

RESEARCH

Measuring and monitoring quality in satellite echo services within critical care: an exploration of best practice

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Abstract

The subspecialty of critical care echocardiography is a rapidly developing area of cardiac imaging. The United Kingdom Committee for Critical Care Echocardiography was set up in 2009 to examine the remit of echocardiography in critical care, and a successful collaboration between the British Society of Echocardiography (BSE) and the Intensive Care Society has resulted in the establishment of two new critical care accreditation processes: Focused Intensive Care Echocardiography and Advanced Critical Care Echocardiography. These accreditation processes are currently driving the development of satellite echo services within critical care departments throughout the UK. Individual practitioner – and more recently, departmental – accreditation have become well-established processes advocated by the BSE. Practitioner accreditation promotes accountability, and departmental accreditation standardises the environment in which practitioners operate. The accreditation of individual echocardiographers has been embraced by the critical care fraternity; we propose that departmental accreditation for critical care echo services be viewed in the same way. Identifying quality indicators for satellite echocardiography services within critical care areas is therefore the focus of the present quality exploration: our aim is to propose a set of parameters against which satellite critical care echo services can be benchmarked. In publishing our suggestions, we hope to stimulate debate in light of the rapid evolution of critical care echocardiography as a subspecialty practice. We suggest that our proposed parameters could be used to maintain satellite critical care service standards and to help identify departments capable of delivering high-quality services and training in critical care echocardiography.

Key Words

- ▶ satellite echocardiography service
- ▶ critical care
- ▶ audit parameter
- ▶ quality indicator
- ▶ departmental accreditation

Introduction

Quality in healthcare

Barack Obama, the current president of the US, argues that a society cannot define itself as being developed unless it has a high-quality healthcare system that is accessible to all members of that society (1). In the UK, there is a healthcare system which has been free at the point of access since 1948. Sixty years later, in 2008, the quality of

that healthcare service was called starkly into question by Lord Darzi in his report *High Quality Care for All* (2).

One broad-brush definition of quality in healthcare is ‘the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge’ (3).

High-quality healthcare is a hard task master. It requires us to define and regulate every stage of

clinical processes through a continuous cycle of reflection and correction. Audit is a key example of cyclical reflective practice, and it was identified by Lord Francis in his enquiry into the Mid-Staffordshire Hospitals as being a vital component of a high-quality healthcare system (4).

Context of the present quality exploration

Delivered by advances in echocardiographic imaging capabilities and by a trend towards non-invasive diagnostics and clinical resuscitation end-points, the subspecialty of critical care echocardiography is a child of our time. In 2009, the UK Committee for Critical Care Echocardiography was set up to examine the remit of echocardiography in critical care (5). This led to a successful collaboration between the British Society of Echocardiography (BSE) and the Intensive Care Society (ICS), which culminated in the establishment of two new critical care accreditation processes (6).

These accreditation processes are designed to meet the immediate clinical needs of patients admitted to critical care. The first is Focused Intensive Care Echocardiography (FICE) – a foundation process applicable to all critically ill patients (<http://www.ics.ac.uk/ics-homepage/accreditation-modules/>). FICE allows clinicians to identify gross cardiovascular abnormalities – for example, acute right heart dilatation, which may indicate major pulmonary embolus, or evidence of cardiac tamponade or profound hypovolaemia – and thereby enables the immediate stabilisation of a patient. FICE is overseen and administered by the ICS.

The second process – Advanced Critical Care Echocardiography (ACCE) – has been designed to augment FICE. It is administered by a joint committee of the ICS and BSE (6, 7). This accreditation sits alongside, but is distinct from, the existing BSE accreditation processes in adult transthoracic and transoesophageal echocardiography. The ACCE syllabus is exclusively referenced to transthoracic practice and incorporates aspects of knowledge from the outpatient practice of transthoracic echo and critical care medicine (7).

