. The Focused Assessment with Sonography in Trauma (FAST) scan was the first such protocol and has since been expanded from abdominal, pelvic and cardiac views to include thoracic views. Other described protocols include RUSH (17), ACES (18), EGLS (19), and SHoC for hypotension and cardiac arrest (20).

C. IMAGING ORIENTATION CONVENTIONS

With the exception of cardiac, endocavity, certain procedural and MSK applications, the accepted convention for image orientation is as follows:

- Transducer/Probe applied in the Transverse Plane - Screen Left = Patient Right
- Transducer/Probe applied in the Longitudinal Plane - Screen Left = Patient Cephalad

Machine manufacturers provide a marker on the screen that corresponds to a physical marker on one side of the transducer/probe to assist with and record orientation of saved images/clips.

Certain MSK and procedural applications will require positioning the patient and machine in different ways e.g. for internal jugular vein cannulation, the operator and machine are located at the head of the bed so that when the transducer/probe is applied in the transverse plane – screen left corresponds to patient's left.

Cardiac PoCUS, especially the transthoracic views and applications, evolved from echocardiography practice and literature. Echocardiography is performed by an operator and machine located on the patient's left (PoCUS operators are almost always located on the patient's right). It is this operator location difference that historically resulted in the echocardiography orientation convention:

- Parasternal Long Axis – Screen Left = Patient Left (cardiac apex)

Adoption of echocardiography orientation conventions by PoCUS operators for cardiac PoCUS has often resulted in some confusion for novice PoCUS users and in some centres,

PoCUS faculty have elected to use standard PoCUS orientation when performing cardiac PoCUS specifically the parasternal long axis view (e.g. screen right = patient left (cardiac apex)). Note that the orientation for other cardiac views; parasternal short axis, apical four chamber and subxiphoid view are the same in both conventions (screen right = patient left).

There are advantages and disadvantages to both approaches for cardiac PoCUS. The echocardiography convention is supported by a large amount of educational resources, online videos and textbooks, whereas the PoCUS convention appears more anatomically correct on screen when the operator is located on the patient's right and is more consistent for novice users.

The CAEP EUC makes no specific recommendations on which orientation convention should be used for cardiac PoCUS, but does recommend consistency within departments based on local PoCUS policy.

2. TRAINING AND COMPETENCY

A. GENERAL OVERVIEW

Competence in POCUS requires a combination of image generation and interpretation skills alongside a strong understanding of the clinical utility of the various applications. Currently, both EM trainees as well as many practicing emergency physicians are undertaking PoCUS training. From an instructional perspective, the acquisition of PoCUS skills by physicians-in-practice as compared to EM trainees pose different challenges. Generally, mastery of new skills requires a much greater effort than the fine-tuning of existing ones (21). While a practicing EM physician may readily grasp the applicability of PoCUS in resuscitation, these truths may be less obvious to EM trainees in their first years of training. Performing PoCUS in strictly psychomotor terms involves mastery of image generation through appropriate transducer manipulation that may be more difficult to master for a clinician who has spent much of their career not using such equipment. Furthermore, timely and efficient use of PoCUS, proper interpretation of findings, and the integration of the above into the care of what are, at times, critically ill patients is all the more complex. For these reasons, training and assessment of PoCUS competence amongst EM trainees and physicians-in-practice are necessarily different.

In general, training in PoCUS should incorporate a significant amount of experience scanning clinical cases in a clinical setting. Such experience may be supplemented by scanning workshops, or training sessions that involve volunteers or PoCUS simulation (3). The key features of this learning phase are focused around optimising the physicians skills in:

1. Generating optimal images,
2. Interpreting the images, and,
3. Incorporating the images into clinical decision-making.

B. RESIDENCY

The recently proposed CAEP PoCUS curriculum contributes to a strong foundation for quality and growth of PoCUS in Canadian EM training programs (15). Similar to other established PoCUS curricula, this first iteration centers on emergent and potentially life-saving applications (22). While FAST, identification of AAA, identification of intrauterine pregnancy (IUP) by transabdominal approach, basic cardiac ultrasound for identification of pericardial effusion, and ultrasound-guided vascular access are already commonly taught throughout Canadian EM training programs (23) the addition of thoracic and focused cardiac ultrasound represents substantial growth in what are considered core applications. Indications for thoracic ultrasound include the detection of pneumothorax, pleural effusion/hemothorax, and interstitial lung syndrome. Indications for focused cardiac ultrasound include the detection of marked left or right ventricular enlargement, global cardiac systolic function, and volume status.

Emerging evidence on the nature of PoCUS learning curves (24) combined with expert opinion (25) support the need for a multitude of training scans in order to develop efficient and

reliable image generation skills. However, it is unlikely that the number of scans required is the same for each trainee. We recommend that trainees be assessed at regular intervals (both on shift as well as outside the clinical context) in order to ensure progression of proper technique. This approach is in keeping with the upcoming Canada-wide adoption of competency-based residency training and is further reinforced by the adoption of POCUS as a core entrustable professional activity (EPA) of emergency medicine. While the adoption of additional applications may pose logistical challenges related to time and resource constraints (6), it is anticipated that through cooperation and support from training programs, these challenges can be overcome.

Acceptable methods of training encompass a broad range of methods including direct supervision (including during real patient care or on standardized patients outside a clinical context), review of saved patient scans/images (indirect supervision), simulation, online learning modules, didactic lectures, and ultrasound courses (15). Given that regional disparities and differences in resources will be best addressed through a flexible teaching model that employs a variety of instructional and supervisory methods, it is important that residency programs are provided with the resources required to make PoCUS training of the highest quality. In response to this need, PoCUS educators throughout Canada have embarked on preparing an open-access curriculum for sharing PoCUS education material (EDSonoShare - www.EDSonoShare.ca). In this partnership, all work will continue to be attributed to the respective authors/creators of the learning material (and their respective institutions).

