

# Point-of-care cardiac ultrasound in acute medicine – the quick scan

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## ABSTRACT

The optimum management of acute medical patients requires prompt and accurate diagnosis, monitoring and treatment. The clinical history and physical examination remain central to diagnosis, but often need supplementation by laboratory testing or imaging. Echocardiographic assessment of cardiac structure and function provides valuable information that can aid diagnosis and assess clinical progress. It has many advantages as an imaging modality, and recent technological advances have resulted in hand-held, battery-powered ultrasound devices that provide high-quality images. Three broad applications of cardiac ultrasound now exist: conventional echocardiography, focussed echocardiography and the quick-scan. A quick-scan using a hand-held ultrasound device is readily integrated into the bedside clinical assessment, providing information that can be used immediately in diagnostic reasoning; it can also guide pericardiocentesis. Hand-held ultrasound devices can also be used in acute situations, as well as geographically remote areas or special situations (eg disaster zones) where other imaging is not available. However, the diagnostic yield of echocardiography is user dependent, and training is required for its benefits to be realised, adding to the hardware costs. More data are needed on the incremental value of hand-held ultrasonography and a quick-scan over conventional methods of assessment, their impact on clinical outcomes, and cost effectiveness.

**KEYWORDS:** Quick-scan, point-of-care, acute medicine, echocardiography, physical examination, hand-held ultrasound

## Introduction

Echocardiography assesses cardiac structure and function more accurately than does physical examination.<sup>1</sup> Its use has uncovered previously unsuspected cardiac abnormalities. For example, up to 20% of patients thought to have acute chronic obstructive pulmonary disease (COPD) exacerbations might in fact have left ventricular (LV) failure.<sup>2</sup> Thus, echocardiography

is integral to acute medicine and is included within the UK acute medicine syllabus.<sup>3</sup> Hitherto, echocardiography has usually been delivered from the cardiology department within office hours, but there is now a worldwide trend towards echocardiography training for acute, emergency and intensive care physicians, to provide point-of-care scanning. This has been facilitated by the development of portable and, more recently, hand-held ultrasound (H-USS) devices. Hand-held echocardiography (the 'quick-scan') is poised to become an extension of the clinical examination directly relevant to managing acute illness. This is a potentially liberating and powerful development, but there are also concerns principally relating to training and governance. Here, we discuss the applications, advantages and limitations of devolved quick-scan cardiac ultrasound by H-USS.

## Hand-held ultrasound devices

Three categories of echocardiography machine exist. 'High-end' machines typically cost around £100,000 and are large and better suited to the echocardiography department. Portable machines typically cost £30,000–£40,000 and are often battery powered, enabling movement between beds without being turned off. They have slightly inferior image quality and less advanced software compared with high-end machines. H-USS devices costing around £5,000 are portable and ideal for integration with the clinical examination. They include the Acuson P10 (Siemens Healthcare, Surrey, UK) and VScan (GE Healthcare, Buckinghamshire, UK) (Fig 1). The latter measures 135x73x28 mm, weighs 390 g, and comprises a phased-array ultrasound probe attached by a thin cable to a rechargeable, flip-screen device with an 8.9-cm display that shows 2D images with colour Doppler.

Standard and portable echocardiography machines have large internal hard-drives and can easily be backed up onto electronic storage systems that enable viewing and analysis using readily available software. The hand-held machines currently have limited internal storage on a flash card, which needs to be downloaded to a PC. This is relatively time consuming and many physicians choose not to archive studies and to write a report in the patients' case-files rather than using the departmental electronic reporting system.

These technical categories broadly correspond to three types of scan, although there can be overlap: standard echocardiography, focused echocardiography or a quick-scan

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**Fig 1.** The VScan. Reproduced with permission of GE Healthcare. © 2014 General Electric Company.

(Table 1). The standard echocardiogram is the comprehensive study, typically taking 30–40 min, involving 11 views and multiple modalities. A focused study addresses a simple question, for example, assessment of residual effusion after pericardiocentesis, and is usually only safe as follow-up to a standard study. There is no consensus on the components of a quick-scan. We use it to exclude significant disease in four areas: LV size and function; right ventricular (RV) size and function; valvular structure and function; and pericardial fluid.

