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FOR EMERGENCY MEDICINE

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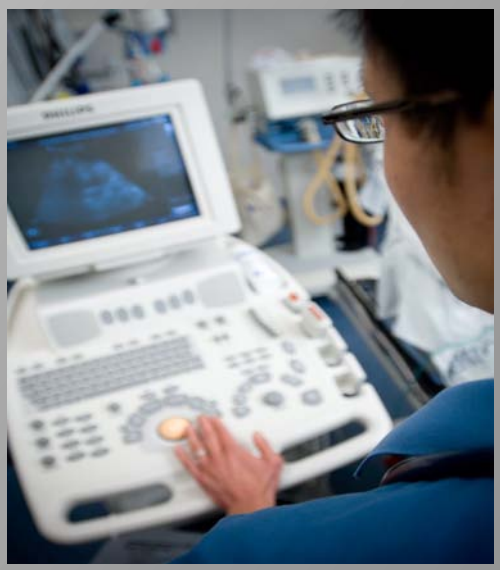
Point-of-Care Ultrasound Curriculum Guidelines

Emergency Ultrasound Special Interest Group



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The Emergency Ultrasound Special Interest Group (EUSIG) was tasked by the Clinical Practice Committee (CPC) of the International Federation of Emergency Medicine (IFEM) to produce curriculum guidance for ultrasound training in emergency medicine (EM). The document was written by the Point-of-Care Ultrasound Curriculum Project Team (PoCUS-CPT). Experts in point-of-care ultrasound use peer-reviewed the document.

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1.1 Introduction

IFEM has developed this document on point-of-care ultrasound (PoCUS) training programs and practice governance as part of an effort to provide structure and suggested guidelines for best practice. It was developed as a consensus document drawing on regional and national guidelines already in practice around the world. It is not meant to be prescriptive, but rather to outline the important features of a sound training and practice program. This is in contrast to the World Health Organization and World Federation of Ultrasound in Medicine and Biology guidelines, which tend to focus on practice guidelines for comprehensive consultative diagnostic ultrasound imaging; the distinction between PoCUS and consultative ultrasound imaging is important. Definitions of PoCUS are discussed below in more detail. PoCUS is not meant to replace comprehensive ultrasound imaging, which is a consultative test that focuses on traditional radiologic methods for fully evaluating anatomy and physiology. Rather, it is a complementary diagnostic tool that can help make the clinician more efficient, more independent, and more confident in their medical decision-making.

What is point-of-care ultrasound and how can it benefit emergency medicine?

Definitions of what is point-of-care ultrasound (PoCUS) may vary depending on the circumstances of how it is utilised. However, for most emergency physicians the following explanation would encompass the essence of its use:

"a diagnostic or procedural guidance ultrasound that is performed by a clinician during a patient encounter to help guide the evaluation and management of the patient."[1]

Alternative names for PoCUS include:

- Emergency ultrasound,
- Focused ultrasound, and
- Clinician-performed ultrasound.

The use of PoCUS as an adjunct to the practice of emergency medicine is now well established. Initially, evidence to support using PoCUS came from experiences managing patients who had sustained blunt trauma. However, the scope of practice expanded as emergency physicians identified clinical problems where PoCUS was able to aid in patient evaluation and to guide invasive procedures. Examples of such applications include identification of abdominal aortic aneurysm, focused cardiac ultrasound in cardiac arrest or shock states, identification of pleural fluid and air, identification of an intrauterine pregnancy in the first trimester, identification of a deep vein thrombosis and more recently focused scanning for patients with TB and HIV/AIDS (FASH). In everyday practice the emergency physician regularly faces challenges in trying to identify serious pathology or to reduce adverse consequences during procedures in a timely manner. Necessity is the mother of invention and as a result emergency physicians will continue to think of innovative uses and expand the portfolio of PoCUS practice. The American College of

Emergency Physicians (ACEP) further classified PoCUS into the following functional clinical categories:[2]

- *Resuscitative*: ultrasound use as directly related to an acute resuscitation,
- *Diagnostic*: ultrasound utilized in an emergent diagnostic imaging Capacity,
- *Symptom or sign-based*: ultrasound used in a clinical pathway based upon the patient's symptom or sign (eg, shortness of breath),
- *Procedure guidance*: ultrasound used as an aid to guide a procedure,
- *Therapeutic and Monitoring*: ultrasound use in therapeutics or in physiological monitoring.

A key feature of PoCUS is that it is not a replacement to consultative radiology performed ultrasound practice but a focused ultrasound examination usually performed at the bedside of the patient, often in suboptimal conditions and with time limitations. Hence the application is structured to answer a focused clinical question (or set of questions), which can augment clinical care. Such practice often transcends specialty boundaries and has relevance to other clinician groups. A point worth noting is the fact that the more obvious a clinical abnormality is on PoCUS, the more likely it is to be clinically relevant – for example, a large aortic aneurysm is easier to find and this correlates with increased clinical risk of rupture.

Popularity of use of PoCUS has also been influenced by a newer generation of tailored ultrasound systems: reduction in cost and relative size, improved portability and quality, ease of use and speedy start-up times.

With a plethora of PoCUS applications available, there are continued challenges to ensure that such PoCUS can be delivered with adherence to good governance principles. Considerations include:

- *Adequate training*: a multifaceted approach needs to be adopted as some pathology conditions will be seen infrequently, there may be a paucity of trained supervisors and one-to-one supervision is not always possible. The use of simulation is becoming more established.[3] Web-based resources are also becoming more popular.[4] In North America PoCUS fellowships are well established to ensure appropriate opportunities for PoCUS training are provided.
- *Credentialing*: it is essential to ensure a trainee has demonstrated competency in a particular application before they can practice independently. There is evidence to demonstrate that competency can be assumed after a number of ultrasound examinations have been undertaken, although in practice not all logged examinations are of the same quality. Others favour the use of trainees triggering a competency assessment once they feel ready. Such an assessment is undertaken against a number of objective criteria and is not based on the number of logged scans only. Being competent to practice is not just about being able to undertake the application examination but importantly understanding the relevance of what the findings mean to clinical practice.
- *Governance*: once independently practising, the emergency physician needs to ensure that they keep their skills up to date. Hiatuses in performing a particular application may result in loss of skill. Peer review and audit has an important role in demonstrating continued competency. Keeping up to date with the latest medical research in this area is essential. Regular maintenance and quality assurance review of ultrasound equipment is required.

Point-of-Care tailored to local circumstances

There are established PoCUS curricula available in many developed nations. National EM bodies mostly oversee this role – e.g north America, Europe, Australasia and South Africa.[2,6-9] There are also international bodies that have provided curriculum advice that encompasses global EM.[5] Not all EM training programmes include a mandatory PoCUS component - this is becoming less the case as the benefits of PoCUS are appreciated.

Many established curricula are tailored to the regions they cover and, although there are similarities, they are not always the same. This reflects the difference in EM practice between nations. Factors that may influence which PoCUS applications should be included in a curriculum include:

- *Burden of disease:* different pathologies in different parts of the world mean that certain applications may be irrelevant, for example the FASH scan is not as useful in developed nations that do not see many cases of HIV/AIDs and TB. In addition the impact of the disease to the local population is important and may necessitate its inclusion into a curriculum despite not being common.[10]
- *Equipment:* the decision as to what applications to include depends on access to equipment. For example, focused PoCUS in early pregnancy is often limited by the lack of a transvaginal transducer. Lack of equipment and servicing is a particular problem in developing nations and can severely limit the type of applications adopted.
- *Difficulty:* the ability to train and retain skills for particular applications is important when considering which applications to include. If an application is very difficult to learn and practice, then it will often be omitted from a PoCUS curriculum, whether or not it is useful to the emergency physician.

Therefore, PoCUS training and practice needs to reflect the nuances of EM in the particular region it covers. The specific applications and steps in training should be chosen to suit to the local EM environment. One size does not fit all and therefore it is not appropriate to have an inflexible global curriculum.

This document can be used as a toolkit to aid local development of a suitable PoCUS curriculum if one does not already exist. All PoCUS curricula should share a common structure and principles, and should adopt best practices where possible.

Innovation and ownership

It is important that locally developed curriculums are relevant to local EM practice. Local EM bodies should have ownership. Whilst adhering to common principles, innovation in all aspects of the curriculum design and implementation should be encouraged at all levels. Such innovative enhancements can then be disseminated and shared by all. Hence IFEM promotes PoCUS curricula being driven from the local level, as opposed to a policy dictated from above.

Key components and principles

The basic components common to all curricula may be divided into two: the content of the PoCUS curriculum (i.e. what specific applications are included) and the methodology of training and practice.

The content of the curriculum should include details of the applications to be included. As noted above, these may vary due to local factors. However, IFEM recommends the inclusion of certain essential 'applications', which should be considered mandatory regardless of region:

(a) understanding of the physics/operation of the ultrasound machine, and

(b) good governance in PoCUS practice.

The methodology of curriculum delivery centres on the various steps in training and demonstration and maintenance of competency. There are many ways that these steps can be undertaken and recommendations of best practice are detailed later in this document.

Role of IFEM

IFEM is tasked with supporting the international development of training and practice in PoCUS, regardless of region and socioeconomic issues. This document will help authors of existing curricula ensure that key components are incorporated. It will also help regions that have no existing PoCUS curriculum to establish one. Despite recognising that content and methodology of PoCUS curricula will vary for reasons previously discussed there will be a common structure and theme apparent in all. This may allow transferability of PoCUS skills internationally leading to establishment of reciprocity arrangements.

We hope that this document will guide existing and new PoCUS curricula to be fit for purpose and suitable for the region they cover. We would like to re-emphasise that local innovation and solutions to training problems should be locally driven as opposed to mandated from IFEM. We firmly believe that PoCUS development is essential for contemporary EM practice.

A checklist of curriculum elements that should be included in a PoCUS curriculum can be found in Appendix C. IFEM will not accredit curricula – this should be a self-regulating step - but we are happy to provide advice via the UEMSC Chair.