Physicians who have recently completed postgraduate PoCUS training do not need to obtain external PoCUS competency certification, although some may still choose to do so. Most Canadian EM programs offer robust PoCUS training, and through collaboration, more programs will follow. The CAEP EUC supports the recognition of PoCUS skills obtained and assessed during residency training as part of a physician's certification in EM. Emergency Departments (and their respective privileging bodies) are encouraged to clearly define the credentials required to practice PoCUS locally. Where concerns or questions about credentials arise, privileging bodies are encouraged to contact representatives from the training program in question to objectively review its composition and determine if the training program meets their local standards.

C. PHYSICIANS IN PRACTICE

Questions remain as to how best teach the integration of new psychomotor skills into clinical practice (26). In an era of patient-centric medicine where initial practice by novices on real patients is less acceptable (27), many psychomotor tasks are preferably first learned outside the clinical context. PoCUS is no different, with many physicians first developing their basic scanning skills on volunteers or standardized patients at courses. Once again, emerging evidence on the nature of PoCUS learning curves combined with expert opinion leave little doubt that physicians require a supervised training phase (traineeship) following this introduction to a new PoCUS application (ranging anywhere from 10-50 scans for most applications) (24).

Currently practicing physicians interested in developing competence in PoCUS generally do so through self-directed study, course attendance, performing practice scans on patients and

volunteers, video review or enrollment in traineeships and fellowships. Many of these physicians then go on to challenge examinations offered by such organizations as the Canadian Point of Care Ultrasound Society (CPoCUS) or by their local PoCUS programs which then offer certificates to clinicians who have successfully completed their training requirements and passed exams assessing their proficiency. Attaining such certificates is done for a variety of reasons including demonstration of a newly acquired skill, recognition of continuing professional development, as well as to meet local requirements for privileges.

To assist both our physician membership and those involved in privileging (including department heads and managers where applicable), the CAEP EUC recommends the following three components of training be considered essential when evaluating a physician's PoCUS credentials and determining corresponding privileges:

1. Clearly defined introduction to the PoCUS skill
2. Traineeship with supervision that may include scanning in both the clinical and non-clinical setting. This training phase should maximize exposure to both normal and abnormal findings and should include exposure to a representative sample of model/patient body habitus.
3. A summative assessment of knowledge (including clinical integration and comprehension assessments) and an image generation assessment that includes a directly observed practical exam.

Details of any POCUS training program undertaken by a physician should be readily available for review upon request by the department head/chief or privileging entity. The above criteria can then be applied to then determine if the training in question meets these minimum standards.

How these complex skills can be best introduced into a practicing physician's clinical skill set remains a topic of controversy. Approaches that rely exclusively on the review of saved images seem to fall short as they do not offer an entire picture (including how long it took the clinician to obtain the adequate views) and are subject to selection bias. This is especially relevant given the increasingly important role PoCUS plays in emergency resuscitation. Evidence exists that without proper and deft image-generation skills' acquisition, such integration may lead to inadvertently prolonged pulse checks (28,29) which may adversely impact patient outcomes.

Review of saved images should play a substantial role to quality assessment and improvement reviews after physicians have completed a proper traineeship. It could also be an innovative way to evaluate instructor performance by measuring improvement of trainees under the supervision of an apprentice instructor. This might be more difficult to put in place for remote departments with limited staff and means and shouldn't be seen as a deterrent to acquiring POCUS skills. Most practicing physicians should focus their training on acquiring the psychomotor efficiency and accuracy necessary to obtain good-quality images to improve their clinical assessment of critically-ill patients. POCUS should be seen by this population of learners as a new tool to augment the quality and precision of the differential diagnoses proposed for any critically-ill patient. This population of trainees are taught to use this tool by always deferring to

their clinical judgment when in doubt on how best to integrate it to the whole picture.

With regards to the incorporation of invasive scans (transvaginal and transesophageal POCUS), much can be learned from the surgical literature. Kneebone *et al* made the case for the use of simulation in surgical training to address this challenge of novel skill integration (26). They proposed an interactive relationship where the clinical and simulated environments complement each other in a regular and consistent fashion. TEE during resuscitation of critically-ill patients is in the realm of the feasible for EM physicians. Arntfield *et al* discussed feasibility of training for EM physicians for TEE focused exams with good retention of learned skills (30). ACEP has also recently published guidelines endorsing the use of point of care TEE (31). In EM, simulated encounters of critically-ill patients and invasive scans may allow physicians to focus on the complex mix of problem solving and psychomotor skills associated with these cases.

D. OTHER HEALTHCARE PROVIDERS

Increasingly, non-physician healthcare providers are using PoCUS to improve bedside care. Emergency Medical Services (EMS)/Prehospital applications, especially when during transport over distances that include fixed and rotary wing emergency services, can have a positive impact on patient outcomes by helping identify and prioritize injuries (32–41). As PoCUS leaders within these fields emerge, their expertise will be critical in developing relevant training and assessment processes.

It is recommended that the training of these clinicians should be similar to that of physicians in terms of an introduction, a supervised traineeship, and an assessment of knowledge, but clear distinctions should be made recognizing the austere nature of transport medicine and the impact of this environment on scanning. For example, the tight confines of a helicopter translate into very real limitations in terms of scanning and image optimization.

