Point of care ultrasound: Breaking the sound barrier in the emergency department

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Emergency and critical care physicians have pioneered the use of Point of Care Ultrasound (POCUS) in the management of their patients. POCUS has the potential to expedite care and diagnosis as well as improve patient safety. Over the last 30 years, ultrasound machines have become more portable and less expensive, and the image processing and quality has improved to the point where some POCUS machines are comparable to some of their radiology counterparts. There has been a large uptake in ultrasound use among the critical care specialities and more recently among other medical and surgical colleagues. Training, credentialing, quality assurance, infection control and image storage are all challenges that departments implementing ultrasound will face as the scope of practice expands.

What is POCUS?

When compared with a full radiological examination, the POCUS exam is limited. It is focused on answering specific questions relating to the suspected pathology and area being imaged.¹ An example of this is the extended focused assessment with sonography in trauma (E-FAST) exam where the clinician aims to detect free fluid within the abdomen, pericardium and in the pleural spaces and evidence of pneumothorax.² In contrast, in a comprehensive examination of the abdomen, free fluid would be identified but the organs themselves would also be interrogated for potential injury. A formal examination is impractical in the unstable trauma patient where every minute counts for patient survival; identification of intraperitoneal fluid in this patient expedites their journey through the Emergency Department (ED) for definitive management in theatre.³ Many clinicians prefer the terms originally proposed by the American Society of Echocardiography (ECHO), 'focused', 'limited' and 'comprehensive', as this reflects the aims of the scan and the level of training of the operator, rather than the geographical location where the scan is performed.⁴

What are the benefits of POCUS?

There are numerous studies outlining the benefits of ultrasound in procedural guidance. This is now the standard of practice when inserting central lines⁵⁻⁷ and performing nerve blocks^{8,9} where ultrasound use has shown to improve success rates and decreases complication rates. POCUS is also used to aid decision-making and monitor response to treatments. The physician can utilise their history and physical examination findings and integrate these with their ultrasound findings into the patient's assessment. In some instances, the diagnostic abilities of POCUS clinicians can be comparable to their radiology colleagues and may avoid the need for a formal ultrasound scan. For example, in abdominal aortic aneurysm (AAA) scanning, the sensitivity and specificity for emergency physician scanning approaches over 99% for the ruling in or out the presence of an aortic aneurysm with positive likelihood ratio approaching infinity.¹⁰

The portability of ultrasound machines has enabled emergency physicians to bring enhanced diagnostic skills to the patient's bedside, explain the diagnosis and demonstrate to the patient the presence or absence of pathology in real time. POCUS improves patients' understanding of their diagnosis¹¹ as well as improving their perception of their ED experience and their physician's abilities.¹²

What are the risks associated with POCUS?

Ultrasound is an extremely user-dependent test modality, and whilst some basic techniques may be easily acquired such as needle guidance, acquiring the skills to accurately perform and interpret images to incorporate safely into practice takes years to master. There are many factors that may influence the quality and the decision-making in POCUS such as patient factors, operator skills both in image acquisition and interpretation and machine quality.¹³ Identification and knowledge of artefacts and false positives and negatives is of vital importance.¹⁴ Importantly, the most recent review of lawsuits relating to POCUS performed by Emergency Physicians in the United States, related to failure to perform, or delay in performing, a POCUS scan. Interestingly, none were related to misinterpretation of the scan.¹⁵

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What are the main governance issues around POCUS?

It is critical that each hospital/network has a scalable, robust and efficient means of quality assurance to ensure the accuracy of scans performed. Central to this is the ability to store POCUS images on a system which allows for retrieval and review of images. Emergency Physicians around Australasia currently use a number of different forms of image storage – ranging from images being stored on the individual machines, to external hard drives, to use of the hospital's existing radiology Picture Archive and Communication System (PACS). PACS designed specifically for POCUS, such as QPATH^{TM,16} are also now becoming available, which will improve review, feedback mechanisms and education of clinicians.