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2.1 Overview of a point-of-care ultrasound curriculum

This section describes the anatomy of a PoCUS curriculum. The core principle of this guidance is that it allows for regional or national variations for each part (e.g. a choice of which applications to include and different methods of assessment). IFEM promotes innovation and devolution within a standard framework, rather than a centralized one-size fits all approach.

PoCUS skills are critical to the clinical development of an emergency physician and a minimum skill-set should be mandatory for all graduating EM trainees.[1,2]

The ultrasound education provided to EM trainees should be structured to allow residents to incorporate ultrasound into daily clinical practice.[3]

PoCUS requires emergency physicians to become knowledgeable in the indications for ultrasound applications. Image acquisition and interpretation are integral to the concept of emergency ultrasound but the ability to integrate findings into direct patient care in a busy clinical environment is the ultimate goal.

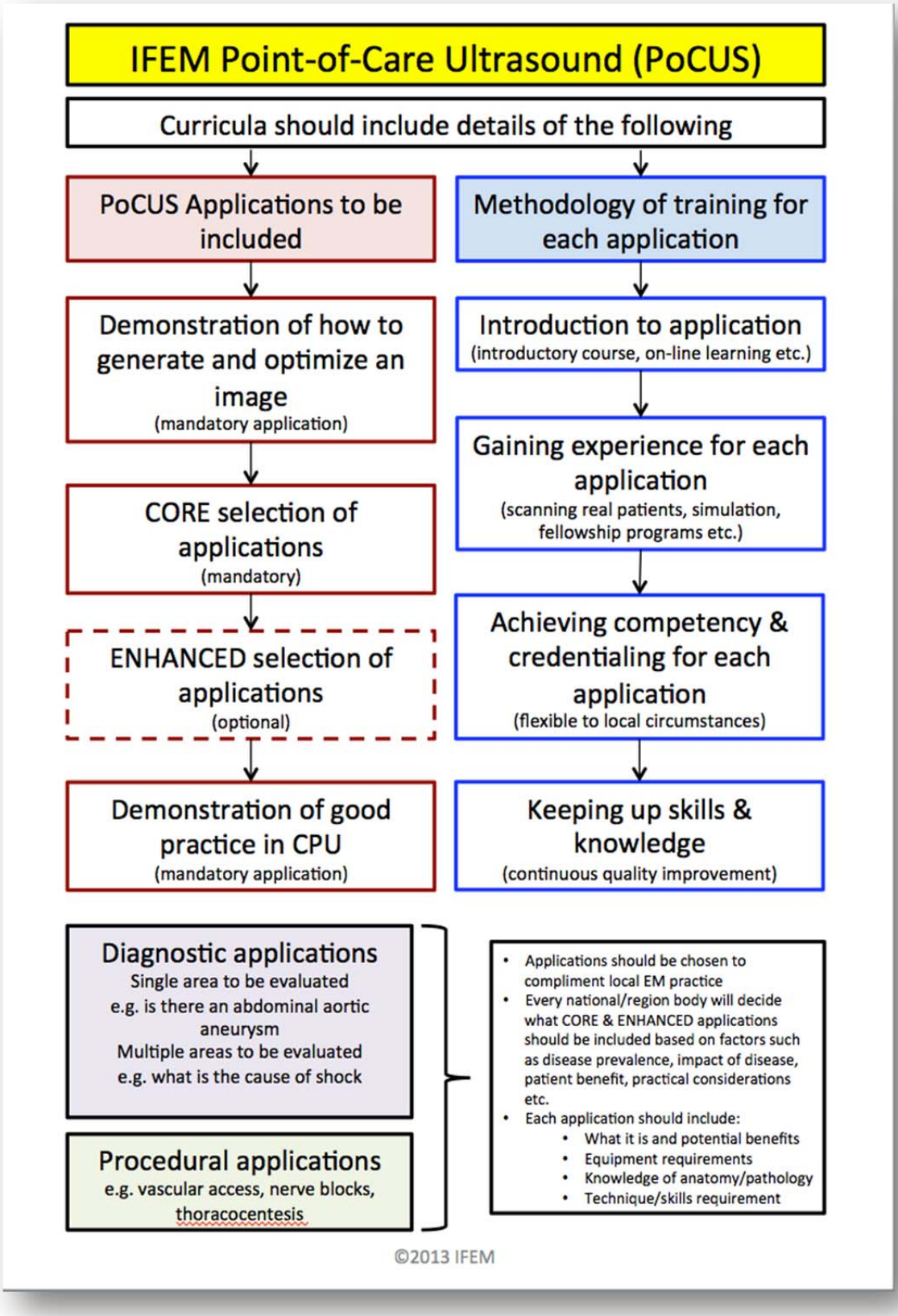
There are no internationally recognized guidelines and only a few national guidelines that address ultrasound training for physicians in emergency settings.[4,5,6,7]

Current guidelines support a competence-based approach. However, many of them still reflect the largely traditional systematic discipline-based use of ultrasound, with training and competencies split into organ- or system-based categories.[8,9]

The IFEM approach

The IFEM curriculum for PoCUS provides a structure and guidance to member organizations, rather than a definitive curriculum for international ultrasound training and practice. An overview of this is seen in figure 1.

IFEM aims to complement current national curricula rather than replace them; and to provide organizations with a framework to support locally relevant training and assessment programs within an international curriculum skeleton.



The IFEM curriculum for PoCUS applies to training during residency/specialty training and beyond. It is anticipated that most emergency medicine trainees should become familiar with the theoretical principles of ultrasound during their first 2 years of specialty training and should attend an approved course or undergo local or web-

based modular education in ultrasound. We recommend that formal assessment and credentialing of these skills and theoretical principles should be completed before the end of the trainee's emergency medicine program. Much of the learning could be delivered by e-modules, before the trainee proceeds to practical training and evaluation.

We encourage member organizations to include training in ultrasound in their general emergency medicine curricula and specialty examinations. We hope that in the near future, core PoCUS competency will be a universal skill for emergency physicians that will not require special or additional education and assessment outside a standard EM training program or residency.

As IFEM member organizations develop their curricula for Emergency Ultrasound, it is important that an evidence-based approach is adopted, as well as one that dovetails with the currently available national guidelines previously described.

As such, we recommend that each member organization should define what constitutes core and enhanced practise: PoCUS according to their local needs and skills. We encourage organizations to follow the consensus reached by IFEM, based on collective experience, as to what skills can realistically be defined as core and enhanced.

Each organization and each emergency department must be prepared to ensure the competency of their physicians, according to their needs. We have a responsibility to practice and teach appropriate ultrasound skills that meet the needs of specific patient populations.

A combined approach of teaching and assessing technical skills, image interpretation and clinical integration will be important in achieving these goals internationally.

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2.2 Examples of existing point-of-care ultrasound curricula

The Canadian Association of Emergency Physicians (CAEP) recently published a revised position paper on emergency point of care ultrasound that defined “basic” and “advanced” diagnostic and procedural applications. The list is extensive and reflects the maturation of point of care ultrasound practice in Canadian emergency departments. They recommend mandatory emergency ultrasound training for emergency residents and strongly encouraged ultrasound training for practicing emergency physicians. CAEP stated that training guidelines should be developed using both available evidence and the experience of credible experts.

CAEP recommended PoCUS applications:

Basic Applications

- Cardiac arrest
- Assessing for pericardial effusion
- Thoraco-abdominal trauma
- Early pregnancy
- Abdominal aortic aneurysm
- Central vascular access

Advanced Applications (diagnostic)

- Evaluation of left ventricular function
- Volume depletion
- Jugular venous distention
- Undifferentiated hypotension, shortness of breath, chest pain
- Gallbladder disease
- Hydronephrosis, bladder volume
- DVT
- Thoracic pathology (pneumothorax, pleural effusion)
- Ocular pathology and elevated intraocular pressure
- Testicular pain
- Joint effusion and tendon rupture
- Peripheral vascular access

Procedures that benefit from the assistance of ultrasound:

- Thoracentesis
- Paracentesis
- Pericardiocentesis,
- Lumbar puncture
- Cutaneous and peritonsillar abscess drainage
- Foreign body removal

- Pediatric bladder catheterization
- Joint aspiration
- Temporary pacemaker placement
- Regional anesthesia
- Confirmation of endotracheal tube placement

The standards of the Canadian Emergency Ultrasound Society (CEUS) are among the most stringent in North America. CEUS advocates a two-phase training program, leading to certification as an Independent Practitioner (IP). Candidates must first take a suitable introductory course, one where the four basic applications (sub-xiphoid cardiac for pericardial effusions and global activity, aorta for AAA, abdomen for free fluid and uterus for first-trimester IUP) are well-covered in a setting that offers considerable probe time. Examples of suitable courses available in Canada include EDE, ECCU, EDTU and University of Ottawa. After such an introductory course, a further 200 scans (50 each of cardiac, aorta, abdomen and uterus) must be performed under direct supervision of a CEUS IP. This is followed by a series of exams: written, practical (which tests the candidates ability to teach the technique) and visual. CEUS recognizes training and experience gained in other programs and waives some or all of the scanning requirements for suitable applicants. The exams are never waived.

CEUS believes training in “advanced applications” of emergency ultrasound should be limited to IPs. No specific guidance is provided as to the number of scans needed to gain adequate skill in these applications (see CEUS Position Statement on Advanced Applications at http://www.ceus.ca/008-position_statements/008-01.advanced_applications.htm).

CEUS recognizes the following indications for emergency ultrasound:

- Shock
- Trauma
- Cardiac
- Abdominal aorta
- Pregnancy (First Trimester)
- Procedural guidance
- Thoracic
- Deep venous thrombosis
- Biliary
- Renal/Bladder
- Soft tissue
- Musculoskeletal
- Ocular
- Nerve Blocks

The UK College of Emergency Medicine (CEM) published recommendations for two levels of competency in emergency ultrasound in 2006/2008 with an update in 2009. They recommend that all emergency physicians be trained to use ultrasound for which they describe as core (formerly Level 1) applications:

- FAST,

- Abdominal Aortic Assessment,
- Vascular Access, and
- Echo in Life Support

This approach reflects the one set out in the 2005 Royal College of Radiologists position paper “Ultrasound Training Recommendations for Medical and Surgical Specialties”.