Nursing colleagues are undertaking training to assist with vascular access (42). There is also growing evidence to support use of PoCUS by nurses as part of the assessment of the dyspneic patient by identification of B-lines as an adjunct to the nursing assessment (43). As stated above, many PoCUS applications may play a critical role in not only initial assessment but also therapeutic surveillance. It is not unreasonable to suggest that our nursing colleagues will soon be monitoring response to therapeutic interventions through PoCUS - alongside glucometers, thermometers, blood pressure monitors and the like. It is recommended, for those already in practice, that any PoCUS traineeship should include the key features listed above.

Simultaneously, an increasing number of Canadian medical schools are introducing PoCUS in undergraduate medical education (44). The growth of PoCUS in specialties such as anesthesia, critical care, general surgery, internal medicine, obstetrics-gynecology and emergency medicine has sparked interest about the potential of ultrasound training in undergraduate medical education (45–48). The programs that have incorporated some form of ultrasound training in undergraduate training have shown higher satisfaction rates amongst medical students and enhanced student learning of anatomy, physiology, and examination skills. The addition of PoCUS can assist with physical exam skills since it allows students to visualise human anatomy and associated pathologies in a non-invasive manner. Furthermore, a recent

study of the impact of PoCUS training on clinical reasoning suggests that students are able to appropriately integrate PoCUS findings into their clinical decision making (49). This is a welcomed development as it promotes a strong foundation upon which each speciality can build.

E. FELLOWSHIPS

Emergency Medicine PoCUS Fellowships are responsible for the advancement of EM-PoCUS through scholarship, education, and advocacy. Their role is to train PoCUS providers to become skilled sonographers, outstanding educators, solid academics who have the skill set to interpret and perform PoCUS research, and administrators with the ability to develop and manage a PoCUS program in an expert manner. There are several established fellowships across Canada (www.PoCUS.ca).

An Area of Focused Competence (AFC) Diploma program for *Acute Care Point-of-Care Ultrasonography* (PoCUS) has recently been approved by the Committee of Specialties of the Royal College of Physicians and Surgeons of Canada (50).

F. CONTINUING PROFESSIONAL DEVELOPMENT

Physicians are expected to keep current with medical and health care developments throughout their careers and are supported by the Canadian Colleges in their CPD and lifelong learning goals.

The practice of PoCUS by Emergency Physicians has become established throughout Canada; however it remains a rapidly developing area of practice and is likely to warrant specific CPD focus for the next 5-10 years. Physicians in practice are encouraged to follow the above recommendations in order to acquire the PoCUS skills appropriate to their practice area. There are a number of established, high quality courses in Canada and worldwide that provide training and updates in the many areas of PoCUS relevant to Emergency Physicians.

For practicing Physicians, the transition from having no PoCUS competency to acquiring core level competency can be initially difficult, however the knowledge and skills required to attain core level competency are the foundation for developing competency in many of the other PoCUS applications. Although a proportion of physicians will choose not to develop their PoCUS competencies beyond a basic core level, those that do are likely to find that these additional competencies are much easier to acquire (21) and all Emergency Physicians are encouraged to do so.

The Free Open Access Medical education (FOAM) community (EM Blogs, Twitter, YouTube, etc) are often an excellent resource for keeping up to date with PoCUS applications and technique (51–53). There is also a growing body of evidence (supportive and in some cases non-supportive) within the medical literature relating to all areas of PoCUS. Emergency Physicians should consider and carefully appraise these sources as part of their CPD and lifelong learning goals.

3. EMERGENCY PoCUS PROGRAM MANAGEMENT

Emergency PoCUS program management includes components of program leadership definitions, monitoring and quality assessment suggestions as well as machine choice and maintenance. Recommendations are provided to assist EDs in developing PoCUS leaders and to help those leaders develop expertise and establish robust programs that will improve patient care.

A. LEADERSHIP

1. Local Leadership

All hospitals with a designated Emergency Department and PoCUS equipment should have a named physician (*PoCUS Lead*) responsible for development and maintenance of the emergency ultrasound program. In smaller and rural hospitals, this role may be assumed by those with other ‘quality’ responsibilities e.g. the department head, however there are many examples of local enthusiasts providing high quality PoCUS leadership (See Appendix 5).

Academic Emergency Departments should have a *PoCUS Program Director*.

PoCUS Lead / PoCUS Program Director responsibilities may include (54):

- i. Administration
 - Program development and compliance
 - Quality, including image archiving and quality improvement
 - Machine maintenance, infection control
- ii. Education
 - PoCUS training for emergency medicine residents
 - PoCUS training for medical students
 - PoCUS training and CPD for practicing physicians
 - PoCUS training for nurses and paramedics
 - PoCUS electives and fellowships
- iii. Clinical Excellence
 - Local PoCUS competency assessment
 - Collaborating with other local specialty PoCUS clinicians (e.g. Anesthesia, Critical Care, Internal Medicine and Pediatrics) and other related departments with established ultrasound programs (e.g. Radiology, Cardiology and Ob/Gyn)
- iv. Research
 - Performing and collaborating in local/national or international PoCUS related research

A *PoCUS Lead* will, as a minimum, have completed (or be in the process of completing) competency in at least the CAEP Core PoCUS applications. It is expected that the majority will have a special interest in PoCUS and will have completed additional PoCUS training (15).

A *PoCUS Program Director* will, in addition, have had significant PoCUS training and experience. It is expected that the majority will have completed a PoCUS Fellowship or equivalent.

