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EACVI CONSENSUS DOCUMENT

# Focus cardiac ultrasound core curriculum and core syllabus of the European Association of Cardiovascular Imaging†

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There is a growing trend of using ultrasound examination of the heart as a first-line diagnostic tool for initial patient evaluation in acute settings. Focus cardiac ultrasound (FoCUS) is a standardized but restricted cardiac ultrasound examination that may be undertaken by a range of medical professionals with diverse backgrounds. The intention of this core curriculum and syllabus is to define a unifying framework for educational and training processes/programmes that should result in competence in FoCUS for various medical professionals dealing with diagnostics and treatment of cardiovascular emergencies. The European Association of Cardiovascular Imaging prepared this document in close cooperation with representatives of the European Society of Anaesthesiology, the European Association of Cardiothoracic Anaesthesiology, the Acute Cardiovascular Care Association of the European Society of Cardiology and the World Interactive Network Focused On Critical Ultrasound. It aims to provide the key principles and represents a guide for teaching and training

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† The document is endorsed by the Acute Cardiovascular Care Association (ACCA) of the European Society of Cardiology, the European Association of Cardiothoracic Anaesthesiology (EACTA), the European Society of Anaesthesiology (ESA), and the World Interactive Network Focused On Critical Ultrasound (WINFOCUS).

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of FoCUS. We offer this document to the emergency and critical care community as a reference outline for teaching materials and courses related to FoCUS, for promoting teamwork and encouraging the development of the field.

**Keywords** echocardiography • focus • cardiac ultrasound • point-of-care ultrasound • emergency • education • training • teaching • limited bedside cardiac ultrasound • syllabus • curriculum

## Background

Cardiac ultrasound can provide important, often life-saving information in critical/emergency settings. Data acquisition depends on specific imaging targets, conditions or scenarios, the ultrasound equipment used, techniques and protocols applied, and related to the level of training and skill of the operator and the individual operator's profile. Ideally, these examinations should always be performed by an experienced acute/intensive care practitioner, appropriately trained both in echocardiography and acute/intensive cardiovascular care.[1,2] Although historically cardiologists were almost exclusively responsible for performing/supervising and interpreting echocardiographic examinations in acute/emergency settings, fully trained cardiologists are not always available where medical emergencies occur.

The European Association of Cardiovascular Imaging (EACVI) has long recognized that a range of medical professionals are involved in the management of cardiovascular emergencies on a daily basis, and not only cardiologists.[1,3] These include emergency physicians, intensive care specialists, anaesthesiologists, sonographers/cardiac physiologists and fellows in training.[1,3] Despite their diverse medical backgrounds, all of them are able to recognize important findings and obtain key answers in emergency settings by using cardiac ultrasound, provided they have the appropriate training. Indeed, from the ethical point of view, emergency ultrasound examination of the heart should be performed by any properly trained medical professional and avoid delay in diagnosis.[1,3]

There is a growing trend for using cardiac ultrasound as a first-line diagnostic tool for initial patient evaluation in acute settings.[1,3] To make critical decisions, the attending physician does not necessarily need the whole data set of cardiac morphology and function that is required for a comprehensive echocardiographic exam.[4] Instead, in the majority of emergency situations, restricted information may be used to understand underlying pathophysiology, narrow the differential diagnosis, initiate therapy and/or to trigger further diagnostic work-up. Since the introduction of transthoracic echocardiography in the hands of non-cardiologists in the late 80 s, it has been convincingly demonstrated that relevant information regarding the heart and circulation in acutely ill patients can be collected by means of rapid echocardiographic scanning protocols.[5] Current evidence supports the contention that operators do not need always to be fully trained in comprehensive echocardiography in order to obtain crucial diagnostic information.[6–29]

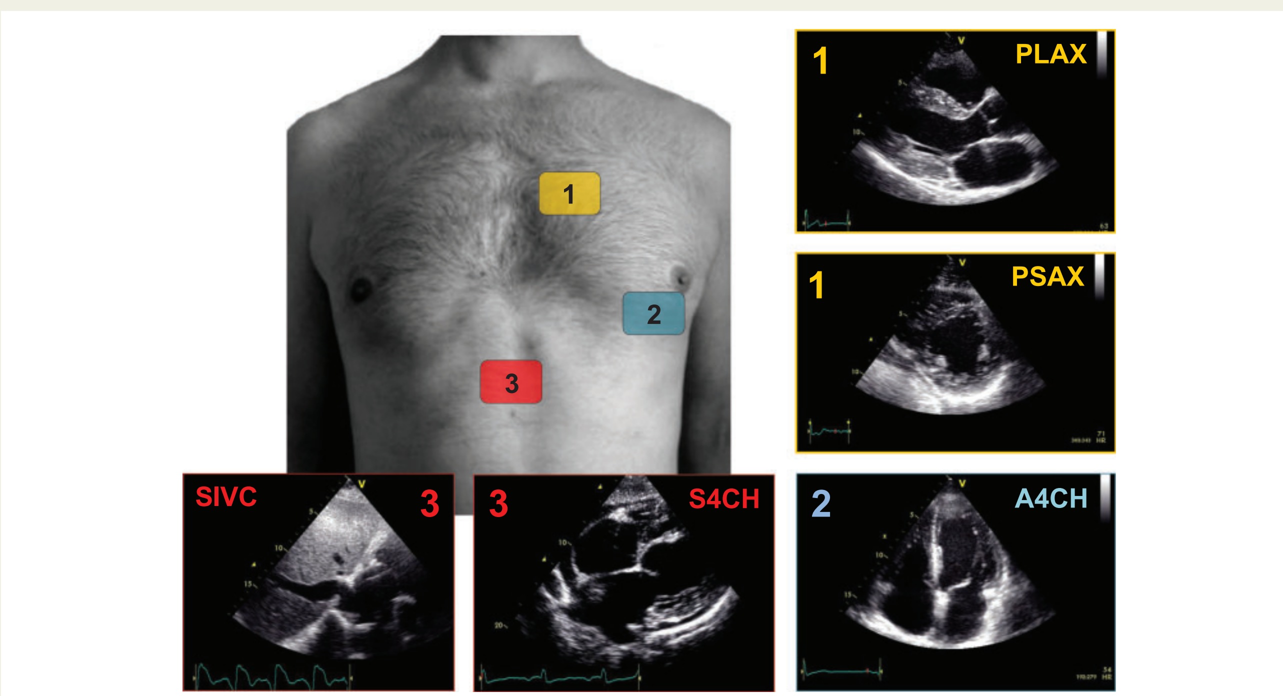


**Figure 1** Basic FoCUS examination views. From the parasternal window (1), parasternal long-axis (PLAX) and short-axis (PSAX) views can be obtained; apical 4-chamber view (A4CH) is obtained from the apical window (2); subcostal inferior vena cava (SIVC) and subcostal 4-chamber (S4CH) views can be obtained from subcostal window (3).

Focus cardiac ultrasound (FoCUS) is defined as a point-of-care cardiac ultrasound examination, performed according to a standardized, but restricted, scanning protocol (*Figure 1*), as an extension of the clinical examination. It is undertaken by an operator not necessarily trained in comprehensive echocardiography, but appropriately trained in FoCUS, who is usually responsible for immediate decision-making and/or treatment.[3,6,7] When compared with comprehensive echocardiography, FoCUS is limited by a number of factors, including time-constraints, restricted image acquisition protocol, the experience of the operator, and the technical capabilities of available equipment (e.g. pocket-sized imaging devices). Accordingly, there is a risk of missing potentially important abnormalities and/or misreading/misinterpretation of an incomplete data set.[3] These concerns have been expressed and addressed in detail by the EACVI in the document on FoCUS, which emphasized the need for specific education and training in FoCUS in order to fully exploit its advantages and mitigate potential risks.[3] The EACVI viewpoint on FoCUS is summarized in *Table 1*.[3]

Since cardiovascular diseases are often associated with pulmonary abnormalities/manifestations (such as pulmonary oedema and pleural effusions), lung ultrasound examination (LUS) is considered in the FoCUS core curriculum.[17] We believe that LUS limited to the recognition of pleural effusions and interstitial syndrome, should be performed in each case as an integral part of FoCUS examination, in analogy with the physical examination of the patient that always entails auscultation both of the heart and the lungs. In addition, since FoCUS may reveal key information in cardiac arrest that may directly change the management, it is currently integrated in the advanced cardiovascular life support (ACLS) algorithm.[30–32]

By definition, therefore, the content and duration of education and training programmes and competency requirements are substantially different comparing FoCUS with comprehensive echocardiography.[3] Currently, recommendations, statements, and protocols for education and training in FoCUS are defined by a range of diverse societies/organizations who are fully responsible for organizing teaching courses and ensuring final competence/skillset of practitioners.[3,5–7,17–27,33–35] The EACVI recognized that both cardiologists and non-cardiologists can perform either echocardiography or FoCUS depending on their background/training, the clinical circumstances, existing equipment and expertise.[3] Indeed, the question is not whether FoCUS should be used by non-cardiologists in situations when critical information is needed to direct patient management, but rather how to define standards for training and education in order to secure safe and efficient use of FoCUS in emergency cardiac care.[3] If FoCUS is performed by an operator not formally authorized for clinical decision-making (e.g. sonographers, fellows in training), it is essential to ensure that the findings are promptly communicated to the physician responsible for patient care.