These new accreditation processes are driving the development of satellite echocardiography services within critical care departments throughout the UK (8, 9, 10). Without regulation, we risk creating a cohort of non-accountable echocardiographers. Identifying quality benchmarks for satellite echocardiography services within critical care areas is therefore the focus of the present quality exploration.

Aim of the present quality exploration

The aim of the present quality exploration is to propose a set of audit parameters against which satellite critical care echo services can be benchmarked.

Methodology

In order to establish our proposed parameters, we have integrated information from three major sources:

- established clinical practice in the Adult Intensive Care Unit (AICU) at the John Radcliffe Hospital in Oxford, which is currently one of the largest providers of in-house critical care echocardiography services in the UK;
- the available literature on identifying clinical audit parameters; and
- the BSE process of departmental accreditation (DA), which represents the most closely relevant process of quality assessment.

Clinical practice at the John Radcliffe Hospital

The AICU at the John Radcliffe Hospital runs a critical care echocardiography service that consists of a consultant clinical lead (CL) and echocardiography fellows who are trainees in Advanced Intensive Care Medicine (ICM) (11). At any one time, there are two fellows in training as well as a number of trainees undertaking the FICE program (facilitated by Oxford Critical Care Echocardiography Fellowship (OCCEF) members). This has enabled transthoracic echocardiography to be performed almost exclusively by in-house ‘echo’ team members who are familiar with the indications for and use of echocardiography for the resuscitation, monitoring and diagnosis of the critically ill.

Since the program’s inception in August 2009, there has been a steady rise in the demand for and number of echocardiograms performed on the unit as the wider clinical team members become familiar with the way in which echocardiographic information can be integrated into clinical care. This increased activity motivated us to try to benchmark our quality. In doing so, we realised that as of yet there are no established quality indicators for critical care echocardiography service practices. As a first step towards developing a benchmark framework, and in order to gauge the quality of our own service, we embarked on a service provision assessment.

At the current rate of activity, 1300 echocardiograms are performed annually across two critical care sites

Indications for echoes performed - AICU, John Radcliffe

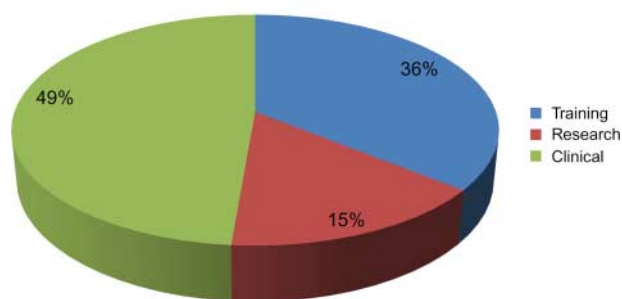


Figure 1

Categorisation of echocardiograms performed on the AICU at the John Radcliffe Hospital, Oxford. The majority of echocardiograms are clinically indicated.

(with a total of 20–22 staffed level two or three beds). Of these, our data indicate that 49% are performed for clinical indications, 36% for training purposes and 15% for research (Fig. 1). Of the clinical echocardiograms, the majority (84%) are performed by an OCCEF member; only 16% are performed by either a Cardiology consultant, registrar or echocardiography technician (Fig. 2). A transoesophageal examination is requested in 1% of cases following transthoracic examination. Evidence indicates that in the UK, the management of patients in intensive care is changed in approximately 50% of cases in response to an echocardiogram (8, 9, 10); we estimate a similar effect of echocardiography on management in our unit.

Literature on establishing audit parameters

Indicators include explicitly defined and measurable elements against which the quality of delivered care can be assessed (12). They are most often grouped into three categories according to a conceptual model developed by Donabedian for evaluating the quality of care; these categories describe the 'structure', 'process', or 'outcomes' of care (13). The term 'standard' should be reserved for defining the level of quality achieved against a particular indicator. In relation to echocardiography, 'structure' denotes the infrastructure through which care is delivered, such as staffing, facilities, equipment and training; 'process' refers to the delivery of care, which includes image acquisition, storage, interpretation and reporting; and 'outcomes' are events that occur as a result of the influence of an echocardiogram on clinical decision making, and they can include morbidity, mortality, cost and referring physician satisfaction (14). Indicators may

measure event frequency within or performance by healthcare systems. 'Quality' indicators are designed to specifically measure the quality of delivered care (12).