Physicians in either of these leadership roles should be given support by their organizations in order to develop these attributes if required. They are encouraged to directly or indirectly participate in national or international PoCUS organizations to keep current on the landscape of point-of-care ultrasound. Departments are expected to balance resources requirements to support physicians in meeting these deliverables.

2. Regional Leadership

It is recommended that regional academic centres and their associated geographically-located smaller emergency departments collaborate with respect to program management. This will enable regional programs to develop, with support for training, local CPD and quality improvement. While it is likely that the *Emergency PoCUS Program Director* will play a major role in this, PoCUS experts / enthusiasts in smaller hospitals may want to take on regional leadership responsibilities.

B. QUALITY

1. Documentation

- i. Barriers to quality PoCUS documentation include perceived time constraints, lack of certification and fear of litigation (55).
- ii. The results of **all** PoCUS examinations must be clearly documented in the medical record. This may be hand written in the chart or entered into an electronic medical/health record (56).
- iii. This report should be concise and include the following:
 1. Indication
 2. Type of scan / area examined
 3. Findings
 4. Interpretation
- ii. Indeterminate scans (where PoCUS was attempted, but for various reasons the images were of insufficient quality to interpret) should also be clearly documented.
- iii. This report must be available to other physicians involved in the care of the patient.
- iv. Incidental findings should be documented and communicated to the patient and their primary care provider or most responsible physician (MRP).
- v. PoCUS examinations performed for training purposes and without clinical indication may also be documented in the chart if findings that could influence the clinical course are present.

2. Image Archiving

- i. Many larger and academic Emergency Departments in Canada are archiving images and clips for every examination performed. This is considered **best practice** and **strongly recommended**.

Advantages of image archiving include:

- Education and training
 - Enables Quality Improvement programs (57)
 - Enables other Physicians involved in the care of the patient to have access to the images/clips allowing comparative examinations and tracking progress (58)
 - Medico-legal considerations (59)
 - Research
- ii. We strongly recommend that larger and academic Emergency Departments actively work towards implementing a robust PoCUS image archiving system.
 - iii. Smaller departments should also consider how they may be able to archive images in a practical/cost-effective way.
 - iv. There are already a number of approved PoCUS image archiving systems that integrate securely with hospital information systems. We encourage others to provide further innovative scalable solutions that meet the needs of both larger and smaller departments and are in accordance with regional Personal Health Information Protection Act (PHIPA) policies and regulations.
 - v. Refer to CAEP EUC webpage (<https://caep.ca/>) for further information on image archiving / middleware solutions.
 - vi. While dynamic media (video clips) are better able to confirm full acquisition for certain applications, particularly for trainee review, they do consume more storage and are not necessarily required for every application.
 - vii. Each PoCUS application will best be achieved using a standard set of images/video clips. This enables PoCUS program quality assurance. Recommended CAEP EUC PoCUS application archiving standards can be accessed via the CAEP EUC website (<https://caep.ca/>).

3. Educational Image Archiving and Sharing

It has been accepted practice in Canada and internationally to use illustrative images and clips to highlight presentations, publications and educational social media posts. All identifying data must be securely stripped from both the image and the file. Any use of these images and clips must be in accordance with regional health information protection acts, policies and regulations (60).

4. Quality Assurance and Quality Improvement

Quality Assurance (QA) is a process of audit and review to determine compliance with an established standard or policy. Quality Improvement (QI) is a process to address deficiencies identified in the QA review and also a method of improving upon current established standards to improve services. Both QA and QI are important components of a department PoCUS quality program (61). A strong quality program is integral to the safe practice of PoCUS and should be incorporated into the overall emergency department quality program (62).

Components of a local PoCUS quality program will include some or all of the following:

- A named physician designated and responsible for development and maintenance of the emergency ultrasound program (*ED Ultrasound Lead/Program Director*).
- An established image archiving solution
- A local registry of physician PoCUS competency
- A system of physician PoCUS performance review, including sample review of archived scans, findings and interpretation.
- A system of feedback of the results of physician PoCUS performance review.
- Inclusion of PoCUS specific cases in regular department morbidity and mortality (M&M) meetings
- Incorporation of PoCUS competency, PoCUS performance, M&M feedback into department Physician Achievement Review (PAR) or equivalent.
- An ongoing program of PoCUS education, support and development.

Resource Considerations

A PoCUS quality program requires resources, including physician time and administrative support. Departments are expected to balance the competing demands placed on resource allocation in order to support successful program delivery. Many larger academic centers (especially those with PoCUS Fellowships) will already have implemented much of the above. Others will have EM quality programs in place that could be expanded to include PoCUS quality. In smaller hospitals, the department head may be the only resource available and will have to consider which of the above recommendations are achievable locally and what support is available regionally e.g. regional archiving, regional PoCUS education and competency development. See Appendix 5 for Rural EM PoCUS.