# Rationale/scopes/aims of this curriculum and syllabus

Whereas respecting the complexity of the topic and diversity of medical professionals who undergo training in FoCUS, there is a growing need to set standards in education/training in FoCUS by the EACVI in their role as a reference echocardiography community. The EACVI Task Force members believe that the development of defined recommendations for education/training and knowledge/skills requirements is essential to achieve full integration of FoCUS into the management of the critically ill/emergency patient. The EACVI Task Force members also believe that this activity should be coordinated between professional societies/organizations already involved in education/training in FoCUS.[3] Thus, the current document is prepared in close cooperation with representatives of the European Society of Anaesthesiology (ESA), the European Association of Cardiothoracic Anaesthesiology (EACTA), the Acute Cardiovascular Care Association (ACCA) of the European Society of Cardiology, and the World Interactive Network Focused On Critical Ultrasound (WINFOCUS). This document should therefore provide a good foundation for a future collaboration between the EACVI and the respective societies/associations/organizations involved in FoCUS educational and training activities, by means of preparing

**Table 1 Summary of the EACVI viewpoint on FoCUS**

- FoCUS should only be used as a point-of-care cardiac ultrasound examination, aimed to detect a limited number of critical cardiac conditions
- FoCUS may provide key clinical information regarding the presence of pericardial effusion/cardiac tamponade, left and right ventricular size and function, intravascular volume status, and may aid decision-making during cardiopulmonary resuscitation
- FoCUS should never be considered or reported as echocardiographic examination
- Educational curriculum and training programme for FoCUS should be designed and conducted by the specialty professional organizations/societies involved in treating medical emergencies, including cardiac, with continual collaboration with reference echocardiographic communities
- FoCUS should only be used by the operators who have completed appropriate education and training programme, and who fully understand and respect its scope and limitations
- Whenever the information about cardiovascular abnormalities provided by the FoCUS exam is insufficient for the immediate or definitive care of patients, these should be referred to a comprehensive echocardiographic examination as soon as possible, and as compatible with clinical priorities
- FoCUS examinations should be recorded and permanently stored and reports issued in a timely manner
- Continual supervision and quality control of the FoCUS examinations are essential, provided preferably by accredited echocardiographic laboratories and emergency echocardiography services
- Reference echocardiographic community representatives should actively follow developments in the field and, whenever appropriate, work on improving educational and training curricula in concert with respective specialities professional societies/organizations, to deliver the best possible care for the patients

Modified from reference 3.

recommendations and consensus documents,[6,7] endorsing documents, adjusting educational and training programmes, organizing research projects and joint professional and scientific meetings.[3] We offer this document to the emergency and critical care community as a reference outline for teaching materials and courses related to FoCUS, for promoting teamwork, and encouraging discussions and the development of the field.

The intention of this core curriculum and syllabus is to define a unifying framework for educational and training processes/programmes that should result in competence in FoCUS for various medical professionals dealing with diagnostics and treatment of cardiac or cardiac-like emergencies. It aims to provide the key principles and represents a guide for teaching and training of FoCUS, providing a platform for a structured approach to certification and sources for preparing educational material.

Based on this curriculum/syllabus, educational and training programmes in FoCUS should:

- enable individuals, after appropriate training, to identify relevant critical cardiovascular and lung/thoracic pathologies in order to direct and/or facilitate immediate patient management
- clearly state the scope and limitations of FoCUS
- set the basis for development of educational materials
- set the basis for continuing education in the field
- set the basis for individual certification in FoCUS by the EACVI in the near future.

# Training candidates

FoCUS utilizes a highly restricted protocol that represents a small part of the standard comprehensive echocardiographic examination. However, being trained in comprehensive echocardiography does not necessarily mean that a cardiologist/sonographer will inevitably be able to provide the specific answers demanded by the critical clinical scenario, unless they are familiar with this setting. This is particularly important in certain aspects of cardiovascular evaluation, in particular in the context of critical care interventions (for example positive pressure ventilation, the use of inotropes or mechanical circulatory support, and response to volume loading). Although cardiologists who have completed basic echocardiography training outlined in the EACVI recommendations[36] are qualified to perform echocardiography in all emergency situations, for optimal use of FoCUS, they should be familiar with the FoCUS scope, approach, and Core Curriculum. In this regard, they could also benefit from additional training in basic LUS and the use of cardiac ultrasound in cardiac arrest in ACLS-compliant manner and knowledge on the effects of critical care interventions on ultrasound findings.

The educational and training requirements presented in this document are therefore aimed for both non-cardiologists and cardiologists who intend to use FoCUS in the emergency setting. These requirements could be recognized and accepted as a standard guide for education and training for all medical professionals intending to use FoCUS in medical emergencies irrespective of their speciality. This includes (but is not limited to) cardiologists with insufficient formal training in echocardiography, intensivists, anaesthesiologists, emergency medicine physicians, trainees/fellows in the aforementioned specialties, and general practitioners. This document is intended also to serve as the basis for preparation of the future EACVI certification exam in FoCUS.

# Training and competence for performance and interpretation of FoCUS

All education and training programmes on FoCUS should result in full understanding and respect of the scope and limitations of FoCUS.[3] Only in this way FoCUS can improve emergency cardiovascular care.

## Basic theoretical knowledge on cardiovascular disease

Since various medical professionals who intend to use FoCUS may have relatively limited knowledge of cardiovascular diseases compared with cardiologists, additional theoretical learning might be needed to enable trainees with different medical backgrounds to understand, interpret and fully integrate cardiac ultrasound findings into the clinical context.[1,3] The cardiovascular diseases/conditions proposed by the EACVI for additional learning programmes for non-cardiologists undergoing training on emergency echocardiography,[1] are addressed in the theoretical/teaching part of FoCUS training programmes (Part 1, in *Table 2*).[3]

## Learning technique for performing FoCUS

FoCUS does not equate to comprehensive echocardiographic examination.[1,3,36–39] Furthermore, FoCUS should be distinguished from ‘goal-oriented’ (targeted) echocardiographic examination, performed by the fully trained echocardiographer attempting to obtain an answer to a specific, often critical and frequently complex clinical dilemmas (e.g. failure to wean from mechanical ventilation, exclusion of inter-ventricular dyssynchrony, echocardiography in mechanical circulatory support). In comparison to comprehensive echocardiography, the learning curve for FoCUS is relatively rapid, as the content and duration of training can be simplified and narrowed.[3] It is important to appreciate, however, that the inherently limited approach linked to FoCUS scanning protocols does not imply substandard imaging, technical simplicity, and easily achievable competence in FoCUS. We believe that full competence in performing FoCUS cannot be achieved in few days, no matter how well a particular course is organized and/or how skilled the teachers are. Thus, although the relevant courses can be delivered in one or a few days, they are the starting point of additional supervised practice until competence in FoCUS is achieved. It is especially important to understand that higher technical skills are often needed for optimal image acquisitions by FoCUS in unfavourable emergency settings typically using a portable or pocket size imaging device, compared to elective scanning of stable patients in the echocardiography laboratory with a high-end imaging system, low-level lighting and in the left lateral position.[1,40] Of note, due to the logistics related to emergency cardiovascular care and due to its limited scope, the FoCUS examination provides mostly qualitative assessment of cardiac morphology and function. Therefore, widely available, low-cost, portable, hand-held, and pocket-size imaging devices are likely to be used more frequently by FoCUS operators instead of fully equipped echocardiographic machines.[9–16] While in this way FoCUS can be performed in virtually