When developing quality indicators, it is important to gather all available relevant information, including expert opinion, current practice, assessment of similar clinical processes and the wider literature (15). Wherever possible, indicators should be based on high-quality scientific evidence. Where evidence is lacking, indicator development must rely on evidence surrogates, such as expert opinion or guidelines. Professional group opinions are deemed to be more consistent than individual practitioner judgements are, and they are therefore preferable; individual judgements may be more prone to bias and a lack of reproducibility (12). When experts disagree, techniques can be used to reach consensus.

BSE DA process

The BSE champions practitioner accreditation as a means of ensuring individual competence and quality performance. However, the ability to competently perform an echocardiogram or to deliver a quality echocardiography service presupposes the existence of a safe, organised and constructive 'echo environment'. An individual sonographer can only perform as well as this environment allows. To this end, the BSE has more recently promoted DA as a desirable, if not essential, element in the maintenance of quality in echocardiography, and it has

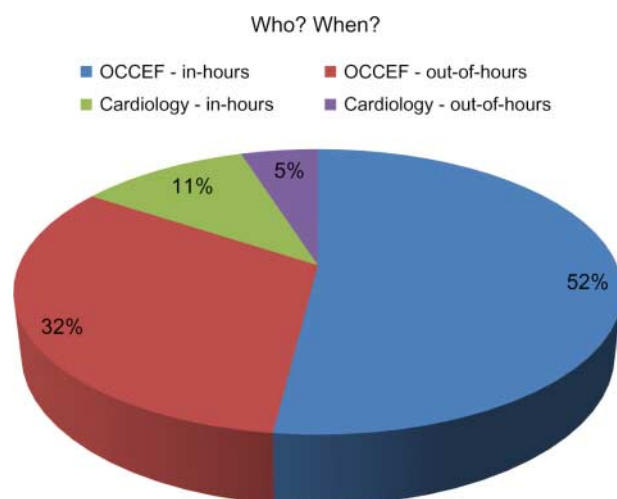


Figure 2

Analysis of who performs clinical echocardiograms in- and out-of-hours on the AICU at the John Radcliffe Hospital, Oxford. Both registrars and consultants are included. 'Cardiology' also includes technicians. OCCEF, Oxford Critical Care Echo Fellowship group. In-hours, 0800–1759; out-of-hours, 1800–0759.

taken the view that all departments should hold transthoracic DA as a minimum (16).

The BSE's DA indicators (or 'standards', see <http://www.accredityourdepartment.org/eligibility/standardstte.aspx> accessed 01/03/2015) align closely with the structure–process–outcome model for healthcare quality assessment. It is worth noting, however, that in practice it can be difficult to identify evidence of a direct link between the results of any imaging modality and the outcome for an individual; indeed, given the lack of evidence directly linking imaging to improved outcomes, using clinical outcome indicators to assess departments has been deemed largely unfeasible (14). Established BSE DA quality indicators therefore focus primarily on the structures and processes that could reasonably be considered most likely to collectively improve patient outcomes.

The quality indicators which define BSE DA have been determined by an expert panel in a consensus process based on experience (J Allen, BSE Council, personal correspondence). There are no randomised trials that demonstrate that achieving standards for these quality indicators results in better departmental performance or patient outcomes. Nevertheless, the aims of DA are highly laudable, and DA has been largely endorsed across the globe as a practical mechanism through which to focus on quality (17, 18, 19). Accreditation in the UK is voluntary at present. To achieve DA, echocardiography departments have to meet optimum standards in staffing and training, organisation and equipment and the performance and reporting of studies, but they must also demonstrate a willingness to engage in quality assurance (16).