C. ULTRASOUND MACHINES

1. Machine Specifications & Purchase Considerations

The choice and purchase of an ultrasound machine requires a considerable amount of time and research. Potential users should have a chance to try the machine during real clinical encounters. Ideally, trial machines should be available for at least a week to provide the best sense of its applicability for an individual department's needs. The following factors should be considered in selecting the best machine for a particular emergency department:

i. Machine Characteristics

- a) *Durability and Warranty* - Machines used in the ED are subject to heavy use without much preventive care. Suitable machines should have strong joints, few protruding areas, and durable probes and connections. Even the toughest machines will fail at times, and a comprehensive warranty program that includes both efficient repair and quick shipping of loaner equipment is crucial.
- b) *Portability* - ED PoCUS machines may be either cart-based, handheld or smartphone-based. Cart-based systems should have a small footprint and be easily maneuverable in small spaces. Carts also offer the advantage of providing storage space for gel, cleaning supplies, log books and spare probes. Handheld and smartphone systems can be carried in the provider's pocket or bag. A system to minimize the theft of small machines should be developed to fit local practice.
- c) *Screen Size* - Screen size needs to be balanced with portability and will depend somewhat on the ED setting. In centres with learners or large care teams, a bigger screen will facilitate teaching.
- d) *Battery Life/Chargeability* - Battery life should be sufficient to scan several patients in a row without requiring AC power. Charging should be easy, via a standard wall plug or charging dock. Some machines come with the option of extra batteries that extend scanning time.
- e) *Quick Boot-Up Time* - This should be as fast as possible and should allow for emergent scanning without requiring the input of patient identifiers.
- f) *Infection Control* – Machines (including keyboard, screen, transducers, cables and cart) must be easily cleanable and meet local infection control standards (see section 3C2 and Appendix 3).

ii. Machine Availability

Ultrasound machine(s) must be immediately available to an Attending Emergency Physician in the Emergency Department at all times.

The CAEP EUC recommends that Emergency Departments should have one ultrasound machine for every Attending Emergency Physician on shift.

The number of machines required in a department should be based on the maximum number of Attending Emergency Physicians in any one shift (no including handover periods) e.g. Hospital A has the following Emergency Department staffing allocation:

Day – 2 Attending Emergency Physicians
Evening – 3 Attending Emergency Physicians
Overnight – 1 Attending Emergency Physician

The Emergency Department for Hospital A should have 3 ultrasound machines.

For some hospitals this recommendation may take some time to achieve. The CAEP EUC recommends that the minimum number of machines should be based on the number of distinct patient areas. There should be a minimum of at least one machine for every distinct clinical area (e.g. Acute, FastTrack, etc) including one machine **always** located in the Resuscitation area/Trauma. Some Canadian Provincial Colleges already mandate the above or similar.

iii. Transducers and Imaging Capabilities

- a) *Transducer Selection* - Ideally, ED PoCUS machines should be equipped with phased array, curvilinear and linear probes. Other options include microconvex probes for pediatrics and lung, endocavitary probes for transvaginal ultrasound, transesophageal probes for resuscitation, and hockey stick-shaped probes for procedures. Departments on very tight budgets may opt to use a phased array transducer in lieu of a curvilinear transducer for abdominal applications. It is optimal for all transducers to be attached to the machine at the same time. Transducer changes slow down the user who may wish to do multiple types of scans, and increase the likelihood of transducer damage and failure.
- b) *Imaging Modes* - Every ED PoCUS machine should be capable of B-mode, M-Mode, and Colour Doppler. Pulsed Wave and Continuous Flow Doppler are also typically included on most modern machines and will be of variable utility to ED users.

- c) *Artifact Filters* - Most modern machines come with a selection of artifact filters (e.g. Tissue Harmonics, Compound Imaging and others) that can be selected as part of an exam preset. The ability to turn these on and off is important to allow visualization of artifacts when required (e.g. lung imaging).
- d) *Calculation Packages* - Centres interested in developing their members' advanced cardiac and vascular skills should evaluate the machine's functionality for calculating parameters such as cardiac output, pulmonary artery (PA) pressures, etc. Basic caliper measurements are standard on machines.

iv. Storage & Workflow

- a) *External/Third Party System Archiving* - Departments currently using a formal archiving system such as Picture Archiving and Communication System (PACS) or other third party software, should confirm system compatibility. Ideally, the new machine should be capable of WiFi transmission in the correct format (usually DiCOM). This should also be a consideration for departments contemplating the implementation of such a system within the lifetime of the machine.
- b) *Workflow for External Archiving Systems* - This must balance simplicity and accuracy. Saving scans and interpretations must be intuitive, but the system must require enough patient identification to ensure that every study is attributed to the correct patient. Emergency Department Information System (EDIS) - generated picklists that appear automatically on the US machine are the most efficient way to do this but require IT development and support. Departments may instead choose to use patient bracelet barcode scanners that attach to the US machine, or other work arounds. Manual entry should be avoided because of the potential for error.
- c) *Manual Archiving* - Programs without formal external archiving systems may wish to archive their images directly on the machine itself, thus requiring an adequately sized hard drive, or use a USB connected storage drive, which must comply with local hospital privacy policies.

v. Centre-Wide Consistency

For some centres, particularly those with learners or multiple sites, it may be beneficial to have identical machines across an organization or at different sites. Compromise may be needed to find a machine that fits all PoCUS users (e.g. anaesthesia, intensive care, internal medicine).

vi. User Ability

In selecting a machine, the ultrasound lead must be realistic about the skills of the physicians using the machine. In some departments, a very simple machine with just a few buttons and adjustments will be best, while in others, a very advanced machine might be needed. In most departments, a balance between these two extremes will be necessary: the machine must be user friendly enough to allow basic users to answer their clinical questions, but not be so simple that more advanced users feel limited and unable to make progress with their ultrasound skills.

vii. Application Support

Vendors should provide access to an application support specialist both at the time of initial installation and subsequently on request to assist with exam preset configuration, software upgrades and other modifications such as network configuration, adding wifi connectivity, archiving ability and new transducers.

viii. Educational Support

Programs which offer frequent teaching courses will wish to discuss what options are available for loaner equipment.