**Table 2 Minimal education/training requirements for achieving competence for performing FoCUS**

| | |
|---|---|
| Part 1. Basic theoretical knowledge on cardiovascular disease[a] | |
| Acute coronary syndrome/acute myocardial infarction | |
| Mechanical complications of acute myocardial infarction | |
| Acute aortic syndrome/aortic dissection | |
| Acute pulmonary embolism | |
| Acute heart failure/cardiogenic shock | |
| Acute pericarditis | |
| Cardiac tamponade | |
| Acute myocarditis | |
| Cardiomyopathies | |
| Aortic stenosis | |
| Acute valvular regurgitation | |
| Ventricular hypertrophy | |
| Pneumothorax | |
| Endocarditis | |
| Cardiac sources of embolism (tumours and masses) | |
| Traumatic injuries of the heart | |
| Part 2. Pre-recorded cases review (25 cases)[b] | |
| LV dilatation/dysfunction | 4 |
| RV dilatation/dysfunction | 4 |
| Pericardial effusion | 4 |
| Tamponade | 3 |
| Hypovolemia | 3 |
| Cardiac arrest | 3 |
| Pleural effusion | 2 |
| LUS B-lines | 2 |
| Part 3. Mastering technique for performing FoCUS—log-book (50 cases) to include minimum number of the following conditions[c]: | |
| LV dilatation/dysfunction | 5 |
| RV dilatation/dysfunction | 5 |
| Pericardial effusion or tamponade | 3 |
| Hypovolemia | 5 |
| Cardiac arrest or peri-arrest | 2 |
| Pleural effusion | 2 |
| LUS B-lines | 3 |

Competency evaluation should be incorporated in the ongoing training process and required numbers increased if needed to achieve competence of each trainee.
[a]Essential information of practical clinical importance only (lectures, web-based e-learning) (modified from the reference 1).
[b]Pattern recognition by online teaching with self-evaluation or reading with experts.
[c]At least one case in each category must be performed by the trainee under direct expert supervision; the rest of the cases trainee can perform unsupervised, but the images and reports must be reviewed together with the supervisor.
LUS, lung ultrasound; LV, left ventricular; RV, right ventricular.

**Table 3 Suggested targets of FoCUS examination and related emergency cardiovascular scenarios/conditions that might be addressed**

| |
|---|
| Targets |
| Global LV systolic function and size |
| Global RV systolic function and size |
| Pericardial effusion, tamponade physiology[a] |
| Intravascular volume assessment |
| Gross signs of chronic cardiac disease[b] |
| Gross valvular abnormalities[c] |
| Large intracardiac masses[d] |
| Scenarios |
| Circulatory compromise/shock |
| Cardiac arrest |
| Chest pain/dyspnoea[e] |
| Chest/Cardiac trauma |
| Respiratory compromise |
| Syncope/presyncope |
| Conditions |
| Ischaemic LV/RV dysfunction |
| Mechanical post-MI complications |
| Cardiomyopathies (i.e. DCM, HCM, Takotsubo) |
| Myocarditis |
| Cardiac tamponade |
| Pulmonary embolism |
| Hypovolaemia/shock |

Modified from references 3 and 32.
[a]Based on detection of 2D signs of compression of right-sided chambers (systolic collapse of the right atrium, diastolic collapse of the right ventricle) rather than Doppler-based study of intracardiac flows.
[b]Major LV dilatation or severe hypertrophy, right ventricular hypertrophy, major atrial dilatation.
[c]Recognizable by FoCUS without the use of Doppler-based techniques (e.g. massive disruption or marked thickening of leaflets, flail, anatomic gaps).
[d]Large valve vegetations or visible intracardiac or inferior vena cava masses/thrombi.
[e]Subtle regional wall motion abnormalities as well echocardiographic signs of acute aortic syndrome are not evidence-based targets for FoCUS; therefore, despite actual FoCUS findings, all patients with chest pain and suspected acute coronary syndrome or acute aortic syndrome, should be referred as soon as possible to comprehensive echocardiography.
DCM, dilated cardiomyopathy; HCM, hypertrophic cardiomyopathy; LV, left ventricular; MI, myocardial infarction; RV, right ventricular.

all situations where it is needed, the inherent limitations of such devices must be considered. Trainees should master not only the examination technique but also the interpretation of findings and professional communication in a time-sensitive manner. This should be clearly explained during the training process and fully appreciated by both teachers and trainees.

Suggested teaching and training targets for FoCUS are listed in *Table 3*.[3,32] Studies demonstrate that identification of these basic, but critical cardiovascular conditions and pathologies by FoCUS[3,32] may beneficially modify patients management,[31,41–51] and predict outcome.[52–56] Any attempt to expand this list of teaching and training targets for FoCUS should be discouraged due to increased risk of inappropriate use and errors.[3,12,32] Thus, only a simple detection of abnormally enlarged cardiac chambers, signs of severe left and right ventricular dysfunction, large pericardial effusion, and/or extremely altered intravascular volume status, should be the part of FoCUS exam. Although trained FoCUS operators may occasionally identify gross valvular abnormalities, large intracardiac masses, or striking regional wall motion abnormalities, such patients should be referred to an expert for a comprehensive echocardiographic evaluation.[3] In all cases where a cardiac cause is suspected but FoCUS findings are negative ('normal'), patients should be immediately referred for

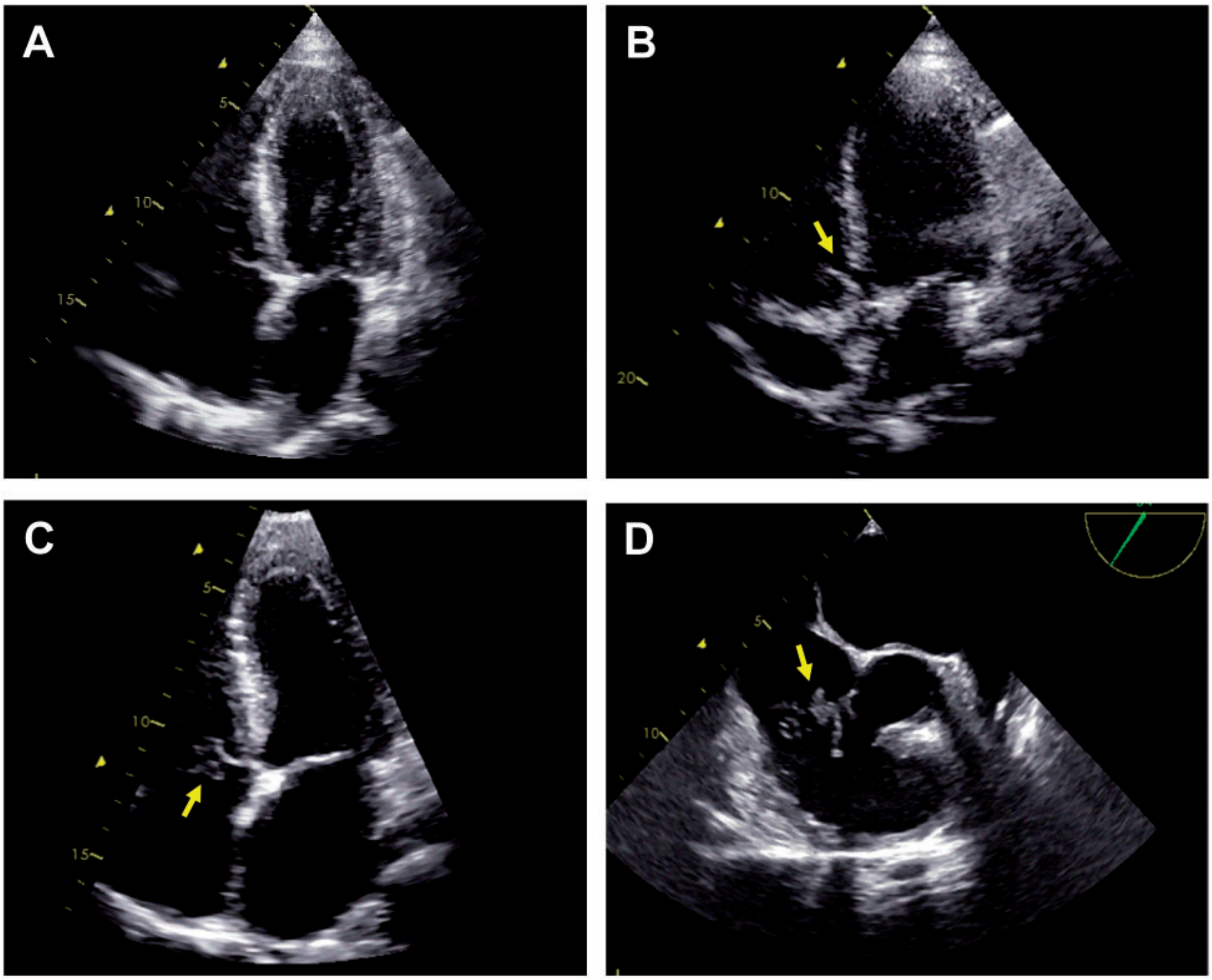


**Figure 2** The FoCUS examination by on-call physician did not reveal a potential cause of a cardiac murmur in a young febrile patient (A). Comprehensive echocardiography showed a small ventricular septal defect (B, arrow) along with suspicious tricuspid valve vegetation (C, arrow), which was confirmed by transoesophageal echocardiography (D, arrow). Apical 4-chamber view is shown in panels A, B and C.

