Point-of-Care Ultrasound (POCUS) in Perioperative and Intensive Care: Its Role in Haemodynamic Assessment and Clinical Decision-Making

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Abstract. *Point-of-care ultrasound (POCUS) enables rapid, repeatable and question-focused imaging at the bedside and has become an integral tool in anaesthesiology and critical care. It is used to differentiate the mechanisms of shock, assess ventricular function, evaluate the lungs and pleura, identify venous congestion and guide vascular access and other procedures. The aim of this narrative review was to synthesise current evidence and recommendations on the clinical applications, diagnostic logic, limitations and competency requirements of POCUS in the perioperative and intensive care setting. International recommendations, consensus documents, diagnostic-accuracy studies, systematic reviews and narrative reviews published predominantly between 2003 and 2026 were examined. The evidence shows that focused cardiac ultrasound reliably identifies gross ventricular dysfunction, pericardial effusion and right ventricular dilatation; lung ultrasound accurately detects pneumothorax, interstitial syndrome, consolidation and pleural effusion; integrated multi-organ protocols help classify shock into hypovolaemic, distributive, cardiogenic and obstructive components; and ultrasound guidance reduces mechanical complications of central venous catheterisation. Fluid responsiveness is better assessed by dynamic measurements, such as stroke-volume change during passive leg raising, than by inferior vena cava diameter alone. POCUS complements, but does not replace, clinical examination, comprehensive echocardiography and radiological imaging. Its safe use depends on a defined clinical question, integration of findings with other data, awareness of artefacts and limitations, and structured training with competency assessment.*

Keywords: *point-of-care ultrasound; POCUS; anaesthesiology; intensive care; shock; haemodynamic monitoring; lung ultrasound; focused cardiac ultrasound*

1. Introduction

In anaesthesiology and critical care, the clinical condition of the patient can change within minutes. Hypotension, hypoxaemia, acute respiratory failure and shock require rapid identification of the underlying mechanism, because treatment differs fundamentally depending on whether the problem is hypovolaemia, vasodilation, ventricular failure or obstruction to flow. Physical examination and standard monitoring are often insufficient to make this distinction, and transport of an unstable patient for formal imaging carries its own risks.

Point-of-care ultrasound (POCUS) is ultrasonography performed and interpreted by the treating clinician at the bedside to answer a focused clinical question. Over the past two decades, portable and handheld ultrasound devices have become widely available, and

structured protocols have been developed for cardiac, lung, vascular and abdominal examination (Frankel et al., 2015; Spencer et al., 2013; Volpicelli et al., 2012). In the perioperative period, POCUS is used before surgery to assess cardiac function or gastric content, during anaesthesia to investigate unexplained hypotension or hypoxaemia, and after surgery in the recovery room and intensive care unit (Bradley et al., 2023; Vrancken et al., 2026).

POCUS does not replace comprehensive echocardiography or radiological imaging. Its strength lies in speed, repeatability and integration with the clinical context; its weaknesses are operator dependence, limited views and the risk of over-interpretation. The objectives of this review were therefore (i) to describe the clinical logic of question-focused ultrasound; (ii) to summarise the principal cardiac, lung and venous applications; (iii) to discuss integrated assessment of shock and fluid responsiveness; (iv) to outline procedural applications; and (v) to address limitations, sources of error and competency requirements.

2. Materials and Methods

This article was prepared as a narrative literature review. Relevant publications were identified in PubMed/MEDLINE, Scopus and Google Scholar using combinations of the terms "point-of-care ultrasound", "focused cardiac ultrasound", "lung ultrasound", "perioperative ultrasound", "shock", "fluid responsiveness", "passive leg raising", "venous excess ultrasound" and "ultrasound-guided central venous catheterization".

Priority was given to international evidence-based recommendations and consensus statements (American Society of Echocardiography, Society of Critical Care Medicine, international lung ultrasound recommendations), diagnostic-accuracy studies of widely used protocols, systematic reviews and meta-analyses, and recent narrative reviews addressing perioperative and postoperative intensive care practice. English-language publications concerning adult patients were considered.

Findings were synthesised thematically into the domains of clinical logic, cardiac ultrasound, lung and pleural ultrasound, integrated shock assessment, procedural guidance, and limitations and training. Because the review was not designed as a systematic review or meta-analysis, no PRISMA selection flow, risk-of-bias scoring or pooled statistical analysis is presented, and the conclusions should be interpreted in this context.

