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Beyond the Probe: Artificial Intelligence and Point-of-Care Ultrasound in Critical Care

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Abstract

Point-of-care ultrasound (POCUS) has become an important component of bedside assessment in critical care. It allows clinicians to rapidly evaluate cardiac function, pulmonary pathology, vascular structures, volume status, and other physiological processes. The combination of POCUS with artificial intelligence (AI) represents an emerging development that may improve image acquisition, automated measurement, interpretation, education, and clinical decision support. Recent research indicates increasing interest in AI-supported POCUS, particularly for cardiopulmonary applications. However, technical performance does not automatically translate into improved patient outcomes. Differences in image quality, operator experience, patient populations, ultrasound equipment, and clinical environments remain important challenges. This mini review discusses the potential role of AI in POCUS and identifies priorities for future clinical research.

Keywords: Point-Of-Care Ultrasound; POCUS; Artificial Intelligence; Critical Care; Echocardiography; Ultrasound-Guided Procedures

Introduction

POCUS has changed the speed at which clinicians can obtain physiological information at the bedside. In critically ill patients, decisions often need to be made before formal imaging or specialist consultation is available.

Cardiac ultrasound may provide information about ventricular function and pericardial effusion. Lung ultrasound can support assessment of pulmonary oedema, pneumothorax, or other respiratory abnormalities. Vascular ultrasound can facilitate vascular access and assessment of venous pathology. The increasing use of handheld ultrasound devices has further expanded accessibility. At the same time, AI is beginning to influence how ultrasound images are acquired and interpreted. Recent literature describes applications involving automated image recognition, measurement, probe guidance, and training [1,2].

AI-Assisted Image Acquisition

One of the major limitations of POCUS is operator dependency.

A novice clinician may understand the clinical question but struggle to obtain a diagnostically useful image. AI could potentially provide real-time guidance by identifying whether the probe position and orientation are appropriate. Such systems could indicate when an image is technically adequate or suggest small probe movements to improve

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visualization. This has particular potential in emergency and critical care settings, where rapid assessment is often required.

Automated Image Recognition

AI-based image recognition may help identify anatomical structures and clinically relevant findings.

In echocardiography, computer vision can potentially recognize cardiac chambers and assist with measurements. In lung ultrasound, algorithms may identify characteristic artefacts and patterns. The attraction is not that AI would replace the clinician, but that it could provide standardized quantitative information.

Hemodynamic Assessment

One particularly promising application is haemodynamic evaluation.Critical care clinicians frequently need to determine whether hypotension is related to reduced preload, impaired cardiac function, vasodilation, or other mechanisms. POCUS can contribute to this assessment, but interpretation is influenced by ventilation, vasoactive medications, preload conditions, and disease state. A 2026 review emphasizes that POCUS interpretation must remain contextualized within the patient's dynamic physiological state. [2]AI may eventually assist by integrating multiple ultrasound measurements with clinical data.

AI and Training

Another potential benefit is education.AI-supported ultrasound platforms could provide immediate feedback to trainees regarding image quality, anatomy, and acquisition technique. This could allow learners to practice independently while receiving structured guidance. However, educational AI should not encourage learners to treat automated image interpretation as infallible. The educational objective should remain physiological reasoning and image interpretation.

Challenges Image Quality

AI performance is strongly dependent on image quality. Poor acoustic windows, obesity, mechanical ventilation, dressings, drains, and unusual anatomy can all affect performance.

Generalizability

An algorithm trained using expert-acquired images may perform differently when used by inexperienced clinicians.
Equipment Variation Different ultrasound manufacturers and software platforms can generate different image characteristics. This creates a potential barrier to model portability.

Clinical Context

An ultrasound finding should rarely be interpreted in isolation.

The same ventricular appearance can have different clinical implications depending on ventilation, volume status, vasopressor use, and disease trajectory.

Clinical Implications

- AI-assisted POCUS could potentially:
- reduce operator variability;
- assist novice practitioners;
- improve automated measurements;
- provide real-time image-quality feedback;
- support hemodynamic assessment;
- accelerate emergency diagnosis;
- improve ultrasound education.

The greatest potential may occur when AI integrates ultrasound with other clinical information rather than interpreting a single image independently.

Future Research

Future studies should move beyond technical accuracy.

Researchers should evaluate whether AI-assisted POCUS improves diagnostic accuracy, reduces time to diagnosis, changes treatment decisions, or improves patient outcomes. Multicenter prospective studies will be particularly important.

Conclusion

The combination of POCUS and AI represents a promising development in critical care. Its value will depend not simply on how accurately an algorithm recognizes an image but on whether it helps clinicians make better decisions.

AI should therefore be viewed as an additional bedside assistant, not as an autonomous ultrasound specialist.

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