emergency echocardiography examination to be undertaken by an echocardiographer trained to the level of independent operator (*Figure 2*).[1]

Numerous high-quality FoCUS courses and programmes are widely available. They may have different characteristics (e.g. not all have ACLS-compliance as a part of syllabus), but several commonalities. All of them aim to enable individuals to undertake a focused scan and identify basic cardiac conditions and pathologies after a short, intensive and narrowly-targeted training.[5,17,35] These courses should be considered as an introductory/starting point for education/training process, offering theoretical/didactic learning (*Table 2*, Part 1), reviews of pre-recorded cases together with experts (pattern recognition) (*Table 2*, Part 2), and initial hands-on training on live models or patients. However, we believe that in order to achieve full competence in FoCUS, it is essential that practical training is extended to post-course proctored ultrasound examinations in real-life scenarios according to these requirements (*Table 2*, Part 3). Although it seems unlikely that strictly predefined minimal number of hours of hands-on image acquisition training, or the number of performed/interpreted cases would ever fit all,[3,6,7,17–27] the EACVI proposes minimal requirements that, if fulfilled, should result in competence in performing FoCUS by the vast majority of trainees (*Table 2*). Competency evaluation should be incorporated into the ongoing training process and, if needed, the proposed numbers in *Table 2* may be increased to achieve full competence in FoCUS in all trainees.[3]

Examination technique should be learned first on virtual echocardiography simulators, live models or stable elective patients, and then mastered in real-life clinical scenarios where FoCUS is typically performed. For training, not only fully equipped echocardiographic machines, but also portable and pocket-size imaging devices should be used.[3,7] Initially, scanning should be performed under direct proctored supervision. Later, this can be partially replaced with supervised review of recorded material and reports. Every attempt should be made to expose trainees to a case mix that includes a wide range of clinical scenarios/conditions that might be addressed by FoCUS.[3]

LUS is a logical companion of FoCUS in everyday clinical practice since it may help in the differential diagnosis of acute dyspnoea and hemodynamic instability.[57–60] Thus, detection of B-lines ('lung comets') (*Figure 3*) and pleural effusion is encompassed in the FoCUS core curriculum.

There are not many situations in medicine with such a vital need for accurate extra information to be used for guiding life-saving patient management as it occurs in cardiac arrest and in the peri-arrest setting. It has been shown that in this scenario, FoCUS is more accurate than ECG and physical examination for determining mechanical cardiac function and diagnosing the cause of cardiac arrest.[32] FoCUS may also detect the lack of mechanical activity in pulseless electrical activity, direct management change, and improve the clinical ability to predict outcome.[32] It is essential, however, that brief FoCUS assessment is fully integrated into ACLS algorithm in a time-sensitive manner, without interruption of chest compressions (i.e. every 2 min, within the pulse-check time, ideally from the subcostal view—at least as a start).[30,61,62] There is an evidence that even highly-experienced echocardiographers require specific training in this regard.[30,31,61–64]

Trainees should be taught to record and store FoCUS examinations whenever possible and to issue the reports in a timely manner.[3] Stored data can then be used for documentation, case reviews and consultations, but also for quality control and medico-legal purposes.[3]

Trainees should be advised to never consider or report FoCUS as a standard echocardiographic examination, to always specify in the report the clinical setting and the indication for examination, and to ensure that they practice within the defined governance structures of their institution.[2]

Trainers (proctors) and supervisors can be practitioners with cardiology, intensive care, anaesthesiology or emergency medicine background, either fully trained and preferably certified in echocardiography by national or international authorities (i.e. EACVI), or fully trained in FoCUS, with significant experience in emergency and/or critical care.

# Core syllabus

The FoCUS Core Syllabus of the EACVI describes the fundamental knowledge required for the accurate practice of FoCUS and provides a framework for FoCUS education and training. Additionally, it represents part of the recently updated Echocardiography Core Syllabus of the EACVI,[37,38] modified according to the restricted scope of FoCUS and in line with existing documents proposed by respective specialty societies/associations/organizations already engaged in FoCUS education and training.[17,32,65]

It is strongly recommended that all FoCUS practitioners undertake specific training in the use of FoCUS as a part of ACLS algorithm (i.e. Focus Assessed Transthoracic Echocardiography—FATE,[5] Focused Echocardiography in Emergency Life Support—FEEL,[66] or similar), in order to achieve necessary proficiency.

It should be recognized that all individuals who have undergone full training in echocardiography and/or have successfully passed the EACVI certification process may be considered able to perform FoCUS in a competent way, with three provisions. First, that they are familiar with FoCUS scope, approach and Core Curriculum. Second, that they have completed additional training in basic LUS. Third, that they have undertaken specific training in the use of FoCUS as a part of ACLS algorithm, with a focus on the expected pathologies, communication of findings to the resuscitation team, and ACLS compliance.

# Focus Cardiac Ultrasound (FoCUS) Core Syllabus of the European Association of Cardiovascular Imaging 2018

Based/Modified/According to:

(1) Cosyns B, Garbi M, Separovic J, Pasquet A, Lancellotti P. Education Committee of the European Association of Cardiovascular Imaging

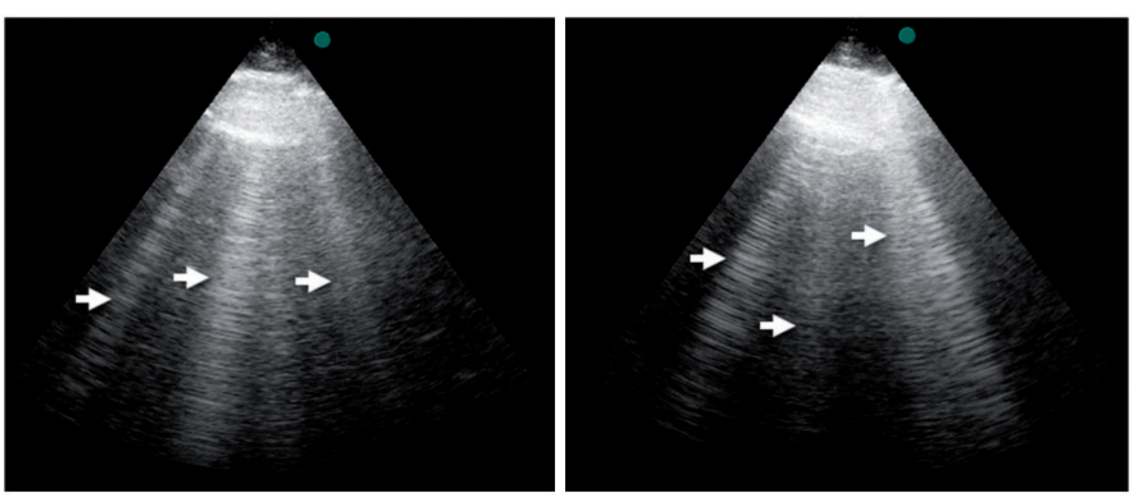

**Figure 3** Lung ultrasound in a patient with incipient pulmonary oedema showing multiple, bilateral vertical white lines (B-lines, arrows) consistent with extravascular lung water. Left panel: left lung; right panel: right lung.

Association (EACVI). Update of the echocardiography core syllabus of the European Association of Cardiovascular Imaging (EACVI). Eur Heart J Cardiovasc Imaging 2013;14:837–9.
(2) Via G, Hussain A, Wells M, Reardon R, El Barbary M, Noble VE, et al.; International Liaison Committee on Focused Cardiac UltraSound (ILC-FoCUS); International Conference on Focused Cardiac UltraSound (IC-FoCUS). International evidence-based recommendations for focused cardiac ultrasound. J Am Soc Echocardiogr. 2014 Jul;27(7):683.e1–e33. (Supplement: BASIC ECHO (WBE) Focused Cardiac Ultrasound Competence-based CURRICULUM)
(3) Core Ultrasound Intensive Care (CUSIC) Accreditation pack
(4) Focused Echocardiography in Emergency Life Support (FEEL). Resuscitation Council (UK) https://www.resus.org.uk/information-on-courses/focused-echocardiography-in-emergency-life-support/ (28 January 2018, date last accessed).
(5) Breitkreutz R, Walcher F, Seeger FH. Focused echocardiographic evaluation in resuscitation management: concept of an advanced life support-conformed algorithm. Crit Care Med. 2007;35(5 Suppl):S150-61.
(6) Price S, Via G, Sloth E, Guarracino F, Breitkreutz R, Catena E, et al. World Interactive Network Focused On Critical UltraSound ECHO-ICU Group. Echocardiography practice, training and accreditation in the intensive care: document for the World Interactive Network Focused on Critical Ultrasound (WINFOCUS). Cardiovasc Ultrasound. 2008;6:49. doi:10.1186/1476-7120-6-49.
(7) Fletcher SN, Grounds RM. Critical care echocardiography: cleared for take up. BJ Anaesth 2012;109:440–2.
(8) Jensen MB, Sloth E, Larsen KM, Schmidt MB. Transthoracic echocardiography for cardiopulmonary monitoring in intensive care. Eur J Anaesthesiol 2004;21:700–7.
(9) Focused Intensive Care Echo (FICE), http://www.ics.ac.uk/ICS/fice.aspx (28 January 2018, date last accessed).