3. Results

3.1. The clinical logic of POCUS

Every POCUS examination should begin with a defined clinical question that can be answered with a binary or semi-quantitative finding: is left ventricular systolic function severely reduced, is the right ventricle dilated, is there a pericardial effusion, is pneumothorax likely, is there evidence of pulmonary oedema or venous congestion? The appropriate focused protocol is then selected, images are acquired, and findings are interpreted together with the history, examination, monitoring and laboratory data. Findings that are uncertain, unexpected or outside the operator's competence should prompt comprehensive echocardiography, radiography, computed tomography or specialist consultation (Spencer et al., 2013; Vrancken et al., 2026).

3.2. Focused cardiac ultrasound and haemodynamic assessment

Focused cardiac ultrasound (FoCUS) uses a limited number of standard views (parasternal long and short axis, apical four-chamber and subcostal) to assess left and right ventricular size and global systolic function, pericardial effusion and signs of tamponade, and gross valvular abnormalities. The American Society of Echocardiography considers FoCUS an adjunct to physical examination that, in trained hands, reliably identifies these major

abnormalities but does not include detailed quantitative assessment (Spencer et al., 2013).

Interpretation requires caution. Visually preserved contraction does not necessarily mean normal cardiac output, which also depends on heart rate, loading conditions and valvular function. A small, hyperdynamic left ventricle with end-systolic cavity obliteration suggests low preload or vasodilation but is not by itself sufficient justification for fluid administration. Right ventricular dilatation with septal flattening may indicate acute pulmonary embolism, right ventricular infarction or increased pulmonary vascular resistance from positive-pressure ventilation, and should not be used to establish a diagnosis without clinical context. Common findings and their interpretation are summarised in Table 1.

Table 1. Common POCUS findings in the haemodynamically unstable patient and their interpretation.

Finding	Possible interpretation	Caveats
Left ventricle: severely reduced global contraction	Cardiogenic component of shock	Septic cardiomyopathy and drugs may also depress function
Left ventricle: small, hyperdynamic cavity	Hypovolaemia or vasodilation	Does not by itself prove fluid responsiveness
Right ventricle: dilated RV, septal flattening	Pulmonary embolism, RV failure, high pulmonary pressure	Chronic pulmonary hypertension and mechanical ventilation can mimic
Pericardium: effusion with chamber collapse	Tamponade	Clinical diagnosis; collapse may be absent after cardiac surgery with localised clot
Pleura: absent lung sliding, no B-lines, lung point	Pneumothorax (lung point is highly specific)	Absent sliding also occurs with one-lung ventilation, apnoea, adhesions
Lung parenchyma: multiple bilateral B-lines	Interstitial syndrome, e.g. pulmonary oedema	Not specific to cardiogenic oedema; also in pneumonia, ARDS, fibrosis
Lung parenchyma: consolidation, effusion	Atelectasis, pneumonia, pleural effusion	Dynamic air bronchograms favour pneumonia
Veins: plethoric IVC, abnormal hepatic/portal/renal Doppler	Venous congestion (VExUS)	IVC affected by ventilation and intra-abdominal pressure

3.3. Lung and pleural ultrasound

Lung ultrasound relies largely on the interpretation of artefacts. A normally aerated lung shows pleural sliding and horizontal A-lines; vertical B-lines arising from the pleural line indicate increased extravascular lung water or interstitial thickening; consolidations and pleural effusions are visualised directly. International evidence-based recommendations support lung ultrasound for the diagnosis of pneumothorax, interstitial syndrome, consolidation and pleural effusion, with diagnostic accuracy that is generally superior to bedside chest radiography (Volpicelli et al., 2012). The BLUE protocol combines these signs with venous assessment in a decision tree for acute respiratory failure (Lichtenstein & Mezière, 2008).

Multiple bilateral B-lines indicate an interstitial syndrome but are not specific to cardiogenic pulmonary oedema. Absence of pleural sliding increases the likelihood of pneumothorax, but sliding may also be absent during apnoea, one-lung ventilation, endobronchial intubation or with pleural adhesions; the lung point is the most specific sign. In the operating room and intensive care unit, lung ultrasound is particularly useful for serial bedside assessment of atelectasis, response to recruitment and evolution of pulmonary oedema.

3.4. Integrated assessment in shock and fluid responsiveness

Combined assessment of the heart, lungs, inferior vena cava (IVC) and, when indicated, the abdomen and deep veins helps classify shock into hypovolaemic, distributive, cardiogenic and obstructive components, recognising that these mechanisms frequently coexist. Protocols such as the Rapid Ultrasound in Shock (RUSH) examination structure this assessment around the "pump", the "tank" and the "pipes" (Perera et al., 2010). POCUS findings must be integrated with

blood pressure, heart rate, lactate, capillary refill time, urine output, the electrocardiogram and laboratory data.