The CEM guidelines advocate preliminary theoretical training that covers relevant anatomy, the physics of ultrasound, levels and sophistication of equipment, image recording, reporting, artefacts, and the relevance of other imaging modalities to ultrasound. Practical experience is gained under the guidance of a named supervisor trained and experienced in ultrasound within a training department. The goal of training is adequate competency, and this must be demonstrated rather than rigid adherence to a fixed number of training scans. There are also provisions for recognizing competency gained outside of the recommended training program

CEM Enhanced (formerly level 2) training requires one year of continuous practical experience (3 -5 exams per week and able to act as a Core trainer) as a Core practitioner and allows training to suitable competence in each of the following areas:

- Urology/renal
- Hepatic/biliary
- Vascular
- Cardiac
- Shock
- Musculoskeletal
- Thoracic
- Gynecology and Obstetrics
- Pediatric
- Invasive procedures

The American College of Emergency Medicine (ACEP) published emergency ultrasound guidelines in 2001 and updated them in 2008. The 2008 guideline recognized that the use of ultrasound in emergency conditions had matured and expanded beyond the boundaries of the 2001 guidelines. The 2008 guidelines began categorizing ultrasound techniques into specific clinical entities that are more applicable to emergency care practice.

The 2008 ACEP Ultrasound Guideline states, “the exercise of clinical privileges in the ED is governed by the rules and regulations of the department. The ED medical director or his/her designate (Emergency Ultrasound Director) is responsible for the periodic assessment of clinical privileges of emergency physicians. When a physician applies for reappointment to the medical staff and for clinical privileges, including renewal, addition, or rescission of privileges, the reappraisal process must include assessment of current competence by the ED medical director. The ED

medical director will, with the input of department members, determine the means by which each emergency physician will maintain competence and skills and the mechanism by which each physician is monitored."

Methods of determining competency include traditional testing, testing using simulator models, videotape review, observation of bedside skills, over-reading of images by experienced sonologists, and monitoring of error rates through a quality assurance process.

According to ACEP, each and every emergency department is entitled to determine, and assess, ultrasound competencies for their ultrasound programs. ACEP has identified the following 11 core competencies:

- Trauma
- Intrauterine Pregnancy
- AAA
- Cardiac
- Biliary
- Urinary Tract
- DVT
- Soft-tissue/musculoskeletal
- Thoracic
- Ocular
- Procedural Guidance

The criteria for inclusion as "core" competencies are "widespread use, significant evidence base, uniqueness in diagnosis or decision-making, or importance in primary emergency diagnosis and resuscitation. Some have been well established for the last 2 decades, and some (DVT, soft-tissue/ musculoskeletal, thoracic, ocular) have more recently emerged due to utility, safety, and research."

ACEP's core competencies are not meant to exclude other applications of emergency ultrasound. The 2008 guidelines state, "many other applications may be used by emergency physicians, and their non-inclusion in the core applications should not diminish their importance in practice."

ACEP's 2008 guideline recommends the following elements of a practice-based program for emergency ultrasound training:

1. Initial training in a 16 – 24 hour introductory course covering the core applications with practical hands-on sessions.
2. Shorter formatted (4-8 hour) courses covering single or combinations of applications to cover core and other emergency ultrasound applications.
3. The training process for emergency ultrasonography should then move beyond didactic and practical hands-on training to include experiential and competency components. The experiential component emphasizes and develops the psychomotor and cognitive components of emergency ultrasound. This period can be viewed as a training, proctoring, or provisional privileging period. Ultrasound examinations performed during this period should be reviewed for technique, speed of image acquisition, organ definition, and diagnostic accuracy.
4. 25 – 50 documented and reviewed cases should be obtained in each core and

non-core emergency ultrasound applications. Some applications such as ultrasound for procedural access require fewer cases given the prior knowledge and clinical experience with the blind procedural technique. If a number of examinations for US-guided procedure are required, ACEP recommends 10 US-guided procedures examinations or completion of a module on ultrasound-guided procedures with simulation on a high quality ultrasound phantom.

5. In order to ensure quality, facilitate education, and satisfy credentialing pathways, a plan for emergency ultrasound quality assurance and improvement program should be in place.

In 1999, the Australasian College for Emergency Medicine first published its policy on the use of bedside US by emergency clinicians (P21, reviewed in 2006).[10] This policy stated the following principles:

1. Ultrasound examination, interpretation and clinical correlation should be available in a timely manner 24 hours a day for emergency department patients.
2. Emergency physicians providing emergency ultrasound services should possess appropriate training and hands-on experience to perform and interpret limited bedside ultrasound imaging.
3. ACEM specifically supports the use of ultrasound imaging by emergency physicians for at least the following clinical indications: traumatic hemoperitoneum; abdominal aortic aneurysm; pericardial fluid; ectopic pregnancy, vascular access, therapeutic diagnostic tests and evaluation of renal and biliary tract disease.
4. ACEM encourages continued research in the area of ultrasound imaging and any other known or evolving bedside imaging techniques and modalities.
5. ACEM encourages Emergency Medicine training programs to provide instruction and experience in bedside ultrasound imaging for their trainees.

In addition, ACEM has published policies specifically addressing the following areas:

1. FAST (focused assessment with sonography in trauma) and AAA (abdominal aorta aneurysm): (adopted in 2000, reviewed in 2006, and in 2011 to include Extended FAST). ACEM defined the standard views required for these examinations, as well as the minimum criteria for training and credentialing in order for an emergency clinician to be considered competent in Australia for these exams.[11] This includes:

   a. A minimum of 25 accurate trauma examinations for the EFAST module. At least 50% of these exams must be clinically indicated and at least 5 should be positive for intraperitoneal, pleural or pericardial fluid.

   b. A minimum of 15 accurate scans of the aorta for the Abdominal Aorta module. At least 50% of these exams must be clinically indicated and at least 5 should demonstrate an aneurysm.

   c. A bedside practical exit exam for each modality

   d. Ongoing maintenance of credentials: at least 3 hours of ultrasound training per

year and perform 25 EFAST examinations for the EFAST module and 15 aorta scans per year for the AAA scan module.

2. Limited bedside echocardiography in the setting of a patient in cardiac arrest or haemodynamic compromise, published in 2011.[12] This policy document includes:

   a. A description of the examination itself.

   b. Minimum introductory course requirements.

   c. A total of 50 examinations of which 25 are performed by the candidate (at least 5 of these clinically indicated, and all reviewed by a sonologist, and at least 5 examinations under the direct supervision of a sonologist) and a further 25 either performed or interpreted by the candidate (for example, previously recorded scans). These 50 cases must include at least two cases each of tamponade, right heart failure / massive PE, hypovolemia or distributive shock and left ventricular failure.

   d. A bedside practical exit exam.

   e. Ongoing maintenance of credentials: at least 4 hours of echocardiography training per year and perform 25 echocardiographic examinations per year.

   f. Ongoing departmental audit.

3. Minimum guidelines on emergency ultrasound courses or the above applications of point of care US: first published in 2000 and reviewed in 2006. This document details the minimum requirements for an introductory course in AAA / EFAST to be deemed acceptable by ACEM.[13]

   In the last decade, ACEM also developed a partnership with the Australian Society for Ultrasound in Medicine (ASUM, www.asum.com.au), a non-profit, multidisciplinary society which seeks to advance the clinical practice of medical ultrasound in Australia for the highest standards of patient care. Together, ACEM and ASUM developed the Certificate in Clinician Performed US (CCPU), a modular qualification for clinicians who seek to practise point of care US.[14] The ASUM CCPU is available for the following applications:

   Abdominal Aortic Aneurysm (AAA)
   Abnormal Vaginal Bleeding
   Acute Pelvis
   Acute Scrotum
   Advanced Clinician Performed Neonatal Ultrasound
   Breast
   Deep Vein Thrombosis (DVT)
   Early pregnancy (basic) and Early pregnancy (advanced)
   Endocrine
   Extended Focussed Abdominal Scan for Trauma (E-Fast)

Image acquisition and optimisation
Introduction to Clinician Performed Neonatal Ultrasound
Monitoring the Foetus
MSK
Ovarian pathology
Pleural Effusion
Physics and Instrumentation
Rapid Cardiac Assessment (RCA)
Renal
Rheumatology
Right Upper Quadrant (RUQ)
Vascular Access (VA)

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3.1 What is a point-of-care ultrasound application?

In practice, PoCUS is broken down into units of practice known as *applications* or *modules*. For example, identification of an abdominal aortic aneurysm is a diagnostic application, whereas using ultrasound to perform a thoracentesis is a therapeutic application. Practice of PoCUS is different to traditional radiological practice and as such PoCUS applications are different and EPs would not be expected to perform all available ones for the following reasons:

1. PoCUS has several limitations (highly operator dependent; can generate misleading images known as artefacts; limited by time constraints, patient position and operator experience).

2. To become proficient in all areas of PoCUS requires much more time and study than the average clinician can afford. Most clinicians do not need, or wish, to become proficient in all areas of PoCUS.

In the emergency and critical care environment the most useful applications answer simple questions, ideally with a binary (i.e. yes/no) answer. For example:

- Is there free fluid in the pleural / pericardial / peritoneal space?
- Is there a pneumothorax?
- Is there an abdominal aortic aneurysm?
- Is the IVC full or empty?
- Are the lungs wet or dry?

In addition, PoCUS can guide focused procedures.

Asking simple binary questions is quite different from the traditional, comprehensive examinations performed by sonographers in radiology departments. Dividing PoCUS into bite-size units allows us to simplify the teaching and quality assurance process.

The specifics of what detail should be included when describing an application is covered in section 3.6.

3.2 Core versus enhanced applications

When designing a PoCUS curriculum, you may choose to decide whether you want applications to be subdivided into *core* (mandatory or basic level) or *enhanced* (optional or more advanced). This should be based on local needs and practice, and the examples below are not to be considered compulsory or exhaustive.

Core applications

In general, *core* PoCUS applications:

- Are simple to learn, perform and interpret
- Are rapid to perform
- Answer simple questions, ideally with a binary (yes/no) answer
- Allow trainees to consolidate key ultrasound skills, which provide a solid foundation to their practice.
- Have significant impact in the area/region being practiced due to burden of disease, local resources or mortality/morbidity considerations.