Quality indicators can be used more actively than simply to indicate DA. For instance, indicator results may be audited to inform local quality-improvement programs by identifying weaknesses in a clinical process and prioritising areas for improvement (20). The completion of audit cycles based on quality indicators can be used to assess the influence of interventions or to benchmark and compare interdepartmental performance (21).

Discussion: a proposed set of quality indicators for a satellite echocardiography service

The evolution of satellite critical care echocardiography services presents a new quality challenge. Quality indicators must be tailor-made in order to truly assess and reflect the quality of echocardiography within the landscape of critical care practice.

Informed by the three information sources outlined earlier, the following is a narrative of the quality indicators and standards we have identified as applicable to the assessment of a critical care echocardiography service. We discuss these parameters under the headings of structure, process and outcome, in accordance with the categorisation of quality indicators that is recognised in both critical care and imaging literature (14, 22, 23).

Structure

Staffing In contrast to central echocardiography departments, a critical care echocardiography service is most probably, but not necessarily, entirely clinician led and delivered (11). The presence of an identified CL with suitable governing body registration, specialty interests and BSE accreditation is the crux of providing a quality critical care echocardiography service.

The CL must have adequate allocated time within his or her contracts to oversee and maintain both service delivery and teaching. Remuneration for this role should reflect the size of the service and the number of trainees operating within it. Our experience indicates that contractual time allocation should be calculated as a synthesis of the number of echocardiograms performed annually and the number of trainees supervised. A reasonable guide is the allocation of one programmed activity (PA) of consultant time per 200 echocardiograms, where 10% of the echocardiograms are over-read and a further 10% require senior input (a standard full-time consultant contract in the UK will usually contain between 10 and 12 weekly PAs, whereas a PA will normally have a timetable value of 4 h).

Other clinicians who perform echocardiograms independently within a critical care echo service must either be BSE or FICE accredited, or they must be deemed capable of practice via distant supervision through a local assessment process (11). The CL is responsible for defining the personnel who make up the service and for overseeing both the function of those personnel within the service and their (as well as his or her own) BSE reaccreditation.

Facilities Critical care echocardiography is, by its nature, performed at the bedside. Environmental standards cannot therefore be imposed. However, the principles of patient care enshrined within BSE departmental environmental standards should be preserved as much as possible. The safe practice of critical care echo requires attention to other large organ support equipment at the bedside, taking appropriate account

of lines, tubing and wires crucial to patient care and optimising patient positioning as much as possible in partnership with the nursing team.

Care should be taken to liaise with patients and their families about the outcomes of scans performed within the service. Information from a clinical echocardiogram given in isolation could be misleading or worrying. Information given in the context of a critical illness should usually be provided via the duty consultant.

Equipment As a group, critically ill patients are often more challenging to scan than are patients who are attending for an outpatient departmental scan. Machine age, quality and portability are therefore vital to the provision of a high-quality service. Where possible, technology should be sourced from the same provider as the parent echocardiography department, because doing so reduces the risk of mistakes from equipment unfamiliarity when it is used by visiting sonographers. Equipment should be modern enough to provide high-quality scanning, be compatible with local storage technology and be equipped with all relevant functions, such as tissue Doppler imaging. Equipment replacement should reflect the workload of the machine and take into account NHS purchasing practices which recommend that imaging equipment be replaced, when possible, every 7 years (24). Equipment should be regularly serviced and compatible with local central storage systems.

The CL should negotiate access (through a service line agreement) to existing departmental storage systems for studies performed in critical care. This avoids the inconvenience of having scans stored on two separate databases, and it facilitates review by members of the parent echocardiography and cardiology departments. The CL should also ensure that members of the critical care team have access to reporting terminals within or near their clinical areas in order to facilitate timely reporting and the senior review of studies as required.

Processes

Study requests The CL should establish and disseminate a list of the clinical indications for immediate (within 30 min), urgent (within 6 h) and elective (within 48 h) echocardiograms. This will aid non-echocardiographer service users to access clinical information and will establish service standards. Requests to the service should be made in a manner that facilitates patient care in accordance with the categories described earlier. Study requests need to be

traceable to allow full auditing of the service, since time from request to study is an important quality indicator.