### Clinical applications, advantages and limitations in acute medicine of a quick-scan using a hand-held ultrasound device

There are several indications for a quick-scan (Table 2) and many benefits (Box 1). A quick-scan is rapid<sup>4</sup> and can quickly identify pericardial effusion, severe LV systolic dysfunction (LVSD), RV dilatation, major heart valve disease and inferior vena cava (IVC) dilatation, allowing immediate potentially life-

saving changes in management. There is good agreement with standard echocardiography.<sup>4–10</sup> It improves the differentiation and management of conditions with overlapping features but contrasting treatments, such as acute LV failure versus acute exacerbation of COPD. This is additionally important where a treatment is contraindicated in the competing diagnosis, or where treatment carries great risk (eg a quick-scan could substantiate the decision to thrombolysate a moribund patient with clinically suspected pulmonary embolism). It can also guide pericardiocentesis.

A quick-scan is suited to acute settings, including the acute medical unit, inpatients,<sup>7,11–13</sup> emergency department,<sup>8</sup> cardiac arrests, intensive care,<sup>14,15</sup> the perioperative period,<sup>5</sup> and special situations, such as mobile medical units, disaster zones and battle zones.<sup>4,15–18</sup> In cardiac arrest, a quick-scan can identify or indicate the presence of reversible causes of pulseless electrical activity (PEA), and distinguish true PEA, which carries a worse prognosis, from pseudo-PEA.<sup>19,20</sup> A quick-scan can be used to triage those who need a standard echocardiogram and contributes to clinical risk stratification.

A quick-scan is not a standard echocardiogram and it has limitations. It is inferior at assessing LV dimensions,<sup>18</sup> RV function and mitral regurgitation,<sup>18</sup> and cannot assess diastolic function. For emergency triage, it performs well when used by operators trained in standard echocardiography, but there are few data for operators trained solely to the level of a quick-scan save for one small study in medical students.<sup>21</sup> This has implications for who can use H-USS. Furthermore, there has been no systematic study of the impact of quick-scans on patient outcomes or costs. The European Society of Cardiology has issued a statement that H-USS should be used in a limited manner, users without accreditation in transthoracic echocardiography should receive formal training and, finally, the patient should be told that the H-USS study does not replace a full study.<sup>22</sup>

### Training issues

A quick-scan can be regarded as an extension of the physical examination with the H-USS acting as an ultrasonic stethoscope. Clinicians with widely differing examination skills and clinical qualifications (eg MRCP) are all entrusted with a stethoscope.

**Table 1.** Different applications of cardiac ultrasound.

Technology	Description	Uses
Quick-scan	Light, hand-held cardiac ultrasound device with basic echocardiographic features but including only imaging and sometimes colour. Images stored on device and can be downloaded onto a personal computer. However, cannot currently download onto electronic storage systems used by standard and focused echocardiography systems	~3–5-min examination. Targeted point-of-care qualitative assessment of cardiac structure and function as an extension of physical examination
Focused echo	Laptop-sized, portable machine. Imaging quality slightly inferior to standard echo and lacks advanced software. Images stored on internal hard drives that can easily be archived onto electronic storage systems and then viewed and analysed with standard software	Quantitative portable assessment of cardiac structure and function
Standard echo	Full-sized machine with more advanced imaging and greater analytical capabilities, including 3D tissue Doppler imaging, speckle tracking, strain analysis, multiple probes, but greater bulk and weight. Images stored on internal hard drives that can easily be archived onto electronic storage systems and then viewed and analysed with standard software	Comprehensive ~30-min echocardiographic assessment of cardiac structure and function

**Table 2. Indications for quick-scan echocardiography along with typical echocardiographic features suggestive of, and consistent with, common medical conditions.**