Examples of commonly included applications include:

- Basic cardiac
    - Is the heart beating?
    - Is there pericardial fluid?
    - Is there an enlarged right ventricle?
    - Is the left ventricle enlarged?
- Basic trauma
    - Is there free fluid in the pleural / pericardial / peritoneal space?
    - Is there a pneumothorax?
- Simple assessment of fluid status
    - Is the inferior vena cava (IVC) full or empty?
- Looking for sites of bleeding
    - Is there an abdominal aortic aneurysm?
- Simple lung
    - Is there a pneumothorax?
    - Is there pleural fluid?
- Simple venous occlusive assessment

  - Is there an occlusive above-knee DVT?

- Simple procedure guidance
  - Peripheral and central line insertion

Enhanced applications

In general, enhanced PoCUS applications are those that:

- Are more difficult to learn, perform and interpret.
- Require prior proficiency in a related more basic core application.
- Answer more complex questions.
- However, they may be simple to learn but have less impact in the area/region being practiced due to different burdens of disease, local resources or mortality/morbidity considerations.

Examples of enhanced applications include:

- Intermediate and advanced echocardiography
  - Is there valvular disease?
  - Is there a segmental wall motion abnormality in the left ventricle?
- Advanced trauma
  - Is there solid organ injury?
- Advanced Lung
  - Are the lungs wet or dry?
  - Is there consolidation?
  - Is there pleural thickening?
- Comprehensive venous occlusive assessment
  - Is there a below-knee DVT?

3.3 Demonstration of how to generate and optimise an image

It is imperative that trainees have a foundation in understanding how ultrasound works, safety issues, ergonomic considerations and how to operate and maintain the equipment. We advocate that this is included as an application in its own right even though this is not a clinically directed module. It would be expected that any PoCUS curricula would specify details of the knowledge, skills and behaviours required to be competent.

Below is a general guide to the level of understanding expected:

Knowledge

- The basic components of an ultrasound system
- Types of transducer and the production of ultrasound, with an emphasis on operator controlled variables.
- Use of ultrasound controls
- Know the frequencies used in medical ultrasound and the effect on image quality and penetration
- The interaction of ultrasound with tissue including biological effects
- Safety issues in ultrasound
- The basic principles of real time and Doppler ultrasound including color flow and power Doppler
- The recognition and explanation of common artefacts
- Image recording systems

Skills

- Can operate the key machine controls
- Transducer changing
- Image manipulation and storage

Behaviour

- Safe practice
- Limitations of own skills
- Integrates ultrasound findings with clinical assessment

3.4 Demonstration of good practice in point-of-care ultrasound

Every user of ultrasound needs to adhere to principles of good practice and governance. We advocate that this is included as an application in its own right even though this is not a clinically directed module. It would be expected that any PoCUS curricula would specify details of the knowledge, skills and behaviours required to be competent.

Below is a general guide to the level of understanding expected:

Knowledge

- Image recording, storing and filing.
- Reporting
- Medico-legal aspects – outlining the responsibility to practise within specific levels of competence and the requirements for training.
- Consent.
- The value and role of departmental protocols
- The resource implications of ultrasound use

Skills

- Integrate PoCUS into departmental clinical governance system (see curriculum section 4.5 for further details)

Behavior

- Adheres to rule-in philosophy (namely, that a focused ultrasound exam may rule in a pathology but generally will be unable to rule it out).

3.5 Diagnostic versus procedural applications

Diagnostic PoCUS applications are those that aid diagnosis by aiding evaluation of the patient or answer clinical questions, such as the examples in sections 2.1 and 3.2. Such an application may answer a simple binary question: 'is there free fluid in the pericardial space?'. It may answer a series of questions: 'why is my patient shocked?'. The latter maybe part of a symptom or syndromic approach to patient care. As introduced in section1.1, ACEP has further broken down diagnostic PoCUS as:

- Resuscitative
- Diagnostic
- Symptom/sign based
- Therapeutic

As a basic requirement, IFEM would expect this to be subdivided into organ-specific or disease-specific.

Procedural PoCUS applications are those that aid a procedure. This may be by providing information of the anatomy prior to a procedure being undertaken. It may also be used to dynamically guide the procedure. Examples include:

- Vascular access
- Foreign body removal
- Draining fluid
    - Pericardiocentesis
    - Thoracocentesis
    - Paracentesis
    - Joint effusions
    - Abscesses
- Peripheral nerve blockade
- Lumbar puncture
- Organ or tissue biopsy

3.6 Anatomy of an application

For each application it is important to specify key information that allows understanding of what it is, when to use it, why and how it is of benefit to EM practice.

Hence the anatomy of each application needs to include details of what trainees will learn with regards to important aspects:

- Knowledge
- Skills
- Behaviour

Knowledge

The trainee needs to be familiar with the rationale for the application. This includes understanding the normal anatomy and physiology of the region(s) being evaluated or subjected to a practical procedure. Appreciation of the pathology being sought if applicable is important.

The normal ultrasound landscape on B-mode should be recognised by the trainee, including additional modalities such as M-mode or Doppler as appropriate. Relevant ultrasound abnormal findings should be recognised also.

Skills

What technique and skills required must be specified clearly. This will aid deciding on what criteria should be included in any assessment of competency. This includes general ultrasound competence as well as the specifics of performing the application scan.

Competence is not a matter of just performing the actual ultrasound scan. Consideration needs to be given to pre-scanning and post-scanning steps, e.g. patient position, patient consent, environmental considerations such as ambient lighting, cleaning the transducers after use, storage of images and writing of a report. Perhaps most importantly for clinicians, competence also implies the integration of the ultrasound findings with the clinical assessment, and an understanding of how the ultrasound findings impact on ongoing patient management.

Behaviour

It is essential that trainees in PoCUS respect the limitations of PoCUS practice, understand its applicability and develop good habits such as maintenance of the equipment, saving images/clips, writing down findings from PoCUS studies and importantly liaising with patients wherever possible.

Equipment

In addition to what the trainees are expected to know and perform, it is useful to specify equipment including consumables. This helps trainers prepare to teach particular applications. In many instances certain applications are out of reach, due to a lack of essential equipment (for example transvaginal probe in advanced obstetric scanning).

Clinical integration

The trainee should be able to apply the findings of the application to clinical practice. It is essential to understand the clinical question or circumstance. It is also necessary to be familiar with the quoted accuracies in the medical literature as this provides a greater understanding of the limitations or strengths of the application. For example:

1. Highly sensitive tests are good at ruling out pathology, e.g. seeing a normal calibre abdominal aorta from the proximal aspect to the distal bifurcation effectively rules out an abdominal aortic aneurysm.

2. Highly specific tests are good at ruling in pathology, e.g. seeing free intra-peritoneal fluid during a focused assessment with sonography scan (FAST) effectively confirms free fluid is present.

However, it is easy to understand how misunderstandings may occur if the trainee is not clear on the exact applicability: in example 1 above, a normal calibre aorta does not rule out abdominal aortic pathology such as a dissection, so the trainee must clearly state the limitations of use. In example 2, the presence of free fluid does not equate with fresh bleeding, as it may have been present due to pre-existing ascites. Hence the nuances of each application must be clear.

Examples of application content

1. Sectional and ultrasonic anatomy

Knowledge

- Anatomy relevant to agreed local ultrasound applications. For example, in EFAST (Extended Focused Assessment with Sonography in Trauma):
- Kidneys, Liver, Spleen, Retro-peritoneal structures (aorta, IVC), Recto-vesical, vesico-uterine and rectouterine pouches
- Heart and pericardium
- Diaphragm, lungs and pleura

Skills

- Describe and sketch key anatomy

Behavior

- Adheres to philosophy of focused ultrasound (rather than a comprehensive exam)

2. Pathology in relation to ultrasound

Knowledge

- Applications are divided by Organ System, Disease System and Procedure Type and then further divided into Core and Enhanced knowledge and interpretation (see curriculum section 5.2 for a more detailed outline of core and advanced knowledge requirements):
- Organ System
    - Cardiac
    - Chest and Lung
    - Aorta
    - Renal and Genitourinary
    - Hepato-biliary
    - Gastrointestinal
    - Ocular
    - Obstetric and Gynecology
    - Venous/Arterial Assessment
    - Soft Tissue
    - Musculoskeletal
    - Nerve blocks
    - Pediatrics
    - Head and Neck
- Disease System
    - Trauma
    - Shock/Hypotension
    - Breathlessness
    - HIV/TB (FASH)
    - Other
- Procedure Type
    - Invasive Procedures
    - Confirmation of Placement/Reduction

Skills

- Acquire and Interpret ultrasound images
- Describe key pathologies

Behavior

- Adheres to philosophy of focused ultrasound (rather than a comprehensive exam)

3. Clinical Integration

Knowledge

- Demonstrate ability to describe how specific ultrasound findings will change or confirm clinical management decisions for core or advanced applications (see section 5.2)
- Combines specific applications to evaluate common clinical problems (e.g. hypotension, dyspnea, HIV assessment, etc.)

Skills

- Integrate ultrasound findings into clinical decision process

Behavior

- Adheres to philosophy of PoCUS
- Aware of limitations of PoCUS
- Aware of need for other investigations

3.7 Choosing what applications should be included in a point-of-care ultrasound curricula

Given the increasing penetration of PoCUS into various clinical specialties that have not traditionally used clinician performed diagnostic imaging at the bedside (emergency medicine, family practice, critical care, specialty care practices like urology, nephrology, orthopaedics and anaesthesia) there has been an explosion of new “point of care” applications looking to answer specific diagnostic questions or looking to assist with procedure guidance. The most important decision for evolving PoCUS curriculums is which applications to start with as a program starts to develop. There are several ways to approach this question

1. Always keep the local medical framework and capacity in mind. If there is no vascular surgical capacity then starting with aorta scanning may not be a good use of clinician time or training.

2. Always keep in mind what other diagnostic imaging resources are available. If there is good availability of pregnancy imaging in a medical system then it may not be wise to start with point of care ultrasound pregnancy applications as this may duplicate efforts, cause friction between care providers and cause unnecessary challenges to a new program. Pick applications where there is a gap between what is available and what the new clinician sonographer can provide. Usually FAST scanning and screening point of care cardiac ultrasound are good places to start.