The dataset obtained for a study should reflect the information requested and the category of immediacy as outlined earlier. For example, when a referral is made for an immediate echocardiogram querying massive pulmonary embolus, it may be neither appropriate nor possible to perform a full study; right heart strain or direct evidence of an embolus should instead be sought. In such patients, a complete study in compliance with the BSE minimum dataset (25) could be performed, if it is clinically indicated, in the fullness of time. When protocols become available for the management of specific aspects of critical illness – for example, when assessing fluid balance (26) – these criteria should be followed. The CL is responsible for obtaining, updating, disseminating and contributing to protocols for the management of critical illness.

Image interpretation, reporting and documentation

A local format for reports should be established which provides both a description of study findings and appropriate interpretation for non-echocardiographers to answer the clinical question posed. The clinical question should be clearly stated at the start of the written report. A written report should be entered in the patient's notes in a time frame which reflects the urgency of patient care. In the critical care environment, this will often be measured in hours for a full study and sometimes in minutes when the FICE protocol is used. A separate formal report may be issued within 48 h when a particular hospital has access to an electronic reporting system.

Processes must be in place for a member of the echocardiography team to access an urgent second opinion. The CL will often function in this role; however, high-quality services should have a nominated link consultant cardiologist who acts as a point of contact for the CL and members of the team. The CL and the link consultant cardiologist should establish systems for regular review of critical care studies for quality assurance, professional development of the team and review of urgent or complex cases.

Service maintenance The CL should establish and monitor a process of cleaning portable equipment after each study that differentiates between 'contaminated' and 'non-contaminated' areas. For example, when an echocardiogram is performed in a side room contaminated with *Clostridium difficile*, the machine should be cleaned using sporicidal wipes. The CL is responsible for

Table 1 Proposed audit parameters for a critical care echo service.

Parameter	FICE accreditation teaching unit	BSE accreditation teaching unit
Structure		
Staffing	Appointed BSE-accredited CL All echocardiography team members i) are identified; ii) are qualified (various levels); iii) work within their qualification level; and iv) take part in reaccreditation (including the CL)	Appointed BSE-accredited CL with adequate PA allocation for service workload All echocardiography team members: i) are identified; ii) are qualified (various levels); iii) work within their qualification level; iv) take part in reaccreditation (including the CL); and v) attend regular quality review meetings
Facilities	Written standards are established and disseminated defining: i) safe practice of bedside echocardiogram with multi-organ support; ii) optimisation of patient positioning; and iii) appropriate liaison with nursing team/duty medical team/patients/families Standards are role modelled and maintained by the CL	Written standards are established and disseminated defining: i) safe practice of bedside echocardiogram with multi-organ support; ii) optimisation of patient positioning; and iii) appropriate liaison with nursing team/duty medical team/patients/families Standards are role modelled and maintained by the CL
Equipment	Portable equipment is: i) less than 7 years old; ii) equipped with relevant software storage packages; and iii) regularly serviced Images are stored	Portable equipment is: i) less than 7 years old; ii) equipped with relevant software storage packages; and iii) regularly serviced Images are stored on the central storage system There is a service line agreement in place for access to the central cardiology department storage facility to facilitate audit and expert review
	Reporting facilities will vary from unit to unit	Reporting and reviewing stations are accessible to all team members in critical care areas
Processes		
Requesting	All echocardiography operators know the indications for an FICE echocardiogram and work within those guidelines Studies are performed in a timely manner Time between referral and completion of a study could be audited The CL ensures that FICE echocardiograms are repeated by a more skilled operator to achieve a BSE minimum dataset where indicated	There is an agreed upon and disseminated list of indications for echocardiograms in the critically ill with agreed categories for: i) immediate; ii) urgent; and iii) elective studies There are agreed upon time parameters for the provision of: i) immediate (30–60 min); ii) urgent (2–4 h); and iii) elective studies (within 48 h) Documentation of referral time and study times in the notes allows auditing More than 75% of elective studies achieve the BSE minimum dataset FICE echocardiograms are repeated where indicated to achieve a minimum dataset The CL formulates, updates and disseminates protocols for specific critical care indications as they become available
Interpretation, reporting and documentation	A written report is entered into the notes for every FICE study undertaken. The study should be labelled 'FICE-scan' There is a nominated link cardiologist	A written report is entered into the patients' notes for all studies and includes: i) time of referral; ii) time of study; iii) type of study (labelled 'FICE-scan' if appropriate); iv) clinical question; v) all relevant parts of the heart; and vi) an answer to the clinical question interpreted for the non-echocardiographer in the clinical context There is a nominated link cardiologist with whom the CL and other team members regularly liaise The critical care echo team attend and contribute to cardiology departmental echocardiography review meetings