I. General principles of Focus Cardiac Ultrasound (FoCUS)
- (1) Scientific background supporting the use of FoCUS
- (2) Differences between FoCUS and comprehensive echocardiography
- (3) Indications for FoCUS
  - ☐ Targets
    - Global LV systolic function
    - Global right ventricle (RV) systolic function
    - Pericardial effusion, tamponade physiology
    - Intravascular volume assessment and fluid responsiveness
    - Signs of pre-existing cardiac disease (marked ventricular dilatation or hypertrophy, atrial dilatation)
    - Gross valvular abnormalities
    - Large intracardiac masses
  - ☐ Scenarios
    - Circulatory compromise/shock
    - Cardiac arrest/peri-arrest
    - Chest pain/Dyspnoea
    - Chest/cardiac trauma
    - Respiratory compromise
    - Presyncope/Presyncope
- (4) Limitations of FoCUS (compared to comprehensive echocardiography)
  - ☐ Inferiority of the imaging devices typically used for FoCUS examination
  - ☐ Narrow list of detectable evidence-based targets
  - ☐ Limited data set due to restricted image acquisition protocol
  - ☐ Typically unfavourable settings (emergencies, critically ill, time constrains)
  - ☐ 'Absent/Present' or 'Yes/No' reporting style
  - ☐ Subtle/Complex cardiac abnormalities difficult to assess

II. Basic ultrasound instrumentation and knobology
- (1) Digital ultrasound machines
  - ☐ High-end ultrasound systems
  - ☐ Portable ultrasound machines
  - ☐ Pocket-size ultrasound devices
- (2) Image display, analysis, and storage
  - ☐ Pixels—effect on image resolution
  - ☐ Display devices—digital monitors, flat screen
  - ☐ Display controls—brightness, contrast
  - ☐ Off-line image analysis/reporting
  - ☐ Storage—temporary/permanent
- (3) Probes suitable for FoCUS and their differences
  - ☐ Transthoracic cardiac phased-array transducer is the preferred probe for FoCUS
  - ☐ Microconvex and abdominal transducers are not ideal for FoCUS, although their use may be considered when no other probes are available
  - ☐ Vascular linear probes are not suitable for FoCUS
- (4) Setting up the ultrasound machine
  - ☐ Default settings
    - Cardiac/non-cardiac (abdominal, obstetrics/gynaecology, vascular) presets
  - ☐ Frequency
    - The relation between the frequency, image quality and penetration
  - ☐ Depth
  - ☐ Sector width
  - ☐ Gain
    - Overall gain and image brightness
    - Choosing gain in different imaging environments
  - ☐ Time-gain compensation
    - Changing the brightness in different regions of the image
  - ☐ Focus
    - Positioning the focus point
    - Dual- and multi-focal imaging
  - ☐ Frame rate
    - Temporal versus lateral resolution
  - ☐ Zoom
  - ☐ Acoustic power
    - Definition
    - The trade-off between improved image quality and the risk of biological effects
  - ☐ Harmonic vs. fundamental imaging
    - Definition
    - Image quality vs. image resolution
  - ☐ Machine settings affecting spatial (axial and lateral) resolution
  - ☐ Machine settings affecting temporal resolution

III. Anatomy and physiology of the heart and great vessels
- (1) Left ventricle
  - ☐ Dimensions
  - ☐ Wall thickness

- ☐ Global LV systolic function
- ☐ Gross regional wall motion abnormalities

(2) RV
- ☐ Dimensions
- ☐ Global RV systolic function
- ☐ Echo findings of RV volume/pressure overload
- ☐ Moderator band

(3) Left atrium
- ☐ Dimensions

(4) Right atrium
- ☐ Dimensions

(5) Interventricular septum—morphology and motion [i.e septal flattening in the short-axis (SAX) view]

(6) Interatrial septum—morphology and motion (i.e. septal bowing to the left or right)

(7) Inferior vena cava (IVC)
- ☐ Dimensions (end expiration)
- ☐ Collapsibility on inspiration (spontaneous breathing)
- ☐ Distensibility at inspiration (mechanical ventilation)

(8) Great vessels
- ☐ Aorta
  - Ascending aorta
- ☐ Pulmonary artery

(9) Mitral valve apparatus
- ☐ Leaflets (anterior, posterior), commisures
- ☐ Chordae tendineae
- ☐ Annulus
- ☐ Papillary muscles

(10) Aortic valve
- ☐ Cusps, commissures, annulus

(11) Tricuspid valve
- ☐ Leaflets (anterior, septal, posterior)

(12) Pulmonary valve

(13) Pericardium
- ☐ epicardial fat (vs. pericardial effusion)

IV. The FoCUS exam

(1) Image acquisition principles
- ☐ Technical considerations
  - Appropriate use of equipment controls
  - Recognition of technical artefacts
  - Recognition of setup errors

(2) Standard FoCUS scanning
- ☐ ECG monitoring (whenever possible)
- ☐ Respiratory cycle monitoring (constriction, tamponade)
- ☐ Standard FoCUS windows/2D views
  - Parasternal
    - ○ Long-axis (LAX) view of the LV
    - ○ SAX view of the LV (at the level of the papillary muscles)
  - Apical
    - ○ 4-chamber view (4CH)
  - Subcostal
    - ○ IVC view
    - ○ Subcostal 4CH view

(3) Principles of echo measurements
- ☐ Timing (end-diastole/end-systole)
- ☐ 2D echo (current recommendations)
  - 2D still end-diastolic/end-systolic frame
- ☐ M-mode—only if it is feasible to align cursor perpendicular to the measured structure
- ☐ Pitfalls and limitations
  - Image quality, drop-outs, poor cavity outline
  - Worse border delineation on frozen frames vs. moving 2D image
  - Poor RV borders delineation, including IVS right side border

V. Targets of the FoCUS exam

(1) Screening for signs of chronic pre-existing cardiac disease
Qualitative (eye-balling) assessment of heart chamber size and size variation (relevant LA and LV dilatation, marked LV hypertrophy, RA dilatation, RV dilatation with hypertrophy, relevant valve calcifications)

(2) Global LV systolic function
1. FoCUS measures of global LV systolic function
   - ☐ Visual ejection fraction
   - ☐ Visual fractional area change (mid-papillary SAX view)
2. Conditions requiring caution in global LV systolic function interpretation (afterload and preload dependence)
   - ☐ Bradycardia and tachycardia
   - ☐ Severe hypotension and hypertension
   - ☐ Mitral/aortic regurgitation
   - ☐ Aortic stenosis/severe hypertrophy
   - ☐ Mitral stenosis
   - ☐ Ventricular septal defect
   - ☐ Severe anaemia, hyperthyroidism, other hyperdynamic states (sepsis)
   - ☐ LV underfilling
   - ☐ Inotropes
3. Regional LV systolic function
   - ☐ Myocardial segmentation and coronary territories of distribution
   - ☐ Wall motion analysis—gross wall motion abnormalities
   - ☐ Qualitative
     - Endocardial motion with concomitant myocardial thickening
     - Hyperkinesis, Normokinesis, Hypokinesis, Akinesis, Dyskinesis
     - Scar recognition (wall thinning, hyperechogenicity)
   - ☐ Awareness of limitations related to limited scanning views and expertise
   - ☐ Awareness of need for referral to comprehensive echocardiography in patients with detected/suspected abnormalities

(3) Basic assessment of global RV systolic function
1. Visual estimation of global RV ejection fraction
   - ☐ Hallmarks of RV failure
     - dilatation
     - free wall hypokinesia
     - septal dyskinesia/flattening
2. Acute vs. chronic cor pulmonale
   - ☐ morphological clues towards chronic pulmonary hypertension (marked RV hypertrophy, RV dilatation)

(4) Assessment of volume status
1. Severe hypovolemia and volume responsiveness
   - ☐ Rationale for the use of FoCUS to assess volume status
   - ☐ Echocardiographic features of severe hypovolemia
     - small, hyperkinetic LV (visual assessment)
     - small, hyperkinetic RV (visual assessment)
     - small IVC (<12 mm)
   - ☐ Effect of positive pressure mechanical ventilation on IVC size