3. Starting with procedure guidance is usually a safe way for a hospital or medical system to get used to the concept of point of care clinician sonographers. No one can object to the concept of improving procedural safety by utilizing ultrasound. In addition, most of the ultrasound guided procedure applications have sound evidence support.

4. Keep in mind local patterns of disease when picking initial applications – if the prevalence of tuberculosis is high it will make sense to learn to identify peri-aortic lymph nodes or if there is a high incidence of hyper-coagulable risk factors (ex. HIV) then screening for deep vein thromboses will be relevant.

5. It is also important to remember that ultrasound curriculum applications should complement the skills of the provider. Family practice physicians may not need to learn obstetric applications in some systems but in other systems this may be the most important application. If the practitioner sees a lot of pediatric patients than becoming familiar with bowel applications may be useful. If the practitioner is more involved with critically ill patients than becoming more proficient in lung and cardiac applications than bowel applications may be a useful focus for early training.

6. There is some cross training skills that are acquired with experience. If the initial application that a practitioner learns is to evaluate the peritoneal cavity for free fluid, over time it will be more obvious to the clinician sonographer when the kidneys look abnormal because they will have gained experience looking at them with the initial FAST scan.

3.8 Examples of applications

Overview

Applications are divided by Organ System, Disease System and Procedure Type and then by Core and Advanced knowledge.

As such, a beginner may become competent in scanning a particular organ system for simple but important pathology (e.g. pericardial effusion), while an advanced user may develop competency to scan the same organ system for other more complex pathology (valvular pathology)

Pathology in relation to ultrasound

1. Knowledge

Organ System	Core Knowledge	Enhanced Knowledge
Cardiac		
	Pericardial fluid	Tamponade
	Asystole	Regional wall motion
	Global LV function	Fluid assessment (w IVC)
		Valvular assessment
		RV size and function
		Cardiac output estimation
Chest and Lung		
	Pneumothorax	Interstitial fluid
	Pleural fluid	Consolidation
		Ventilator management
Aorta		
	Abdominal Aortic Aneurysm	Aortic Dissection
Renal and GU		
	Hydronephrosis	Renal parenchymal assessment
	Qualitative bladder volume	Complex vs. simple cysts Renal Doppler
		Testicular torsion, epididymitis, cysts, fracture
Hepato-biliary		
	Gallstones	Liver - assessment for masses, portal venous thrombosis
	Cholecystitis	Pancreas - assessment for masses, inflammation, cysts
		Spleen - assessment for size, hematoma, parenchymal changes

Gastrointestinal		
		Appendicitis
		Hernia assessment
		Colitis, Ileus
		Diverticulitis
		Pneumoperitoneum
Ocular		
	EOM movement and pupillary reactivity	Lens dislocation
		Retinal detachment
		Retrobulbar hematoma
		Orbital emphysema
		Foreign body
		Optic nerve sheath diameter
Obstetrics & Gynecology		
	IUP yes or no	Adnexal assessment for cysts or masses
	Free fluid in pelvis	Ovarian torsion Uterine masses
Venous/Arterial Assessment		
	DVT evaluation - two point compression lower extremity	DVT evaluation - upper extremity
	IVC evaluation for volume/pressure status	Evaluation of arterial insufficiency, carotid stenosis/CIMT and transcranial Doppler
Soft Tissue		
	Abscess vs. cellulitis	Myositis
Musculoskeletal		
		Fractures, Joint Effusions,
		Tendon, ligament and
		muscular Injuries
Nerve blocks		
		Brachial plexus, forearm
		Intercostal, TAP
		Femoral, sciatic, tibial
Pediatrics		
		Hip evaluation
		Appendicitis
		Pylorus stenosis
		Intussusception
		Lumbar puncture
Head and Neck		
		Evaluation of neck masses for airway compromise
		Vocal cord assessment

Disease System	Core Knowledge	Enhanced Knowledge
Trauma		
	Primary Survey	Secondary Survey

	Pericardial fluid	Fracture
	Peritoneal fluid	ICP/optic nerve sheath
	Pleural fluid	
Shock/Hypotension		
	Cardiac	Cardiac
	Pericardial fluid	Tamponade
	Global LV function	Regional wall motion
	Vascular	Fluid assessment (w IVC)
	IVC	Valvular assessment
	Aorta - AAA	RV size and function
	Chest/Abdomen/Pelvis	Cardiac output estimatn.
	Pleural fluid	
	Peritoneal fluid	Aorta – Dissection
	Adjuncts	
	Pneumothorax	
	DVT assessment	
Breathlessness		
	Cardiac	Cardiac
	Pericardial fluid	Tamponade
	Global LV function	Regional wall motion
	Chest	Fluid assessment (w IVC)
	Pleural fluid	Valvular assessment
	Pneumothorax	RV size and function
	DVT assessment	Chest
		Interstitial fluid
		Consolidation
HIV /TB (FASH)		
	Cardiac	Abdomen
	Pericardial fluid	Echogenic kidneys
	Chest	Lymphadenopathy
	Pleural fluid	Thickened bowel wall
	Abdomen	
	Peritoneal fluid	
Other		

Procedure Type	Core Knowledge	Advanced Knowledge
Invasive Procedures		
	Central line placement	Foreign body removal
	Peripheral line placement	Joint aspiration
	Thoracentesis	Lumbar puncture
	Paracentesis	Arterial line placement
	Abscess drainage	Pericardiocentesis
		Other
Confirmation of Placement/Reduction		
	Fracture reduction	Evaluation of tubes - SPT, Gtube, Jtube
		Airway confirmation
		Other

2. Skills

- Acquire and Interpret ultrasound images
- Describe key pathologies

3. Behavior

- Adheres to focused philosophy

4.1 Overview of the training process

Section 4 provides us with an overview of the 3 training steps necessary to learn PoCUS for a specific module, namely: initial induction, gaining experience and achieving competency. Formalising these steps into a well-structured training programme improves long term learning outcomes. The final make up of a region's training programme will be influenced by local factors/logistics and should therefore be flexible in order to optimally incorporate the 3 basic learning steps.

The initial induction is the first contact session between trainer and trainee, which should focus on the providing the core knowledge of the application, demonstration of the skill and the first time practice under trainer supervision. The formal introductory course is most commonly used but variations may exist due to local resource and logistical challenges.

Gaining experience should only be done via using the ultrasound machine on patients. The key features of this phase are focused around optimising the trainee's skill in:

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

The final phase is accessing if the trainee achieved optimum competence in performing the application. There are various methods available to test for competence and regions may vary. However, current evidence supports the use of a task specific checklist (unique to each module) and a global rating scale (good clinical practice) irrespective of the assessment method chosen.

Section 4.5 focuses on maintaining skills and personal quality assurance after competency has been achieved.

4.2 How to start

The initial introduction between trainee and trainer should clarify the credentialing pathway until competency is reached in either a structured or unstructured training programme. However, current evidence supports exposing trainees to well structured ultrasound training programmes improve their long term maintenance of their knowledge and skills.[1,2]

The aim of your first contact session is to teach the core knowledge for the applications in your curriculum.

Achieving the following learning outcomes will assure that you reach your aim:

1. How the ultrasound module directly applies to patient care
2. How the new skill may be useful in day to day practice
3. Introduction to the practical aspects of using the ultrasound machine optimally for the chosen module
4. Good clinical practice principals applicable to the module
5. Trainer demonstration of the technique and skill set required to perform the scan
6. First time practice of the skill under trainer supervision

There are many methods of delivery you may choose from, however, the formal introductory course is currently the most commonly used by PoCUS curricula worldwide.[3-6] These courses may vary between 1-3 days depending on the modules covered. You may also opt for multiple shorter courses depending on your local logistics and resources. Evidence also support the use of web based learning platforms as supportive or stand alone modalities for teaching practical skills.[7] Local resources and trainer faculty capacity will have a direct influence on the delivery method(s) selected.

You may compile your chosen delivery method(s) from various teaching formats. The most commonly used are:

1. Short lectures,
2. Demonstrations,
3. Hands on skills teaching,
4. Simulation sessions,
5. Open and closed discussions,
6. Passive and interactive web based learning,
7. Practical scanning on real patients.

By successfully reaching their learning outcomes, the trainee will be provided with a solid platform to proceed to the next less structured phase of the training programme.

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4.3 Gaining experience

One of the best ways to gain experience with PoCUS is to use the ultrasound machine on real patients under trainer supervision, although ultrasound simulators are significantly improving. There are three core components, which should be mastered, before PoCUS can be used safely and effectively.

They are:

1. Optimal skill in obtaining proper images
2. Optimal skill in interpreting the images
3. Incorporating image findings into optimal clinical decision-making

Gaining experience in each of these three components is essential to becoming a trained and competent practitioner.

Obtaining images

Gaining experience when obtaining images is the most challenging for the novice PoCUS practitioner. Taking a course to become familiar with ultrasound machine mechanics and techniques for obtaining good quality images is an excellent way to begin. Once the introductory course is over, however, many clinicians find themselves back in their home hospital environment without a mentor or a plan on how to continue to increase image acquisition skills. There are several ways to overcome this.

Any time a patient is getting a diagnostic imaging test (computed tomography scan, formal echocardiogram, or any other imaging test) the new clinician sonographer should ask the patient for permission to scan them. These patients are excellent practice patients as the new sonographer can get immediate feedback regarding their images and their findings. Moreover, the risk of missing a significant finding or overcalling an image with point of care ultrasound is minimized as the “gold standard” imaging test is following closely on from the point of care ultrasound and so can act as a safety mechanism.

Many systems have imaging technologists who may be willing to mentor the new clinician sonographer as they gain skills with image acquisition. Asking these technologists if the new practitioner can observe and learn from the technologist has been a fruitful practice in many countries. This can be expanded to asking other physician colleagues who use ultrasound more regularly in their practice if they would be available to mentor the new clinician sonographer in their early practice. This can be done both with direct observation and with saving clips and images of practice scans that can later be reviewed and reviewed with the expert.