2. Infection Control Issues Associated with Point of Care Ultrasound Equipment

Programs should have a clear policy for infection control, that includes machine hygiene (including keyboard, controls, screen and cart) and the transducers (63–68).

It should be noted that every user should be responsible for performing appropriate cleaning and disinfection of the ultrasound machine and probes before and after every patient encounter.

Sterile ultrasound gel must be used for all invasive procedures that pass a device through tissue (e.g., needle joint aspiration, nerve blocks and vascular access) and for all procedures involving sterile environment or non-intact skin, and on neonates. Sterile gels should be used for procedures performed on intact mucous membranes (e.g., oesophageal, vaginal, etc) and in patients with immunodeficiencies or on immunosuppressive therapy. Aseptic technique should be followed when using sterile gels.

A full description of the infection control recommendations can be found in Appendix 3.

4. PEDIATRIC EMERGENCY PoCUS

The pediatric patient population forms a significant portion of patients seen in the general emergency departments, particularly in areas without local access to a pediatric emergency department. PoCUS performed by emergency physicians has increased dramatically in clinical importance during the past three decades and it is natural and expected that this practice be extended to pediatric patients (69).

The Royal College of Physicians and Surgeons of Canada has included Pediatric Emergency Medicine (PEM) POCUS in their training and re-certification programs and subspecialty accreditation examination. New graduates are expected to be competent in POCUS. Recently, the American Academy of Pediatrics (AAP) published a position statement outlining the scope, practice, training and evidence around PoCUS as it pertains to PEM (70). However, no such document exists to guide general Emergency Physicians on the use of PoCUS for their pediatric patients.

This position statement document serves as a guideline to the recommendations for PEM PoCUS practice amongst general Emergency Physicians.

A. Core PEM PoCUS Applications:

The PEM literature includes many applications that are within the scope of PEM physicians (71). This list is constantly evolving as PEM POCUS leaders advance their skill-set into new modalities. There is no data recommending which PEM applications general EM physicians should be competent in and this is likely to be variable based in the physician's practice.

Currently it is recommended that the following applications be included as core PoCUS competencies for PEM Physicians:

1. *Extended Focused Assessment with Sonography for Trauma (eFAST)*
2. *Focused Cardiac Ultrasound*
3. *Ultrasound-Guided Vascular Access*
4. *Thoracic Ultrasound*
5. *Identification of First Trimester Intrauterine Pregnancy (IUP)*
6. *Soft Tissue; including cellulitis, abscess and foreign bodies*

For other Emergency Physicians who routinely care for pediatric patients, the above core PEM applications also apply and competence is required. General Emergency Physicians using PoCUS for their pediatric patients must be aware of pediatric-specific PoCUS differences in anatomy, indications, pathologies, and management.

B. Scope of Practice

This mirrors the general scope of practice as documented in section 1b though there are specific PEM considerations which the physicians must be aware of and are reviewed below.

Resuscitation - PoCUS has a similar role in children as in adults for resuscitation and shock. Assessment of the heart, lungs and IVC are key. Etiology of cardiac dysfunction differs greatly however and may include congenital, infectious or inflammatory conditions. Assessing for etiologies in the IVC for volume status and the abdomen (e.g. free fluid) is more helpful than assessment of the aorta (72).

Lung - for the diagnosis of pneumonia, pleural effusion, viral pneumonitis, pneumothorax, pulmonary contusion and pulmonary edema (73,74).

Neck - for the diagnosis of neck masses including lymphadenitis, lymph node abscess vs the recognition congenital lesions (e.g. thyroglossal duct cysts, lymphatic malformations) and possibly malignant masses (e.g. lymphoma) (75).

Ocular - for the assessment of globe rupture, ocular foreign body, elevated intracranial pressure via optic disc elevation (76,77).

Renal/bladder - recognition of normal renal anatomy in first UTI, assessment of infant and toddler bladder volume prior to catheterization or bladder aspiration, assessment of hydroureter/hydronephrosis and nephrolithiasis (78,79).

Skull fractures - diagnosis of skull fractures in children under 18 months (children with fontanelles and sutures) (80).

Abdomen - An advanced skill that requires a lot of experience. May include the diagnosis of appendicitis, intussusception, pyloric stenosis, and bowel obstruction (81,82).

Testes - An advanced skill requiring caution, best used to confirm clinical suspicion of epididymitis, orchitis, hydroceles, appendiceal torsion, inguinal hernias (bowel vs sex organ) vs lymph nodes. Although PoCUS should **not** be used to rule out testicular torsion (83) it can be considered as an adjunct to clinical examination and help to establish an alternative diagnosis (see above) when supported by the overall clinical presentation.

Pediatric Hip - for assessment of effusion and localization of pain to the hip joint in a non-verbal limping child (84,85).

Fractures - for assessment of toddler's fracture (86) and other occult fractures, long bone fractures, and guidance of fracture reduction.

C. Training and Competency

Training and competency assessment for PEM PoCUS applications follow the same recommendations as those outlined in Section 2.

D. Challenges

Approach- When performing PoCUS in pediatric patients attention should be given to explaining the role of PoCUS to caregivers and patients. Practitioners might need to alter exam techniques, much like other physical examination components, to match the patient's ability to comply with the assessment.