- ☐ Expected changes of IVC and LV size upon volume status manipulation
  - 2D indices of volume responsiveness
  - 2D dynamic indices of volume responsiveness: IVC collapsibility, IVC distensibility
  - criteria of applicability of dynamic indices of volume responsiveness
- ☐ Vasodilation vs. hypovolaemia.
  - In both cases end-systolic area will be small. In case of vasodilation, end-diastolic area will be either normal or only slightly reduced. In case of *hypovolemia*, end-diastolic area will be much reduced.
- ☐ Challenging situations for volume status assessment
  - Non-passive mechanical ventilation
  - Concurrent cardiac disease (arrhythmia, valve disease, acute RV myocardial infarction, chronic cor pulmonale, dilated cardiomyopathy)

2. Volume overload
   - ☐ FoCUS features of systemic venous congestion
   - ☐ Interpretation of a systemic venous congestion IVC pattern
   - ☐ Interatrial septum position

(5) Assessment of pericardial effusion and cardiac tamponade

1. Pericardial effusion
   - ☐ Diagnosis of pericardial effusion
   - ☐ Differential diagnosis
     - Pericardial effusion vs. pleural effusion
     - Pericardial effusion vs. epicardial fat
     - Pericardial effusion vs. hematoma/clot
   - ☐ Semi-quantitation of pericardial fluid
2. 2D signs of cardiac tamponade
   - ☐ Irrelevance of effusion amount for the diagnosis of tamponade
   - ☐ Echocardiographic signs supporting the diagnosis of (impending) cardiac tamponade (heart chambers compression, systemic venous congestion):
     - RA systolic collapse
     - RV diastolic collapse
     - LA collapse (rare)
     - IVC plethora
     - Swinging heart
   - ☐ Cardiac tamponade despite no detectable echocardiographic features (clinical basis of tamponade diagnosis)
   - ☐ Localized collections—pericardial hematoma (after cardiac surgery, interventional cardiology procedures)—cannot be ruled out by FoCUS!

(6) Gross assessment of heart valves

1. Goals and limitations of cardiac ultrasound valves assessment by FoCUS
   - ☐ FoCUS aim: trigger formal comprehensive echocardiography once gross heart valve abnormalities are suspected
2. Mitral valve
   - ☐ Normal mitral valve morphology and function
     - thin leaflets, complete opening, complete closure at annulus level
   - ☐ Mitral valve findings associated with severe dysfunction:
     - morphological (marked leaflet thickening, calcifications, masses, 'holes')
     - functional (hypermobility, hypomobility)
   - ☐ Clues towards chronic mitral valve disease
     - marked calcifications, LA enlargement, LV enlargement, RV dilatation and hypertrophy
3. Aortic valve
   - ☐ Normal aortic valve morphology and function
     - Thin leaflets, complete opening, complete closure at annulus level
   - ☐ Aortic valve findings associated with severe dysfunction:
     - Morphological (marked cusps thickening, calcifications, masses, 'holes')
     - Functional [(hypermobility, hypomobility, prolapse into left ventricular outflow tract (LVOT)]
   - ☐ Clues towards chronic aortic valve disease
     - marked calcifications, LV Hypertrophy, LV dilation, LA enlargement

(7) Large intracardiac masses

- ☐ Large valve vegetations or visible intracardiac or inferior vena cava masses/thrombi
- ☐ FoCUS aim: with the exception of right heart thrombus suspected in the context of cardiac arrest, detection of masses should trigger formal comprehensive echocardiography

VI. FoCUS in cardiac arrest and peri-arrest

(1) Rationale and indications of the use of FoCUS in cardiac arrest and peri-arrest scenarios (non-shockable rhythms)

(2) Specific goals of the use of FoCUS in cardiac arrest (differentiation of electro-mechanical dissociation ('True PEA') from organized mechanical contraction with no pulse ('Pseudo-PEA'), early detection of return of spontaneous circulation, identification of potentially treatable causes)

(3) PEA conditions detectable with FoCUS in cardiac arrest (mechanical causes of PEA: severe hypovolemia, massive pulmonary embolism, cardiac tamponade, dramatic LV dysfunction, pneumothorax)

(4) Asystole confirmation (cardiac standstill)

(5) The FEEL protocol

- ☐ Advanced cardiovascular life support (ACLS) compliance of FoCUS in cardiac arrest
- ☐ The FEEL protocol [cardiopulmonary resuscitation (CPR) and preparation, execution, CPR resumption, interpretation, and management]

VII. FoCUS in shock and/or dyspnoea

(1) FoCUS patterns in shock

- ☐ Acute LV failure
- ☐ Acute RV failure
- ☐ Acute biventricular failure
- ☐ Hypovolemia/vasodilatation
- ☐ Cardiac tamponade
- ☐ Suspected acute valve disease

(2) Interpretation of FoCUS findings in clinical context

(3) Immediate referral for comprehensive echocardiography in situations going beyond FoCUS diagnostic capability

- ☐ Doubtful/inconclusive findings
- ☐ Acute chest pain—suspected acute coronary syndrome
- ☐ Suspected acute aortic syndrome
- ☐ Chronic heart disease
- ☐ Suspected valve disease
- ☐ Findings not matching with the clinical context

(4) Simplified FoCUS reporting

(5) Wet lungs pattern—multiple, diffuse bilateral B-lines (lung 'comets') by LUS

VIII. Lung ultrasound (LUS)

(1) Pleural effusion

- ☐ Ultrasound appearances of pleural fluid

☐ Assessment of size of effusion
☐ Distinguishing between pleural, pericardial and abdominal fluid collection

(2) Wet lungs pattern (B-lines—lung ‘comets’)
☐ Recognition of interstitial syndrome
- Recognition of B-lines
- Differentiating between physiological and pathological B-lines (multiple, diffuse, bilateral B-lines)

IX. Acknowledged competence in FoCUS after completion of training process

(1) Understanding of basic instrumentation of ultrasound machines
(2) Optimization of depth, sector width, zoom, frequency, harmonics, focus, overall gain, sectorial gain, reject, compression, dynamic range, m-mode sweep speed
(3) Ability to obtain 2D FoCUS scan views
(4) Ability to recognize basic ultrasound anatomy of heart chambers, valves, great vessels and pericardium
(5) Application of M-Mode on LV [parasternal long-axis veiw (PLAX) or parasternal short axis view (PSAX)] and IVC (subcostal inferior vena cava (SIVC) view]
(6) Correct qualitative assessment of the size of LV, RV, LA, RA (screening for signs of chronic cardiac disease: LV dilatation/hypertrophy, LA dilatation, RV dilatation/hypertrophy, RA dilatation)
(7) Correct linear measure of RV free wall thickness (for detection of signs of chronic RV disease—chronic cor pulmonale)
(8) Correct linear measure of heart chambers size
(9) Digital storage of images and clips and digital archive management
(10) Ability to differentiate normal from abnormal global LV systolic function
(11) Ability to detect large wall motion abnormalities
(12) Understanding of potential causes of a global and regional wall motion abnormalities
(13) Ability to appreciate dynamic changes of LV systolic function (improvement, deterioration) due to evolution of the disease and/or effects of treatment
(14) Differentiation of normal from abnormal RV systolic function
(15) Understanding of potential causes of RV failure
(16) Ability to appreciate dynamic changes of RV systolic function (improvement, deterioration) due to evolution of the disease and/or effects of treatment
(17) Visual estimation of LV size (PSAX, subcostal short axis views)
(18) Visual estimation of IVC size (SIVC view)
(19) Measurement of IVC size (SIVC view)
(20) Recognition of the ‘classical’ hypovolemic profile in the spontaneously breathing patient (hyperdynamic LV and RV, small IVC)
(21) Recognition of the ‘classical’ hypovolemic profile in the mechanically ventilated patient (hyperdynamic LV and RV, small IVC)
(22) Measurement of IVC collapsibility index (SIVC view—2D and M-Mode)
(23) Measurement of IVC distensibility index (SIVC view—2D and M-Mode)
(24) Correct interpretation of IVC findings in light of ongoing mechanical ventilation and potential concurrent cardiac disease
(25) Recognition for the need of volume responsiveness assessment tools other than FoCUS
(26) Understanding of potential causes of hypovolemia and systemic venous congestion
(27) Ability to visually appreciate LV size and IVC variations upon volume status manipulations
(28) Understanding of potential causes of vasodilation and differential diagnosis of vasodilatation vs. hypovolemia
(29) Detection of pericardial effusion, assessment of its echogenicity (fluid vs. clot/hematoma), amount estimation
(30) Differentiation of pericardial effusion from pericardial fat pad and pleural effusion
(31) Recognition of RA systolic collapse (A4CH and S4CH views), RV diastolic collapse [PLAX, A4CH and subcostal four chamber (S4CH) views] and LA systolic collapse (PLAX and A4CH views)
(32) Recognition of tamponade effects on IVC
(33) Clinical diagnosis of tamponade; recognition of confounding factors potentially sustaining a diagnosis of tamponade despite no clear echo features (post-surgical setting, pulmonary hypertension, RV failure, RV hypertrophy)
(34) Indication to pericardiocentesis
(35) Visualization of the mitral valve in more than one plane (PLAX, apical 4CH)
(36) Recognition of 2D signs potentially associated with severe mitral regurgitation (e.g. flail, prolapse, masses, missed coaptation, disruption)
(37) Recognition of 2D signs potentially associated with severe mitral stenosis (e.g. marked thickening, diastolic hypomobility, LA enlargement)
(38) Visualization of the aortic valve (PLAX)
(39) Recognition of 2D signs potentially associated with severe aortic regurgitation (e.g. cusp prolapse into LVOT, missed coaptation, masses, disruption)
(40) Recognition of 2D signs potentially associated with severe aortic stenosis (e.g. marked cusps thickening and/or calcifications, systolic hypomobility, LV hypertrophy)
(41) Understanding of potential causes of severe mitral disease (post-infarction papillary muscle rupture, acute endocarditis, severe regurgitation/stenosis in the setting of chronic valve disease)
(42) Understanding of potential causes of severe aortic disease (acute endocarditis, severe stenosis/regurgitation in the setting of chronic valve disease)
(43) Appropriately referring the patient with suspected valve disease to comprehensive echocardiographic assessment
(44) Application of FoCUS in cardiac arrest according to correct indication (non-shockable rhythms) along with execution of CPR according to ACLS guidelines
(45) Recognition of FoCUS findings of PEA (cardiac standstill)
(46) Correct preparation of FoCUS for FEEL
(47) Timely execution of FoCUS in cardiac arrest (after minimum 5 CPR cycles, within the pulse check time, anticipated conclusion when required)
(48) Correct execution of FoCUS in cardiac arrest (subcostal view first, video clips acquisition and storage)
(49) Appropriate interaction and communication with ACLS team during FoCUS examination in cardiac arrest
(50) Appropriate action plan generation upon FoCUS findings in cardiac arrest and simplified FoCUS reporting (delayed)