There are services that will review images for new clinicians for a fee and offer remote mentoring via web based image portals. The increasing wireless capabilities of ultrasound machines mean that images can be transmitted in real time and several studies have demonstrated that streaming to web based interactive portals like Skype, FaceTime, etc. can be ways of getting image feedback and mentoring

even if a local expert is not available in one's own practice environment. However, one must be mindful of not breaching patient confidentiality and adhering to local information governance arrangements.

Finally, there are increasing numbers of simulators that can provide opportunities for practice – especially for scans that are invasive and involve some discomfort to the patient (i.e. transesophageal echocardiography or transvaginal sonography) it may be to the novice scanners advantage to practice initially on a simulator.

Interpreting images

Gaining experience interpreting images is obviously part of the process of learning to *obtain* a good image. The immediate feedback of formal diagnostic imaging for the patient and the new clinician sonographer can help to confirm initial image interpretation made at the bedside and a new clinician sonographer can gain experience and confidence by utilizing formal diagnostic imaging in the early phase of their training as a check. For example, if a EU ultrasound study was performed to evaluate the kidneys and aorta and identified a left sided hydronephrosis and a normal aorta, this can be confirmed by the subsequent urological computed tomography scan. However, there are increasing numbers of on-line and web-based image banks where new clinician sonographer can practice their interpretation skills (see Table 1). Indeed some of these websites and portals even have competency assessment tests that the new clinician sonographer can take to provide evidence to their practice governing board or hospital administration as evidence of their growing competency. Many of these sites have refresher lectures for the new clinician to review the specifics of an application as well. Below is a table of some popular English-language based sites but this is by no means an exhaustive list.

Table I. On-line educational resources for clinician-performed ultrasound

Resource	Free	Lectures	Exams	Image Review	Cases
www.sonoguide.com	☐	☐		☐	
www.emsono.com		☐	☐	☐	☐
www.emsono.com/acep/exam.html	☐		☐		
www.saem.org/narrated-lectures	☐	☐			
www.emergencyultrasoundteaching.com	☐	☐		☐	☐
Itunes – UCIMC Ultrasound Education	☐	☐			
www.ultrasoundpodcast.com	☐	☐			
www.sonocloud.org	☐			☐	
www.sonospot.com	☐	☐		☐	☐

Incorporating into clinical decision-making

Finally, the most challenging area to gain experience in for the new sonographer is to begin to incorporate point of care ultrasound findings into clinical practice. The most important quality the new clinician sonographer can pose is humility as the trajectory of new skill acquisition means that no new sonographer will be perfect. In the beginning, involve colleagues when making clinical decisions and be humble of

your diagnostic abilities. Show your images to the surgeon when you think you see appendicitis. Review the images of hydronephrosis with the urologist. Images are an amazing way to communicate and the important challenge is in the beginning not to let all your other clinical clues be overshadowed by the ultrasound image but to use them in context with what you already know as a clinician. If there is a stripe of anechoic space in Morison's pouch but the patient has had no trauma, has no liver disease and is hemodynamically stable the clinician should suspect that the stripe is perinephric fat and not free fluid.

There are several ways to start this process safely. One is to use pre-ultrasound and post-ultrasound decision logs to track the impact point of care ultrasound is having on patient care. The clinician records what they think the diagnosis is and what they would do next pre and post-ultrasound. An audit of these logs can help troubleshoot any problematic applications, clinicians or decision-making protocols. Another method for tracking the efficacy of PoCUS integration is to have an image quality assurance process where images are reviewed for accuracy of interpretation and patient clinical outcomes are tracked. Finally, records of diagnostic imaging can be kept. In theory, a robust PoCUS program should decrease negative formal diagnostic imaging and increase the yield of formal radiologic testing.

4.4 Achieving competency

The assessment process is the final phase of the training programme with the aim to deter if the trainee gained the necessary competency to perform an application.

Clinical competence is a combination of cognitive factors (acquiring and applying knowledge, decision making, utilising resources and learning from experts), personality traits (communication skills), and psychomotor skills (technical skills).[1,2]

There are three core competencies that need to be assessed for a clinician to be certified as proficient in PoCUS.

1. Image Acquisition,
2. Image Interpretation,
3. Clinical integration of findings into patient management decision-making.

There are several ways that these three skills can be assessed and a discussion of the common methodologies follows below.

Image acquisition

Image acquisition skills in some instances have been assumed when a trainee meets a specified number of “practice” examinations. This number varies from organization to organization and ranges from 25 to 300 depending on the exam and the organization.[3,4] There is some evidence, however, that competency should be assessed by the observation of an expert reviewer using a specified checklist of specific exam functions rather than a specified number of practice examinations.[5,6] If an observation of image acquisition is used instead of a number, the checklist for what constitutes complete and accurate image acquisition should be specified ahead of time (see Appendix B).

Image interpretation

This is an easier metric to score as testing the trainee with a series of clips or still images of both normal and pathologic images can assess image recognition. Equally as important to test in this category, however, is the ability of the trainee to discern that the images presented aren’t adequate to make a diagnosis or that important structures are missing. Tests to assess specific application competency have been developed and are currently in practice.[7]

Clinical integration into practice

This is the hardest metric to assess and literature supporting best practice here is limited. There is some evidence that incorporating simulation based scenarios where trainees must use ultrasound findings to decide on next patient management steps suggest that this is a teachable skill but one that must be consciously assessed to truly assess competency[6]. In addition, some of the image recognition

tests have incorporated patient care scenarios as part of their testing and the trainee must pick the “next best clinical management step” in the multiple choice assessment by looking at the image.

Methods in use

There are various methods whereby trainee competency assessments can be processed.[9-12]

1. Traditional testing via a formal assessment. E.g. OSCE format – most commonly used
2. Testing via simulator models
3. Videotape review
4. Observation of bedside skills whilst trainee formally log scans
5. Over-reading of images by experienced sonologists
6. Monitoring of trainee error rates via a quality assurance process
7. Indirectly, via reaching a predetermined number of scans for the module

The less summative methods will be more resource intensive, both trainer and monetary, which may not be ideal in less established training programmes. The quality of the informal competency assessments is deterred by the quality of trainer(s) supervision due to the subjectivity of the process.

Current evidence supports that best outcomes are achieved when any of the assessment methods chosen, include the following 2 essential components, which are both valid and reliable in assessing competency between different levels of candidate expertise:[13,14]

1. Task specific checklists, unique for each module. These should be be compiled using a Delphi methodology amongst experts for a specific ultrasound module.[15]

Example of image demonstration tasks required for FAST examination[12]		
Acquisition of the best possible image:	Acheived	Comments
Demonstrates RUQ (Morrison’s pouch)		
Demonstrates the spleno-renal interface		
Demonstrates potential fluid in the pelvis		
Demonstrates pericardial views		

* Adapted with permission from College of Emergency Medicine Emergency Medicine Ultrasound Core (Level 1) competency Workplace Based Triggered Assessment – 2010, Adapted from de Cossart and Fish 2005©

2. Global rating scale to assess good clinical practice (standard for all modules)

Example of global assessment for a PoCUS application[12]

Within each of the following three sections, the physician must:	Medical assessors comments during the assessment	Level of Competency?
1. Preparation for the scan		
Greets the patient appropriately and identify the patient		
Confirms that the indication for the procedure is within own competency		
Positions the patient correctly		
Demonstrates appropriate attitude and professional manner		
2. The scan		
Sets up the equipment acceptably		
Probe selection, handling and scanning technique		
Acquisition of the best possible image: Identifies X Identifies Y Identifies Z		
Efficiency - Thoroughness - Speed of scan		
Saves/prints/documents		
3. Post scan		
Appropriate interpretation of the findings		
Integrates information into clinical findings		
Knows if a repeat scan would be useful		

* Adapted with permission from College of Emergency Medicine Emergency Medicine Ultrasound Core (Level 1) competency Workplace Based Triggered Assessment – 2010, Adapted from de Cossart and Fish 2005©

A good example of using both components, the task specific checklist and global rating scale for good clinical practice, in the same assessment sheet, is the Saint John Regional Hospital Emergency Department Ultrasound Core Competency Assessment document 2013 (please refer to appendix B).

Choosing the correct competency assessment method(s), which should be optimally aligned to local available resources and trainer capacity, will deter the overall quality of the PoCUS provider produced by the training programme.

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4.5 Keeping up skills and being up-to-date

It is important that all users of PoCUS recognize the need to be performing applications regularly otherwise skills will be lost.

We recommend continuous logging of activity (before and after assessment of competency/credentialing), quality assurance with piers and regular emergency ultrasound continuing medical education (CME)/continuing professional development (CPD) to keep up to date.

The amount of CME/CPD required to maintain competency is related to the number of applications being utilized, the frequency of use, and other developments in emergency ultrasound and emergency medicine at large. In general, those in charge of ultrasound programs should have at least 5 to 10 hours of CME/CPD credits pertaining to ultrasound activities per year including conference attendance, online educational activities, preceptorships, teaching, research, hands-on teaching, administration, quality assurance/audit, image review, in-service examinations, textbook and journal readings, morbidity and mortality conferences inclusive of ultrasound cases, or others.

Individual credentialed physicians should have 2.5 to 5 hours of the above continuing educational ultrasound activities per year. Educational sessions that integrate ultrasound into the practice of EM are encouraged, and do not have to be didactic in nature but can be participatory.