Table 1 Continued

Parameter	FICE accreditation teaching unit	BSE accreditation teaching unit
Service maintenance	There is access to a more advanced study within a clinically appropriate time frame The CL disseminates written information on local policy for machine cleaning after use in: i) non-contaminated areas and ii) contaminated areas Machine cleaning is carried out after each study	The CL establishes and disseminates a written protocol for the escalation of clinical queries The CL disseminates written information on local policy for machine cleaning after use in: i) non-contaminated areas and ii) contaminated areas Machine cleaning is carried out after each study
Outcomes		
Study outcomes	The CL fully audits the service twice annually and takes action to improve the service in identified weak areas These audits and actions are documented	The CL fully audits the service twice annually and takes action to improve the service in identified weak areas These audits and actions are documented

FICE, focused intensive care echocardiography; BSE, British Society of Echocardiography; CL, clinical lead; PA, programmed activity.

monitoring and maintaining the quality of the echocardiography service through a continuous audit process, and the CL should work collaboratively with the BSE and other critical care echocardiography service leads to develop guidelines, policies and audit strategies, thereby strengthening this developing specialty.

Outcomes

In contrast to departmental scanning, where the clinical influence of a study, which is independent from the rest of patient care, is difficult to isolate and measure, the clinical influence of critical care echocardiography is often identifiable. For example, we can measure how often a study is used to support a pathway of clinical care, generate an intervention or diagnose the cause of a 'failure to progress'. Regular monitoring of these effects through auditing allows a CL to observe the service in action. A fall-off in clinical effectiveness may indicate a change in practice – in structure or process – that should be identified and corrected. For example, studies may be being requested which are unlikely to yield useful information (an issue which could be addressed through education) or a portable echo machine may be producing poor images because of its age.

Table 1 details a list of indicators/auditable parameters derived from the description outlined earlier. We propose two tiers of accreditation: a minimum requirement that should be achieved in order to administer FICE-level studies and safe training; and a more advanced standard aimed at units capable of delivering an ACCE/BSE-level service. Accreditation should not be viewed as an impediment to the development of critical care echocardiography services; rather, it should be viewed as an instrument for

implementing and sustaining high-quality services in all critical care departments, be they large or small.

Conclusions

Our proposed quality indicators for use in critical care echo service accreditation accommodate variations in staffing, grades of accreditation in echocardiography, the working environment, timing and the duration and circumstances of examinations, and they recognise the critical role of links to the parent echocardiography and cardiology departments. The aim of any accreditation process is to improve the quality of delivered patient care. Accreditation of individual echocardiographers has already been embraced by the critical care fraternity. We propose that DA for critical care echo services should be viewed in the same way. Our proposed parameters could also be used to select and advertise departments capable of delivering high-quality training in critical care echocardiography. Our aim is to stimulate debate in light of the rapid evolution of critical care echocardiography as a subspecialty practice. We invite opinion and correspondence on our proposed parameters so that they may reflect practice countrywide. Following consultation, we intend to propose these parameters to the BSE and the ICS in order to establish a framework through which critical care echo services can safely develop and through which individual accreditation in ACCE may flourish.

Declaration of interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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