For fluid responsiveness, IVC diameter and collapsibility alone are unreliable, because they are influenced by mechanical ventilation, intra-abdominal pressure, right ventricular function and respiratory effort. Measurement of the change in stroke volume or cardiac output, for example by left ventricular outflow tract velocity–time integral, during passive leg raising is a more robust approach; a meta-analysis showed that passive leg raising predicts fluid responsiveness with good accuracy when the response is assessed by real-time cardiac output measurement (Monnet et al., 2016). The venous excess ultrasound (VExUS) grading system combines IVC size with hepatic, portal and intrarenal venous Doppler patterns to quantify systemic venous congestion, which may help identify patients in whom further fluid is likely to cause harm (Beaubien-Souligny et al., 2020).

3.5. Procedural applications

Ultrasound guidance for central venous catheterisation allows identification of the target vessel and adjacent structures, assessment of patency and real-time visualisation of the needle. Compared with anatomical landmarks, it reduces the number of attempts, arterial puncture and other mechanical complications, particularly for the internal jugular vein (Brass et al., 2015; McGee & Gould, 2003). Ultrasound also supports arterial cannulation, difficult peripheral venous access, peripheral nerve blocks, pleural drainage and other procedures. Aseptic technique, an appropriate probe, sterile covering and local safety protocols remain mandatory, and ultrasound does not replace correct procedural technique.

3.6. Limitations, errors and competency

POCUS is operator-dependent. Obesity, subcutaneous emphysema, surgical dressings, mechanical ventilation, patient positioning and difficult anatomy may limit image quality. Typical errors include making a definitive diagnosis from a single image or sign, interpreting a negative examination as proof that disease is absent, overestimating the capabilities of handheld devices and failing to document images. Competency requires theoretical knowledge, a sufficient number of supervised examinations, image archiving, regular quality review and clear pathways for referral to experts (Frankel et al., 2015; Spencer et al., 2013). Table 2 summarises a practical approach to safe implementation.

Table 2. Practical framework for safe use of POCUS in perioperative and intensive care.

Step	Action	Key considerations
1. Define the question	Formulate a focused, answerable clinical question	e.g. "Is there a pericardial effusion?" rather than "assess the heart"
2. Select the protocol	FoCUS, lung ultrasound, IVC/VExUS, RUSH, vascular access	Choose views appropriate to the question and the patient's position
3. Acquire images	Optimise depth, gain and probe position; obtain more than one view	Recognise when image quality is inadequate
4. Interpret in context	Combine findings with history, examination, monitoring and laboratory data	Avoid diagnosis from a single sign; consider coexisting mechanisms
5. Act and reassess	Treat the identified mechanism; repeat examination after intervention	Serial examination is a major strength of POCUS
6. Document and escalate	Record findings and images; refer uncertain cases for comprehensive imaging	Supports audit, training and medico-legal safety

4. Discussion

The evidence reviewed here supports POCUS as a valuable extension of the clinical examination in anaesthesiology and intensive care. Its greatest value lies not in isolated images but in answering a specific clinical question and integrating the answer with other information. In unexplained hypotension, a brief cardiac and lung examination can rapidly reveal severe ventricular dysfunction, tamponade, right ventricular dilatation or pneumothorax, conditions that require completely different treatment. In acute hypoxaemia, lung ultrasound can distinguish atelectasis, consolidation, effusion, interstitial syndrome and pneumothorax at the bedside without patient transport (Lichtenstein & Mezière, 2008; Volpicelli et al., 2012).

The second important message concerns fluid management. Static measures such as IVC diameter have limited value in predicting fluid responsiveness, particularly in ventilated patients. Dynamic tests that measure the change in stroke volume during passive leg raising are more reliable (Monnet et al., 2016), and assessment of venous congestion may help identify patients in whom additional fluid is harmful (Beaubien-Souligny et al., 2020). POCUS therefore supports a shift from routine fluid loading towards individualised, physiology-based resuscitation, but it should be combined with clinical perfusion markers rather than used in isolation.

Third, the safety benefit of ultrasound guidance for vascular access is well established (Brass et al., 2015), and real-time guidance should be regarded as standard practice for internal jugular cannulation where equipment and training are available.