Knowledge

- Image recording, storing and filing.
- Reporting
- Medico-legal aspects – outlining the responsibility to practice within specific levels of competence and the requirements for training.
- Consent.
- The value and role of departmental protocols
- The resource implications of ultrasound use

Skills

- Integrate PoCUS into the general departmental clinical governance/ CQI system

Appendix A: Abbreviations

Abbreviation	Description
AAA	Abdominal aortic aneurysm
ACEM	Australasian College for Emergency Medicine
ACEP	American College of Emergency Physicians
AIDS	Acquired Immunodeficiency syndrome
CAEP	Canadian Association of Emergency Physicians
CEM(UK)	College of Emergency Medicine (United Kingdom)
CEM(SA)	College of Emergency Medicine (South Africa)
CEUS	Canadian Emergency Ultrasound Society
CME	Continuing medical education
CPD	Continuing professional development
CPU	Clinician-performed ultrasound
CQI	Continuous quality improvement
DVT	Deep vein thrombosis
EFAST	Extended focused assessment with sonography in trauma
ECCU	Emergency and critical ultrasound
EM	Emergency medicine
EU	Emergency ultrasound
EUSIG	Emergency Ultrasound Special Interest Group
FASH	Focused assessment with sonography in HIV/AIDS
FAST	Focused assessment with sonography in trauma
HIV	Human immunodeficiency virus
IFEM	International Federation of Emergency Medicine
IVC	Inferior vena cava
OSCE	Objective structured clinical examination

PoCUS	Point of care ultrasound
RV	Right ventricle
TB	Tuberculosis
WINFOCUS	World Interactive Network Focusing on Critical Ultrasound

Appendix B: Further examples of assessment documentation

Resident:_____

Cardiovascular Limited Ultrasound Exam Clinical Exercise (CLUE CEX)

Part I: CLUE basic **Date:**_____

Carotid exam (8pts)					
1. Image quality:	0	1	2	3	4
2. Image interpretation:					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		
Cardiac exam for LVEF/LAE (12 pts)					
1. Image quality:	0	1	2	3	4
2. Image interpretation for LVEF:					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		
3. Image interpretation for LAE:					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		
Abdominal aorta exam (8 pts)					
1. Image quality:	0	1	2	3	4
2. Image interpretation					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		

Image quality:
0: no image
1: off axis, poor technique
2: suboptimal
3: adequate for diagnosis
4: good, image optimized

Image interpretation:
0: no knowledge of criteria
1: partial knowledge
2: complete knowledge

Interpretation skills:
0: inaccurate
1: partial credit
2: accurate

Part I Score (28pts):_____ % of Evaluator:_____

Part II: CLUE PLUS **Date:**_____

Cardiac exam for LVEF/LAE (12 pts)					
1. Image quality:	0	1	2	3	4
2. Image interpretation for LVEF:					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		
3. Image interpretation for LAE:					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		
Lung exam for comets, effusion (8 pts):					
1. Overall image quality (avg 4)	0	1	2	3	4
2. Image interpretation for comets/effusion					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		
Cardiac subcostal exam for RV size (8pts):					
1. Image quality:	0	1	2	3	4
2. Image interpretation					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		
Subcostal for IVC (8pts)					
1. Image quality	0	1	2	3	4
2. Image interpretation for IVC collapse					
a. Knowledge of diagnostic criteria	0	1	2		
b. Interpretation skills	0	1	2		

Score Interpretation:

Goal: 80%

Part II Score (36pts):_____ % of Evaluator:_____

TOTAL SCORE (%): _____

Kimura BL, Amundson SA, Phan JN, Agan DL, Shaw DJ. Observations During Development of an Internal Medicine Residency Training Program in Cardiovascular Limited Ultrasound Examination. Journal of Hospital Medicine 2012; 7 (7).

Emergency Department Ultrasound (EDUS)

Core Competency Assessment

Before using this document, the physician should have completed a suitable theory course or series of modules, and received hands-on instruction. They should then have carried out supervised practice of the specified number of scans with maintenance of a log.

This document covers assessments of:

1. Focussed Diagnostic Ultrasound Assessment for
- Abdominal Aortic Aneurysm, (AAA)
- Abdominal,Pelvic and Pericardial free fluid in Trauma (FAST)
- Pericardium and Ventricular motion (Echo in Life Support)
- Early Pregnancy – confirmation of intra-uterine pregnancy (IUP)
- Pleural/Thoracic free fluid (eFAST)
- Lung Sliding (rule out Pneumothorax, eFAST)

2. Focussed Procedural Ultrasound Guidance for
- Insertion of venous catheter

When the physician has reached the recommended number of scans for an assessment (*your trainer will give guidance on the recommended number of scans you require for each modality*), the relevant section of the document is completed by an assessor who will assess them as they scan a patient / volunteer (image acquisition), interpret images and apply their findings to standardized clinical scenarios. When each section is successfully completed, the whole document forms proof of achieving core competency. Whilst the minimum standard is competency to perform, Emergency Physicians should be aspiring for competence to teach. Ultrasound simulation may be used to demonstrate pathology or needle guidance.

SUMMARY

NAME:	HOSPITAL:
PGY:	RESIDENCY PROGRAM:

ULTRASOUND TRAINING

1. CEUS approved course:

Name/Location:_____ Date Completed:_____

And / OR local modular training:

Hospital:_____ Date Completed:_____

Program Director Name:_____

Program Director Email:_____

2. Completed Written / On-line test of knowledge:

Date Completed:_____

3. Completed Bedside Competency Assessment:

	Date	**Date**
	Competent to scan independently	**Competent to teach**
Abdominal Aortic Aneurysm (AAA)		
FAST		
Basic Cardiac (ELS)		
Early Pregnancy (IUP)		
Shock/Resuscitaion (IVC)		
Thoracic (eFAST)		
Vascular Access		

4. Sign off by local Program Director:

_____ D ate:_____

5. Recertification Date:_____

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Section A – Focussed Assessment of the Aorta (AAA)

Name:_____ **Trainer:**_____ **Date:**_____

Logged Experience: number of scans carried out (circle) 0 10 25 50+

Experience certified as evidenced by: _____ (signed by Trainer)

Competency component	Trainer's comments recorded during the assessment	Competent?
1. Preparation for the scan *Greet the patient appropriately and identify the patient. Demonstrate appropriate attitude and professional manner*		
Knowledge of core indications		**Yes ❑ Prompted ❑ No ❑**
Positions the patient correctly and ensures appropriately darkened environment		**Yes ❑ Prompted ❑ No ❑**
2. The scan Sets up the equipment acceptably.		**Yes ❑ Prompted ❑ No ❑**
Probe selection, handling and scanning technique		**Yes ❑ Prompted ❑ No ❑**
Acquisition of the best possible images Identifies Vertebral Body/Shadow Identifies IVC and Aorta in LS and TS Measures AP diameter of aorta accurately		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Thoroughness (heart to bifurcation) Efficiency / Speed of scan Saves/prints/documents *(As per local policy)*		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
3. Post scan Appropriate interpretation of the findings		**Yes ❑ Prompted ❑ No ❑**
Integrates information correctly into clinical scenario (Defines AAA)		**Yes ❑ Prompted ❑ No ❑**

Competency Level

Guide	Level	Trainer (Print and Sign level)
Virtually no prompting required	**Competent to teach AAA**	
Some prompting required	**Competent to scan and interpret findings independently**	
Significant prompting required	**Needs Supervision. If scanning alone cannot rely on negative findings**	

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Section B – FAST (Abdomen/Pelvis/Pericardium)

Name:_____ **Trainer:**_____ **Date:**_____

Logged Experience: number of scans carried out (circle) 0 10 25 50+

Experience certified as evidenced by: _____ (signed by Trainer)

Competency component	Trainer's comments recorded during the assessment	Competent?
1. Preparation for the scan *Greet the patient appropriately and identify the patient. Demonstrate appropriate attitude and professional manner*		
Knowledge of core indications		**Yes ❑ Prompted ❑ No ❑**
Positions the patient correctly and ensures appropriately darkened environment		**Yes ❑ Prompted ❑ No ❑**
2. The scan Sets up the equipment acceptably		**Yes ❑ Prompted ❑ No ❑**
Probe selection, handling and scanning technique		**Yes ❑ Prompted ❑ No ❑**
Acquisition of the best possible images Demonstrates RUQ (Morison's pouch) Demonstrates the spleno-renal interface Demonstrates potential fluid in the pelvis Demonstrates pericardial views		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Thoroughness (complete interface) Efficiency / Speed of scan		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Saves/prints/documents *(As per local policy)*		**Yes ❑ Prompted ❑ No ❑**
3. Post scan Appropriate interpretation of the findings		**Yes ❑ Prompted ❑ No ❑**
Result correctly integrated into clinical scenario		**Yes ❑ Prompted ❑ No ❑**

Competency Level

Guide	Level	Trainer (Print and Sign level)
Virtually no prompting required	**Competent to teach FAST**	
Some prompting required	**Competent to scan and interpret findings independently**	
Significant prompting required	**Needs Supervision. If scanning alone cannot rely on negative findings**	

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Section C – Basic Cardiac (Echo in Life Support)

Name:_____ **Trainer:**_____ **Date:**_____

Logged Experience: number of scans carried out (circle) 0 10 25 50+

Experience certified as evidenced by: _____ (signed by Trainer)

Competency component	Trainer's comments recorded during the assessment	Competent?
1. Preparation for the scan *Greet the patient appropriately and identify the patient. Demonstrate appropriate attitude and professional manner*		
Knowledge of core indications		**Yes ❑ Prompted ❑ No ❑**
Positions the patient correctly and ensures appropriately darkened environment		**Yes ❑ Prompted ❑ No ❑**
2. The scan Sets up the equipment acceptably		**Yes ❑ Prompted ❑ No ❑**
Probe selection, handling and scanning technique		**Yes ❑ Prompted ❑ No ❑**
Acquisition of the best possible images Demonstrates subxiphoid view plus one other view (eg parasternal long or short, or apical four chamber) Identifies pericardial space and any fluid Identifies presence / absence of ventricular wall motion, globally and focal. Comments appropriately on right and left ventricular size and can decide if RV dilated. Thoroughness (complete interface) Efficiency / Speed of scan Saves/prints/documents *(As per local policy)*		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
3. Post scan Appropriate interpretation of the findings		**Yes ❑ Prompted ❑ No ❑**
Result correctly integrated into clinical scenario		**Yes ❑ Prompted ❑ No ❑**

Competency Level

Guide	Level	Trainer (Print and Sign level)
Virtually no prompting required	**Competent to teach Cardiac (ELS)**	
Some prompting required	**Competent to scan and interpret findings independently**	
Significant prompting required	**Needs Supervision. If scanning alone cannot rely on negative findings**	

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Section D – Early Pregnancy (IUP)