(51) Approaching shock (and dyspnoea) systematically: recognition of tamponade, LV failure, RV failure, biventricular failure, hypovolemia, severe (acute) valve disease, wet lungs
(52) Integration of FoCUS findings with available clinical, biochemical and other findings in order to detect the cause of shock/dyspnoea (tamponade, hypovolemia, cardiomyopathy, acute myocardial infarction, acute pulmonary embolism, sepsis, adult respiratory distress syndrome, severe (acute) valve disease, myocarditis, toxins, post-cardiac arrest, acute aortic syndrome, trauma)
(53) Acknowledgement of the need for a comprehensive echocardiography/second opinion in shock patient
(54) Acknowledgement of the need for a comprehensive echocardiography in patient with acute chest pain and suspected acute aortic syndrome or acute coronary syndrome
(55) Appropriate action plan generation upon FoCUS findings in shock/dyspnoea and simplified FoCUS reporting
(56) LUS diagnosis of pleural effusion
(57) LUS diagnosis of pulmonary oedema (wet lung pattern)
(58) Understanding of potential role of FoCUS in cardiac arrest, shock and dyspnoea
(59) Full understanding of limitations of FoCUS and the need for referral to comprehensive echocardiographic examination.
(60) Understanding and full acceptance of the role of supervision and team work

# Core Syllabus Abbreviations list

4CH, four chamber (view)
2D, two-dimensional
A4CH, apical four chamber (view)
ACLS, Advanced Cardiovascular Life Support
ARDS, adult respiratory distress syndrome
CPR, cardiopulmonary resuscitation
FAC, fractional area change
FEEL, Focused Echocardiography in Emergency Life Support
FoCUS, focused cardiac ultrasound
IVC, inferior vena cava
LA, left atrium
LAX, long-axis (view)
LV, left ventricle
LUS, lung ultrasound
EF, ejection fraction
LVOT, left ventricular outflow tract
PEA, pulsless electrical activity
PLAX, parasternal long axis (view)
PSAX, parasternal short axis (view)
RA, right atrium
ROSC, return of spontaneous circulation
RV, right ventricle
S4CH, subcostal four chamber (view)
SAX, short axis (view)
SSAX, subcostal short axis (view)
SIVC, subcostal inferior vena cava (view)

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## References

1. Neskovic AN, Hagendorff A, Lancellotti P, Guarracino F, Varga A, Cosyns B. Emergency echocardiography: the European Association of Cardiovascular Imaging recommendations. *Eur Heart J Cardiovasc Imaging* 2013;**14**:1–11.
2. Lancellotti P, Price S, Edvardsen T, Cosyns B, Neskovic AN, Dulgheru R *et al.* The use of echocardiography in acute cardiovascular care: recommendations of the European Association of Cardiovascular Imaging (EACVI) and the Acute Cardiovascular Care Association (ACCA). *Eur Heart J* 2015;**4**:3–5.
3. Neskovic AN, Edvardsen T, Galderisi M, Garbi M, Gullace G, Jurcut R *et al.* Focus cardiac ultrasound: the European Association of Cardiovascular Imaging viewpoint. *Eur Heart J Cardiovasc Imaging* 2014;**15**:956–60.
4. Steeds RP, Garbi M, Cardim N, Kasprzak JD, Sade E, Nihoyannopoulos P *et al.* EACVI appropriateness criteria for the use of transthoracic echocardiography in adults: a report of literature and current practice review. *Eur Heart J Cardiovasc Imaging* 2017; doi:10.1093/ehjci/jew333.
5. Jensen MB, Sloth E, Larsen KM, Schmidt MB. Transthoracic echocardiography for cardiopulmonary monitoring in intensive care. *Eur J Anaesthesiol* 2004;**21**:700–7.
6. Labovitz AJ, Noble VE, Bierig M, Goldstein SA, Jones R, Kort S *et al.* Focused cardiac ultrasound in the emergent setting: a consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. *J Am Soc Echocardiogr* 2010;**23**:1225–30.
7. Spencer KT, Kimura BJ, Korcarz CE, Pellikka PA, Rahko PS, Siegel RJ. Focused cardiac ultrasound: recommendations from the American Society of Echocardiography. *J Am Soc Echocardiogr* 2013;**26**:567–81.
8. Sicari R, Galderisi M, Voigt J-U, Habib G, Zamorano JL, Lancellotti P *et al.* The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography. *Eur J Echocardiogr* 2011;**12**:85–7.
9. Galderisi M, Santoro A, Versiero M, Lomoriello VS, Esposito R, Raia R *et al.* Improved cardiovascular diagnostic accuracy by pocket size imaging device in non-cardiologic outpatients: the NaUSiCa (Naples Ultrasound Stethoscope in Cardiology) study. *Cardiovasc Ultrasound* 2010;**26**:51.
10. Prinz C, Voigt JU. Diagnostic accuracy of a hand-held ultrasound scanner in routine patients referred for echocardiography. *J Am Soc Echocardiogr* 2011;**24**:111–6.
11. Andersen GN, Haugen BO, Graven T, Salvesen O, Mjølstad OC, Dalen H. Feasibility and reliability of point-of-care pocket-sized echocardiography. *Eur J Echocardiogr* 2011;**12**:665–70.
12. Mjølstad OC, Andersen GN, Dalen H, Graven T, Skjetne K, Kleinau JO *et al.* Feasibility and reliability of point-of-care pocket-size echocardiography performed by medical residents. *Eur Heart J Cardiovasc Imaging* 2013;**14**:1195–202.
13. Esposito R, Ilardi F, Schiano Lomoriello V, Sorrentino R, Sellitto V, Giugliano G *et al.* Identification of the main determinants of abdominal aorta size: a screening by Pocket Size Imaging Device. *Cardiovasc Ultrasound* 2017;**15**:2.
14. Scholten C, Rosenhek R, Binder T, Zehetgruber M, Maurer G, Baumgartner H. Hand-held miniaturized cardiac ultrasound instruments for rapid and effective bedside diagnosis and patient screening. *J Eval Clin Pract* 2005;**11**:67–72.
15. Liebo MJ, Israel RL, Lillie EO, Smith MR, Rubenson DS, Topol EJ. Is pocket mobile echocardiography the next-generation stethoscope? A cross-sectional comparison of rapidly acquired images with standard transthoracic echocardiography. *Ann Intern Med* 2011;**155**:33–8.
16. Liu SC, Chang WT, Huang CH, Weng TI, Ma Matthew HM, Chen WJ. The value of portable ultrasound for evaluation of cardiomegaly patients presenting at the emergency department. *Resuscitation* 2005;**64**:327–31.
17. Price S, Via G, Sloth E, Guarracino F, Breitkreutz R, Catena E *et al.*; World Interactive Network Focused On Critical UltraSound ECHO-ICU Group. Echocardiography practice, training and accreditation in the intensive care: document for the World Interactive Network Focused on Critical Ultrasound (WINFOCUS). *Cardiovasc Ultrasound* 2008;**6**:49.
18. Mayo PH, Beaulieu Y, Doelken P, Feller-Kopman D, Harrod C, Kaplan A *et al.* American College of Chest Physicians/La Societe de Reanimation de Langue Francaise statement on competence in critical care ultrasonography. *Chest* 2009;**135**:1050–60.
19. American College of Emergency Physicians. *Emergency Ultrasound Guidelines* 2008. http://www.acep.org (10 March 2017, date last accessed).
20. Hellmann DB, Whiting-O'keefe Q, Shapiro EP, Martin LD, Martire C, Ziegelstein RC. The rate at which residents learn to use hand-held echocardiography at the bedside. *Am J Med* 2005;**118**:1010–8.
21. Vignon P, Mücke F, Bellec F, Marin B, Croce J, Brouqui T *et al.* Basic critical care echocardiography: validation of a curriculum dedicated to noncardiologist residents. *Crit Care Med* 2011;**39**:636–42.
22. Jones AE, Tayal VS, Kline JA. Focused training of emergency medicine residents in goal-directed echocardiography: a prospective study. *Acad Emergency Med* 2003;**10**:1054–8.
23. Martin LD, Howell EE, Ziegelstein RC, Martire C, Shapiro EP, Hellmann DB. Hospitalist performance of cardiac hand-carried ultrasound after focused training. *Am J Med* 2007;**120**:1000–4.