Indication	Specific areas to assess with a quick-scan	
Acute dyspnoea	Left ventricle	Hypokinetic in left ventricular systolic dysfunction Hyperdynamic with acute severe valve regurgitation or severe anaemia Normal in noncardiac causes, including lung disease
	Right ventricle	Dilated and hypokinetic right ventricle consistent with pulmonary embolism
	Valve disease	Critical aortic or mitral valve disease
	Pericardium	Tamponade
Acute chest pain	Left ventricular function	Regional wall motion abnormality suggests acute coronary syndrome or previous infarct
	Right ventricle	Dilated and hypokinetic right ventricle consistent with pulmonary embolism
	Pericardium	Thickening and fluid in pericarditis
Hypotension	Left ventricular size and/or systolic function	Dilated and hypokinetic with left ventricular failure; small and dynamic with hypovolaemia
	Right ventricle	Dilated after pulmonary embolism; small and dynamic with hypovolaemia
	Inferior vena cava	Dilated with cardiogenic causes; flat with severe hypovolaemia
Syncope	Critical aortic stenosis	Severely reduced aortic valve opening
	Severe mitral stenosis	Severely reduced mitral valve opening
	Hypertrophic cardiomyopathy	Asymmetric left ventricular hypertrophy; septal anterior motion of the mitral valve; mid left ventricular cavity turbulence
Ventricular arrhythmia	Left ventricle size and systolic function: possible evidence of ischaemia and/or infarct, or of impaired function?	Globally or regionally impaired left ventricular systolic function compatible with a substrate for arrhythmia
	Right ventricle	Right ventricular dilatation in right ventricular myopathy
Cardiac arrest	Pericardium	Tamponade
	Hypovolaemia	Small inferior vena cava; small left ventricular cavity
	Pulmonary embolus	Dilated right ventricle; dilated inferior vena cava
	Distinguishing PEA (cardiac standstill) from pseudo-PEA (left ventricle contraction visible)	Assess presence of absence of left ventricular contractile function
Procedural guidance	Guidance of pericardial aspiration and/or drainage	Assess position and depth of fluid; identify best approach; real-time imaging of needle position

PEA = pulseless electrical activity.

**Box 1. Clinical benefits of the quick-scan.**

- > Risk stratification
- > Timely diagnosis
- > Improving clinical diagnosis
- > Cardiac arrest
- > Extension of physical examination
- > Differentiating between competing diagnoses
- > Patient expectations
- > Increasing access to echo
- > Guidance of invasive procedures

However, broad consensus requires demonstration of competency to use an ultrasound machine. This is partly because our culture expects this with the new application of technology, partly because the technique resembles standard echocardiography and partly because more is at stake. Almost no clinical decisions are acted upon without confirmation with a test, whereas the quick-scan, to be valid, should often prompt a change in management. International training programmes exist for peri-arrest quick-scans, including FAST and FEEL. However, no nationally agreed accreditation system for USS in acute medicine exists. In its absence, individual centres are free to manage their own programmes and this is one property of a British Society of Echocardiography-accredited department. One system has been piloted since 2007<sup>23,24</sup> conforming to the requirements of a recent American Society of Echocardiography consensus statement.<sup>25</sup>

The problem with accreditation is not the delivery of initial training but providing the experience for a logbook under a mentor. Furthermore, once an individual is accredited, it is vital that a devolved quick-scan service should be integrated within a total service allowing immediate back-up transthoracic echocardiography if needed, second opinions, clinical opinions, continuing professional development and quality assurance. This might require a reorganisation of echocardiography as a core hospital service rather than a subdepartment within cardiology, and echocardiographers designated for training and maintaining competence in devolved echocardiography. Finally, we propose that clinicians start training in medical school.

### Potential developments in hand-held ultrasonography

H-USS devices will require secure data storage using standardised formats viewable in the more popular imaging suites to aid usability. Data should be easily archived into long-term storage systems that integrate with a patient's medical records. Alternatively, the role of imaging with H-USS needs to be agreed upon if data are not stored in a long-term system. For instance, physical examinations are not recorded digitally but the written record is taken as sufficient evidence of the examination findings. Incorporation of M-mode and various Doppler modes could improve quantification by H-USS. In the future, H-USS could use a smartphone coupled to a probe, physically or wirelessly.

### Conclusion

H-USS in trained hands adds value to the physical examination and is ideally suited to acute medicine. It can be performed rapidly at the point of care and improves diagnosis, emergency decision-making and guidance of pericardiocentesis. Laennec produced the first stethoscope in 1816<sup>26</sup> and, despite early resistance from clinicians, significantly advanced the physical examination. Quick-scans using H-USS provide another potential revolution in clinical examination.<sup>27</sup> ■

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