To maintain the highest standards of diagnostic accuracy and patient care, clinicians performing POCUS must be appropriately trained and credentialed. This is also important for facilitating communication across specialities, as having a recognised qualification means that other specialists can understand exactly what information a POCUS scan can contribute, and, importantly, what it does not cover. The Australasian Society for Ultrasound in Medicine's (ASUM) Certificate of Clinician Performed Ultrasound (CCPU) programme plays an important role in the external credentialing of ED clinicians, as it ensures a minimum standard of proficiency in the use of ultrasound which is widely recognised across Australia and New Zealand, and by other specialties. ASUM currently offers 23 CCPU units across a breadth of speciality applications. The flexibility and modular design of the CCPU has proven very popular among clinicians, as evidenced by the fact that the CCPU is ASUM's fastest growing educational programme.¹⁷ Additionally, a number of critical care specialists have gone on to do their Diploma of Diagnostic Ultrasound (DDU) through ASUM allowing the clinicians to perform comprehensive diagnostic ultrasound scans with an increased scope of practice.¹⁸

The Australasian College for Emergency Medicine (ACEM) is taking a leadership role in setting standards for practice of Emergency Medicine POCUS. POCUS knowledge and skills particularly in procedural guidance, basic ECHO,¹⁹ E-FAST and AAA²⁰ scanning are now firmly established in the training curriculum as a core skill expected of graduating emergency medicine physicians. Similar developments are occurring in several other colleges, including Royal Australian College of Obstetricians and Gynaecologists (RANZCOG), College of Intensive Care Medicine (CICM) and Australian and New Zealand College of Anaesthetists (ANZCA). A large number of emergency physicians are already utilising more advanced scanning techniques for lung/pleura, early pregnancy, ocular, deep vein thrombosis, musculoskeletal, soft tissue, biliary and renal. As the demand for more POCUS training increases, we would anticipate increased skill levels among trainees and new graduates, and, as research expands and develops, development of

speciality-specific ultrasound protocols and skill sets in response to clinical need, rather than those derived from traditional ultrasound protocols.

Infection control has recently been a contentious issue, particularly relating to ultrasound-guided procedures. To the authors' knowledge, there are (to date) no reported cases of serious infections associated with use of POCUS; however, there are reports of infections associated with intracavity probes. To this end, the ASUM has recommended the use of high-level disinfection for every procedure that involves potential blood/bodily fluid contact. This would mandate high-level disinfection for procedures such as IV cannulation, an extremely common and usually uncomplicated procedure in the ED.²¹ In contrast, the American College for Emergency Physicians (ACEP) and ACEM recommend use of a probe cover and low-level disinfection unless there is visible evidence of contamination by blood/bodily fluids.^{22,23} More research into this important area is clearly needed, and as the use of POCUS becomes more common, it is hoped that an evidence base which will inform our practice will be developed.

What is the future of POCUS?

The next 10 years promises to be an exciting time for POCUS, as the continued trend towards smaller, more powerful and more portable machines continues. New and ground-breaking technology such as the much-anticipated IQ ButterflyTM system replaces traditional piezoelectric crystal with semiconductor chip technology that allows a single probe to perform multiple applications.²⁴ With this technology, the price point of portable ultrasound systems may dip below \$2000 when combined with a smartphone device. At this level, it would be a reasonable expectation that all doctors in training, consultants and even medical students may own an ultrasound device, similar to the current requirement to own a stethoscope.

Early experiences from North American medical schools suggest that medical students view ultrasound education very positively overall, and there is evidence to suggest that it actually enhances learning of anatomy and physical examination skills.²⁵ However, designing and implementing medical school curricula that can train large numbers of medical students efficiently and effectively remain challenging, especially in an area where hands-on experience and supervised learning is so critical for success. Novel educational techniques, such as use of high-fidelity phantoms for ultrasound training, show promise in this area, especially as technological advances make the phantoms ever more realistic and customisable.

As this technology becomes available to more and more junior doctors and medical students, the sheer volume of scans may overwhelm even the most robust quality assurance or credentialing programme. Once ultrasound reaches this stage, rethinking our centralised credentialing system and quality assurance methods will inevitably have to change.

Conclusion

The arrival of this disruptive technology brings numerous challenges, but also opens exciting new opportunities for collaboration between clinicians, sonographers and radiologists to improve diagnostic efficiency, accuracy and, ultimately, patient care.

Authorship declaration

The authors acknowledge that (i) the authorship listing conforms with the journal's authorship policy, and (ii) that all authors are in agreement with the content of the submitted manuscript.

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