Research- PEM PoCUS is a rapidly growing field with many new applications being researched over the last decade. Most studies are moving away from proof of concept studies to examining test characteristics of various PoCUS applications to trying to measure the clinical impact of using PoCUS in the assessment of children. Research involving children often presents more challenges and most studies have been performed in pediatric centres by PEM physicians (87). It has been slowed by low prevalence of certain disease and infrequent but high acuity clinical scenarios. It is further impeded by the lack of sufficiently trained PoCUS physicians at many pediatric centres. However, there are a growing number of pediatric centres developing new pediatric-specific applications for the select populations they see. General EM physicians can benefit greatly from these applications, especially when it can influence downstream care such as referral to a centre with pediatric subspecialties. Just as the majority of PoCUS literature is adult based, and Pediatric practitioners have had to exercise caution when applying PoCUS applications to children, general EM physicians should exercise caution when applying pediatric specific applications in non-pediatric centres where the population differs from pediatric study population.

Pediatric vs Adult - PoCUS Interpretation- Interpreting PoCUS in the pediatric population differs from adults. For example, some conflicting literature exists as to the value of a positive FAST exam (88). As in general practice, it is advisable to incorporate FAST findings (positive, negative and indeterminate) into the pediatric specific clinical picture (with its associated unique physiologic responses such as delayed decompensation) when deciding about further investigations, transfer and management.

Respiratory complaints are common in the pediatric ED and PoCUS is increasingly being used to differentiate bacterial pneumonias, viral pneumonias, asthma and other lung processes. While lung PoCUS findings such as bilateral B-lines are found in both pediatric and adult patients, the interpretation of them may differ and depend on the clinical presentation. While viral pneumonia and congestive heart failure (CHF) can occur in both adults and children and both can result in the finding of bilateral B-lines, CHF is much less common in children and will usually be highlighted by the clinical presentation and past medical history.

New PoCUS applications are frequently being introduced in the care of emergency pediatric patients for example the assessment of appendicitis, intussusception, pyloric stenosis

and testicular torsion. Given that the negative predictive value of PoCUS for these conditions is currently unknown, these applications are best considered as “Rule In” rather than “Rule Out” investigations.

It is recommended that General EM physicians who would like to apply POCUS to their pediatric population should seek further education via pediatric POCUS workshops, courses or self-learning through the numerous online resources available.

5. RESEARCH

Although there is a growing evidence base supporting the benefits of PoCUS in Emergency Medicine, much of the literature to date falls short of proving true outcome benefit. Yet current research into Emergency PoCUS is at the cutting edge of clinical research in emergency medicine across Canada and internationally. New applications and uses are being studied and tested frequently and have the potential to make immediate impact on clinical practice. CAEP encourages Canadian PoCUS research, with a goal to lead in this field. It is important that we meet the challenge to conduct well-designed studies to further support our practice. It is vital that proponents of PoCUS progress from the research of competency and feasibility, to look at important patient oriented outcomes (89). We have shown that PoCUS can achieve technical and diagnostic accuracy effectiveness, which address the ability to create an image of interpretative quality and the ability to test how well the image obtained compares to an established “gold standard.” Our more recent and current research often focuses on diagnostic thinking and therapeutic effectiveness; to assess whether PoCUS facilitates the physician’s ability to make a diagnostic decision and whether PoCUS leads to improved care, i.e. better therapy or more rapid provision of an established therapy. We must expand our research priorities into the more challenging areas of clinical effectiveness; does PoCUS improve patient outcomes, such as reducing morbidity and mortality; and societal effectiveness; can PoCUS positively influence outcomes at the population level, such as enhancement of quality of life and overall societal cost-effectiveness? (2).

National EM and critical care medicine organizations should lead by providing the networking opportunities required to develop large-scale, well-designed, multi-centre prospective studies and databases. Collaboration within Canada through the CAEP EUC, the Network of Canadian Emergency Researchers (NCER); within North America through the American College (ACEP) and the Society for Academic EM (SAEM); and internationally through IFEM and WINFOCUS provide opportunities to build large studies, with sufficient sample sizes to provide meaningful answers.

As other diagnostic tools advance, the evidence for PoCUS in each clinical setting should be reviewed, and if necessary, further research undertaken. An example of this is in the setting of trauma. With the increased availability of CT scanning, and the importance of early accurate diagnosis, and the increasing utilization of non-operative management for certain organ injuries, the role of PoCUS (or FAST) has changed from being a major component of decision making regarding operative intervention in a large number of trauma patients, to perhaps having a more limited role regarding patient transfer, and also immediate operative intervention in unstable patients.

The CAEP EUC encourages collaboration in PoCUS research and will maintain an accessible database of planned and ongoing Canadian PoCUS related research activity. In addition, we will perform a regular needs analysis that will provide a list of PoCUS research priorities. These will both be accessible on our CAEP webpage (<https://caep.ca/>).

D. SUMMARY TABLE OF RECOMMENDATIONS

Recommendations	
<i>Scope of Practice</i>	
Core PoCUS for EM	E-FAST, AAA, IUP, Thoracic, Focused Cardiac, Vascular Access This list mirrors that of the CAEP EUC’s recommended EM Residency core ultrasound curriculum.
EM PoCUS Applications (see Appendix 1)	Resuscitative, Diagnostic, Procedural, Therapeutic and Monitoring
<i>Training and Competency</i>	
EM Residency PoCUS Training	A verifiably robust PoCUS training program and completion of residency provides an accepted national standard
Physicians in Practice	Physicians in practice are strongly encouraged to continue developing and expanding their POCUS skillset. Where applicable, POCUS privileges should be based on evidence of competence as defined by a clear traineeship followed by an objective examination of skills and knowledge.
Other Healthcare Providers	PoCUS skills maybe useful in a number of settings and further research is encouraged. Training and competency should follow general recommendations
Medical Students	Inclusion of PoCUS within the curriculum is valued and enhances anatomical knowledge and clinical skills. EM Physicians will continue to play a significant role
Fellowships	There are a number of Canadian PoCUS Fellowships and the RCPSC PoCUS Diploma which will provide support and training for the future EM PoCUS leaders
CPD	Physicians are expected to keep current with evidence and advances in PoCUS practice throughout their careers