The limitations of POCUS must be stated clearly. Diagnostic accuracy depends on operator skill, image quality and the prior probability of disease. A negative or poor-quality examination does not exclude disease, and over-interpretation may lead to inappropriate treatment. Many outcome benefits attributed to POCUS are inferred from diagnostic-accuracy studies rather than demonstrated in randomised trials of patient-centred outcomes. Structured training curricula, competency assessment, image documentation and quality assurance are therefore essential components of implementation (Frankel et al., 2015).

This review has limitations. It is a narrative synthesis, and the selection of literature may be subject to bias. Diagnostic studies differ in populations, reference standards and operator experience. Future research should evaluate the effect of POCUS-guided management on clinical outcomes, define minimum training requirements for perioperative physicians and validate venous congestion assessment in surgical populations.

5. Conclusion

POCUS is an important bedside tool that accelerates clinical decisions in anaesthesiology and intensive care. Focused cardiac, lung and venous examination helps identify the mechanism of shock and hypoxaemia, dynamic measurements improve the assessment of fluid responsiveness, and ultrasound guidance increases the safety of vascular access. Its value depends on asking a focused question and integrating findings with clinical examination and other monitoring. Standardised protocols, continuing education, documentation and competency assessment are essential for safe and effective implementation.

References

1. Beaubien-Souligny, W., Rola, P., Haycock, K., Bouchard, J., Lamarche, Y., Spiegel, R., & Denault, A. Y. (2020). Quantifying systemic congestion with point-of-care ultrasound: Development of the venous excess ultrasound grading system. The Ultrasound Journal, 12, 16. https://doi.org/10.1186/s13089-020-00163-w
2. Bradley, C. A., Ma, C., & Hollon, M. M. (2023). Perioperative point of care ultrasound for hemodynamic assessment:

A narrative review. Journal of Cardiothoracic and Vascular Anesthesia. https://doi.org/10.1053/j.jvca.2023.02.017

3. Brass, P., Hellmich, M., Kolodziej, L., Schick, G., & Smith, A. F. (2015). Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. Cochrane Database of Systematic Reviews, 1, CD006962. https://doi.org/10.1002/14651858.CD006962.pub2
4. Frankel, H. L., Kirkpatrick, A. W., Elbarbary, M., Blaivas, M., Desai, H., Evans, D., et al. (2015). Guidelines for the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically ill patients—Part I: General ultrasonography. Critical Care Medicine, 43(11), 2479–2502. https://doi.org/10.1097/CCM.0000000000001219
5. Lichtenstein, D. A., & Mezière, G. A. (2008). Relevance of lung ultrasound in the diagnosis of acute respiratory failure: The BLUE protocol. Chest, 134(1), 117–125. https://doi.org/10.1378/chest.07-2800
6. McGee, D. C., & Gould, M. K. (2003). Preventing complications of central venous catheterization. New England Journal of Medicine, 348(12), 1123–1133. https://doi.org/10.1056/NEJMra011883
7. Monnet, X., Marik, P., & Teboul, J.-L. (2016). Passive leg raising for predicting fluid responsiveness: A systematic review and meta-analysis. Intensive Care Medicine, 42(12), 1935–1947. https://doi.org/10.1007/s00134-015-4134-1
8. Perera, P., Mailhot, T., Riley, D., & Mandavia, D. (2010). The RUSH exam: Rapid Ultrasound in SHock in the evaluation of the critically ill. Emergency Medicine Clinics of North America, 28(1), 29–56. https://doi.org/10.1016/j.emc.2009.09.010
9. Sams, S. H., & Deshpande, R. (2025). Perioperative critical care point-of-care ultrasound. Critical Care Clinics.
10. Spencer, K. T., Kimura, B. J., Korcarz, C. E., Pellikka, P. A., Rahko, P. S., & Siegel, R. J. (2013). Focused cardiac ultrasound: Recommendations from the American Society of Echocardiography. Journal of the American Society of Echocardiography, 26(6), 567–581. https://doi.org/10.1016/j.echo.2013.04.001
11. Volpicelli, G., Elbarbary, M., Blaivas, M., Lichtenstein, D. A., Mathis, G., Kirkpatrick, A. W., et al. (2012). International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Medicine, 38(4), 577–591. https://doi.org/10.1007/s00134-012-2513-4
12. Vrancken, D., Stessel, B., Nijs, K., et al. (2026). Point-of-care ultrasound in postoperative intensive care: A practical guide for the anaesthesiologist. Best Practice & Research Clinical Anaesthesiology.