Name: _____ **Trainer:** _____ **Date:** _____

Logged Experience: number of scans carried out (circle) 0 10 25 50+

Experience certified as evidenced by: _____ (signed by Trainer)

Competency component	Trainer's comments recorded during the assessment	Competent?
1. Preparation for the scan *Greet the patient appropriately and identify the patient. Demonstrate appropriate attitude and professional manner*		
Knowledge of core indications		**Yes ❑ Prompted ❑ No ❑**
Positions the patient correctly and ensures appropriately darkened environment		**Yes ❑ Prompted ❑ No ❑**
2. The scan Sets up the equipment acceptably		**Yes ❑ Prompted ❑ No ❑**
Probe selection, handling and scanning technique		**Yes ❑ Prompted ❑ No ❑**
Acquisition of the best possible images Demonstrates pelvic organs in LS and TS Identifies bladder Identifies uterine fundus and endometrial stripe Identifies Pouch of Douglas Comments appropriately on proximity of uterus to bladder, uterine contents, and free fluid Thoroughness (complete interface) Efficiency / Speed of scan		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Saves/prints/documents *(As per local policy)*		**Yes ❑ Prompted ❑ No ❑**
3. Post scan Appropriate interpretation of the findings		**Yes ❑ Prompted ❑ No ❑**
Result correctly integrated into clinical scenario		**Yes ❑ Prompted ❑ No ❑**

Competency Level

Guide	Level	Trainer (Print and Sign level)
Virtually no prompting required	**Competent to teach Early Pregnancy**	
Some prompting required	**Competent to scan and interpret findings independently**	
Significant prompting required	**Needs Supervision. If scanning alone cannot rely on negative findings**	

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Section E – Shock/Resuscitation (IVC)

Name:_____ **Trainer:**_____ **Date:**_____

Logged Experience: number of scans carried out (circle) 0 10 25 50+

Experience certified as evidenced by: _____ (signed by Trainer)

Competency component	Trainer's comments recorded during the assessment	Competent?
1. Preparation for the scan *Greet the patient appropriately and identify the patient. Demonstrate appropriate attitude and professional manner*		
Knowledge of core indications		**Yes ❑ Prompted ❑ No ❑**
Positions the patient correctly and ensures appropriately darkened environment		**Yes ❑ Prompted ❑ No ❑**
2. The scan Sets up the equipment acceptably		**Yes ❑ Prompted ❑ No ❑**
Probe selection, handling and scanning technique		**Yes ❑ Prompted ❑ No ❑**
Acquisition of the best possible images Identifies IVC in LS and/or TS Assesses IVC diameter and respiratory phase collapsibility		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Thoroughness (complete interface) Efficiency / Speed of scan Saves/prints/documents *(As per local policy)*		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
3. Post scan Appropriate interpretation of the findings		**Yes ❑ Prompted ❑ No ❑**
Result correctly integrated into clinical scenario		**Yes ❑ Prompted ❑ No ❑**

Competency Level

Guide	Level	Trainer (Print and Sign level)
Virtually no prompting required	**Competent to teach S/R (IVC)**	
Some prompting required	**Competent to scan and interpret findings independently**	
Significant prompting required	**Needs Supervision. If scanning alone cannot rely on negative findings**	

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Section F – Thoracic (eFAST)

Name:_____ **Trainer:**_____ **Date:**_____

Logged Experience: number of scans carried out (circle) 0 10 25 50+

Experience certified as evidenced by: _____ (signed by Trainer)

Competency component	Trainer's comments recorded during the assessment	Competent?
1. Preparation for the scan *Greet the patient appropriately and identify the patient. Demonstrate appropriate attitude and professional manner*		
Knowledge of core indications		**Yes ❑ Prompted ❑ No ❑**
Positions the patient correctly and ensures appropriately darkened environment		**Yes ❑ Prompted ❑ No ❑**
2. The scan Sets up the equipment acceptably		**Yes ❑ Prompted ❑ No ❑**
Probe selection, handling and scanning technique		**Yes ❑ Prompted ❑ No ❑**
Acquisition of the best possible image: Lung bases: Demonstrates the pleural space, vertebral line, and can identify fluid Anterior chest: Demonstrates pleural line, pleural sliding, comet tails/B-lines (+/- M-mode signs)		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Thoroughness (complete interface) Efficiency / Speed of scan		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Saves/prints/documents *(As per local policy)*		**Yes ❑ Prompted ❑ No ❑**
3. Post scan Appropriate interpretation of the findings		**Yes ❑ Prompted ❑ No ❑**
Result correctly integrated into clinical scenario		**Yes ❑ Prompted ❑ No ❑**

Competency Level

Guide	Level	Trainer (Print and Sign level)
Virtually no prompting required	**Competent to teach S/R (IVC)**	
Some prompting required	**Competent to scan and interpret findings independently**	
Significant prompting required	**Needs Supervision. If scanning alone cannot rely on negative findings**	

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Section G – Ultrasound Guided Vascular Access

Name:_____ **Trainer:**_____ **Date:**_____

Logged Experience: number of scans carried out (circle) 0 10 25 50+

Experience certified as evidenced by: _____ (signed by Trainer)

Competency component	Trainer's comments recorded during the assessment	Competent?
1. Preparation for the scan *Greet the patient appropriately and identify the patient.* *Demonstrate appropriate attitude and professional manner*		
Knowledge of core indications		**Yes ❑ Prompted ❑ No ❑**
Positions the patient correctly and ensures appropriately environment		**Yes ❑ Prompted ❑ No ❑**
2. The scan Sets up the equipment acceptably Describes/demonstrates aseptic technique		 **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Probe selection, handling and scanning technique (Centres Vein accurately under probe)		**Yes ❑ Prompted ❑ No ❑**
Patient/Volunteer: Demonstrates the Internal Jugular Vein, Common Carotid Artery Identifies safe position for catheter insertion Demonstrates the Veins and Arteries of the upper arm Identifies safe position for catheter insertion Demonstrates the Common Femoral Vein and Femoral Artery Identifies safe position for catheter insertion Venous Access Mannequin: Demonstrates guidance of needle in TS (+/- LS) Ensures needle tip is visualized at all times Successfully cannulates vessel		 **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Thoroughness (complete interface) Efficiency / Speed of scan		**Yes ❑ Prompted ❑ No ❑** **Yes ❑ Prompted ❑ No ❑**
Saves/prints/documents *(As per local policy)*		**Yes ❑ Prompted ❑ No ❑**
3. Post scan Appropriate interpretation of the findings		 **Yes ❑ Prompted ❑ No ❑**
Result correctly integrated into clinical scenario		**Yes ❑ Prompted ❑ No ❑**

Competency Level

Guide	Level	Trainer (Print and Sign level)
Virtually no prompting required	**Competent to teach Vascular Access**	
Some prompting required	**Competent to perform US guided procedure independently**	
Significant prompting required	**Needs Supervision**	

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Courtesy of Saint John Regional Hospital, Canada, Emergency Department Ultrasound Core Competency Assessment document 2013

Appendix C: Checklist for point-of-care curricula

Curriculum element	Completed	Comments
General considerations		
Review undertaken of your regional circumstances, with regards to: - Burden on disease, - Equipment availability (at present and in the future), - Potential benefits, - Difficulties in training personnel and keeping up to date skills.		
Regular review/update of point-of-care ultrasound curriculum by a tasked group of clinicians		
Applications to be included		
Inclusion of a mandatory application to include how to generate and optimise and image (physics and knobology): *Knowledge* • The basic components of an ultrasound system • Types of transducer and the production of ultrasound, with an emphasis on operator controlled variables. • Use of ultrasound controls • Know the frequencies used in medical ultrasound and the effect on image quality and penetration • The interaction of ultrasound with tissue including biological effects • Safety issues in ultrasound • The basic principles of real time and Doppler ultrasound including color flow and power Doppler • The recognition and explanation of common artefacts		

• Image recording systems *Skills* • Can operate the key machine controls • Transducer changing • Image manipulation and storage *Behaviour* • Safe practice Limitations of own skills		
Inclusion of a mandatory application to ensure good practice and governance in point-of-care ultrasound: *Knowledge* • Image recording, storing and filing. • Reporting • Medico-legal aspects – outlining the responsibility to practise within specific levels of competence and the requirements for training. • Consent. • The value and role of departmental protocols • The resource implications of ultrasound use *Skills* • Integrate EU into departmental clinical governance / CQI system (see curriculum section 4.5 for further details) *Behavior* • Adheres to rule-in philosophy (namely, that a focused ultrasound exam may rule in a pathology but generally will be unable to rule it out).		

A selection of CORE (mandatory) applications which have been chosen due to the following: - Simple to learn, perform and interpret, - Provide a solid foundation to practice, - Have significant impact in the area/region being practiced.		
A selection of ENHANCED (not mandatory/higher level) applications which have been chosen due to the following: - Are more difficult to learn, - Answer more complex questions, - Require proficiency in a related more basic CORE application,] - May be simple to learn but have a lesser impact in the area/region being practiced.		
Specification regarding which applications are diagnostic and which are procedural		
Each application requires specific details regarding: - Sectional and ultrasonic anatomy o Knowledge o Skills o Behaviour - Pathology in relation to ultrasound o Knowledge o Skills o Behaviour - Clinical integration o Knowledge o Skills o Behaviour		
Methodology of training		
Specification of what learning outcomes will be required for each application		

Specification regarding what methods will be undertaken (may be more than one) for the induction step or introduction to the application. The most commonly used are: - Short lectures, - Demonstrations, - Hands on skills teaching, - Simulation sessions, - Open and closed discussions, - Passive and interactive web based learning, - Practical scanning on real patients.		
Specification of what methods will be undertaken to allow experience for each application in the following areas: - Obtaining images, - Interpreting images, - Application of findings to patient care.		
Specification of what methods will be undertaken to ensure credentialing/competency has been achieved for each application in the following areas: - Obtaining images, - Interpreting images, - Application of findings to patient care. (Such assessments should be objective, achievable and fair)		
Specification of what expectations are required to ensure that clinician-performed ultrasound practitioners keep their skills up to date: - Continuous logging of activity, - Minimum scanning activity for a particular application, - Regular peer quality assurance, - Regular CME/CPD		