<i>PoCUS Program Management</i>	
Leadership	All EDs with PoCUS equipment should have a named physician designated and responsible for development and maintenance of the emergency ultrasound program. In smaller departments physicians with existing ‘quality’ responsibilities may assume this role and collaboration with regional centres is recommended.
Documentation	PoCUS report documentation must be completed for all examinations and include: indication, area examined, findings and interpretation
Image Archiving	Many larger and academic EDs in Canada are archiving images and clips for every examination performed. This is considered best practice and strongly recommended
Quality Management	A local PoCUS quality program is the responsibility of the <i>PoCUS Lead</i> and will include ongoing review, support, education and development
Machine Availability	An ultrasound machine must be immediately available. EDs should a minimum of at least one machine for every distinct clinical area and ideally have one ultrasound machine for every Attending Emergency Physician on shift
Machine Specifications	Recommended ultrasound machine specifications are detailed in the full document
Infection Control	Programs should have a clear policy for infection control, that includes machine hygiene (including keyboard, controls, screen and cart) and the transducers
<i>PEM PoCUS</i>	
Core PoCUS Applications for PEM	eFAST, Focused Cardiac, Thoracic, IUP, Soft Tissue and Vascular Access
Key PEM Applications	Resuscitation, lung, neck, ocular, renal/bladder, skull fracture, abdomen, testes, hip and fractures
Training and Competency	Training and competency assessment for PEM PoCUS applications follow the same recommendations as those outlined above

<i>Research</i>	
Priorities	A greater focus on outcome-centered research is required to answer the important questions that remain unanswered.
Needs Analysis	CAEP EUC will perform a regular needs analysis and maintain a network database that will provide a list of PoCUS research priorities

E. NEXT STEPS

1. Scope of Practice

Innovations in PoCUS in emergency medicine will continue. These innovations should be introduced and measured in a way that evaluates the educational, clinical, and societal impact to facilitate knowledge translation. As with any new practice, physicians should rely on evidence appraisal before widely adopting new PoCUS applications.

2. Training and Competency

With the adoption of ultrasound and PoCUS into the curriculum for medical schools, newly qualified physicians will already have many of the core competencies required. Specialties, such as emergency medicine, will ensure that their residency programs provide appropriate training in all PoCUS applications relevant to their practice. Competency in the use of PoCUS will be demonstrated by those successfully completing their residency training. For those physicians who did not receive this training and competency foundation, there will continue to be a need for introductory PoCUS courses and a framework for competency assessment/certification, however this need will gradually diminish.

Maintenance of PoCUS competency is likely to become more important in the future. As with many practical skills utilised in emergency medicine, maintenance of competency is best achieved via several modalities including CPD updates, practical workshops and especially simulation.

3. Program Management and Ultrasound Machines

Leadership and Quality - PoCUS fellowships will provide the program leaders of the future. Many of these may have completed additional recognition such as the RCPSC - Area of Focused Competence (AFC) Diploma program for *Acute Care Point-of-Care Ultrasonography*.

Quality assurance will be a major focus for program leaders. System accreditation is likely to include review of PoCUS program quality. In Canada, reports of PoCUS related malpractice are currently limited. However, this may change if quality assurance does not evolve at the same rate as PoCUS practice.

Billing - Emergency physicians in Canada are remunerated in a number of different ways (90). For those who are remunerated by billing/shadow billing, the use of PoCUS needs to be fairly compensated. The fee structure needs to reflect not only the application/procedure itself but also the cost of the equipment, image archiving and leadership.

Technology - Ultrasound technology continues to evolve. Wireless transducers that display high resolution images on smart tablet devices are already available. Miniaturization, increasing processor power and improving display technology are likely to result better machines that are smaller and cheaper. It is quite clear that manufacturers have set a goal to provide affordable, high quality ultrasound devices that every physician will carry as a personal device, just like the stethoscope. All-in-one transducers utilising a silicon chip rather than an array of crystals and capable of both high and low frequency functions have been developed and are likely to bring this goal of affordable personal ultrasound devices closer to reality (91).

Just as modern ECG machines have software that can interpret 12 lead recordings, manufacturers are working on bringing artificial intelligence(AI) to ultrasound machines (92,93). Real-time anatomical/pathological identification are strong possibilities for the future. AI has already been shown to have potential in echocardiography (94–96) and in the auto detection of B-lines have recently been introduced by some manufacturers.

4. Research

Large prospective PoCUS research studies are needed to answer patient-oriented outcomes. For this to be successful PoCUS experts should be encouraged and supported to become experienced researchers and are encouraged to coordinate and collaborate nationally.

F. CONCLUSION

Since the publication of our previous position statement, the use of PoCUS has continued to expand, both in Emergency Medicine and also in other specialties. PoCUS is now established in the curriculum of a number of Canadian Medical Schools.

With this position statement, we have identified key recommendations for PoCUS that pertain to both adult and pediatric emergency medicine practice. We have expanded on these recommendations in considerable detail, while recognising that, given the wide variation in emergency care settings, there will be differences in how these recommendations are applied locally.

It is the aim of this position statement to provide current guidance in the form of these national recommendations. Emergency Physicians are encouraged to utilise these recommendations to continue to develop PoCUS programs and improve on the already high standards delivered across Canada.

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