24. Royse CF, Seah JL, Donelan L, Royse AG. Point of care ultrasound for basic haemodynamic assessment: novice compared with an expert operator. *Anaesthesia* 2006;**61**:849–55.
25. Mayo PH. Training in critical care echocardiography. *Ann Intensive Care* 2011;**1**:36.
26. Expert Round Table on Ultrasound in ICU. International expert statement on training standards for critical care ultrasonography. *Intensive Care Med* 2011;**37**: 1077–83.
27. Fletcher SN, Grounds RM. Critical care echocardiography: cleared for take up. *Br J Anaesth* 2012;**109**:440–2.
28. Haji DL, Ali MM, Royse A, Canty DJ, Clarke S, Royse CF. Interatrial septum motion but not Doppler assessment predicts elevated pulmonary capillary wedge pressure in patients undergoing cardiac surgery. *Anesthesiology* 2014;**121**: 719–29.
29. Alsaddique A, Royse AG, Royse CF, Mobeirek A, El Shaer F, AlBackr H *et al*. Repeated monitoring with transthoracic echocardiography and lung ultrasound after cardiac surgery: feasibility and impact on diagnosis. *J Cardiothorac Vasc Anesth* 2016;**30**:406–12.
30. Breitkreutz R, Walcher F, Seeger FH. Focused echocardiographic evaluation in resuscitation management: concept of an advanced life support-conformed algorithm. *Crit Care Med* 2007;**35**:S150–61.
31. Breitkreutz R, Price S, Steiger HV, Seeger FH, Ilper H, Ackermann H *et al*.; Emergency Ultrasound Working Group of the Johann Wolfgang Goethe-University Hospital, Frankfurt am Main Focused echocardiographic evaluation in life support and periresuscitation of emergency patients: a prospective trial. *Resuscitation* 2010;**81**:1527–33.
32. Via G, Hussain A, Wells M, Reardon R, El Barbary M, Noble VE *et al*.; International Liaison Committee on Focused Cardiac UltraSound (ILC-FoCUS). International Conference on Focused Cardiac UltraSound (IC-FoCUS). International evidence-based recommendations for focused cardiac ultrasound. *J Am Soc Echocardiogr* 2014;**27**:683.e1–683.e33.
33. Gullace G, Demicheli G, Monte I, Colonna P, Carerj S, Caso P *et al*. Reclassification of echocardiography according to the appropriateness of use, function- and competence-based profiles and application. *J Cardiovasc Echogr* 2012;**22**:91–8.
34. Gullace G, Demicheli G, Monte I, Colonna P, Carerj S, Caso P *et al*. Educational pathway, indication, quality process of the novel Echo classification according to appropriateness of use and application. *J Cardiovasc Med* 2014;**15**:674–82.
35. Price S, Ilper H, Uddin S, Steiger HV, Seeger FH, Schellhaas S *et al*. Periresuscitation echocardiography: training the novice practitioner. *Resuscitation* 2010;**81**:1534–9.
36. Popescu BA, Andrade MJ, Badano LP, Fox KF, Flachskampf FA, Lancellotti P *et al*.; On behalf of the European Association of Echocardiography. European Association of Echocardiography recommendations for training, competence, and quality improvement in echocardiography. *Eur J Echocardiogr* 2009;**10**: 893–905.
37. Update of the Echocardiography Core Syllabus of the European Association of Cardiovascular Imaging (EACVI). https://academic.oup.com/ehjcimaging/article/14/9/837/2397756/Update-of-the-Echocardiography-Core-Syllabus-of (10 March 2017, date last accessed).
38. Cosyns B, Garbi M, Separovic J, Pasquet A, Lancellotti P; Education Committee of the European Association of Cardiovascular Imaging Association (EACVI). Update of the echocardiography core syllabus of the European Association of Cardiovascular Imaging (EACVI). *Eur Heart J Cardiovasc Imaging* 2013;**14**:837–9.
39. Gillebert TC, Brooks N, Fontes-Carvalho R, Fras Z, Gueret P, Lopez-Sendon J *et al*. ESC core curriculum for the general cardiologist (2013). *Eur Heart J* 2013; **34**:2381–411.
40. Popescu BA, Stefanidis A, Nihoyannopoulos P, Fox KF, Ray S, Cardim N *et al*. Updated standards and processes for accreditation of echocardiographic laboratories from the European Association of Cardiovascular Imaging. *Eur Heart J Cardiovasc Imaging* 2014;**15**:717–27.
41. Rozycki GS, Feliciano DV, Ochsner MG, Knudson MM, Hoyt DB, Davis F *et al*. The role of ultrasound in patients with possible penetrating cardiac wounds: a prospective multicenter study. *J Trauma* 1999;**46**:543–51.
42. Mayron R, Gaudio FE, Plummer D, Asinger R, Elsperger J. Echocardiography performed by emergency physicians: impact on diagnosis and therapy. *Ann Emerg Med* 1988;**17**:150–4.
43. Tayal VS, Kline JA. Emergency echocardiography to detect pericardial effusion in patients in PEA and near-PEA states. *Resuscitation* 2003;**59**:315–8.
44. Chardoli M, Heidari F, Rabiee H, Sharif-Alhoseini M, Shokoohi H, Rahimi-Movaghar V. Echocardiography integrated ACLS protocol versus conventional cardiopulmonary resuscitation in patients with pulseless electrical activity cardiac arrest. *Chin J Traumatol* 2012;**15**:284–7.
45. Jones AE, Craddock PA, Tayal VS, Kline JA. Diagnostic accuracy of left ventricular function for identifying sepsis among emergency department patients with non-traumatic symptomatic undifferentiated hypotension. *Shock* 2005;**24**:513–7.
46. Joseph MX, Disney PJS, Da Costa R, Hutchison SJ. Transthoracic echocardiography to identify or exclude cardiac cause of shock. *Chest* 2004;**126**:1592–7.
47. Leung JM, Levine EH. Left ventricular end-systolic cavity obliteration as an estimate of intraoperative hypovolemia. *Anesthesiology* 1994;**81**:1102–9.
48. Zengin S, Al B, Genc S, Yildirim C, Ercan S, Dogan M *et al*. Role of inferior vena cava and right ventricular diameter in assessment of volume status: a comparative study: ultrasound and hypovolemia. *Am J Emerg Med* 2013;**31**:763–7.
49. Feissel M, Michard F, Faller JP, Teboul JL. The respiratory variation in inferior vena cava diameter as a guide to fluid therapy. *Intensive Care Med* 2004;**30**: 1834–7.
50. Barbier C, Loubières Y, Schmit C, Hayon J, Ricôme J-L, Jardin F *et al*. Respiratory changes in inferior vena cava diameter are helpful in predicting fluid responsiveness in ventilated septic patients. *Intensive Care Med* 2004;**30**:1740–6.
51. Moore CL, Rose GA, Tayal VS, Sullivan DM, Arrowood JA, Kline JA. Determination of left ventricular function by emergency physician echocardiography of hypotensive patients. *Acad Emergency Med* 2002;**9**:186–93.
52. Blaivas M, Fox JC. Outcome in cardiac arrest patients found to have cardiac standstill on the bedside emergency department echocardiogram. *Acad Emergency Med* 2001;**8**:616–21.
53. Salen P, O'connor R, Sierzenski P, Passarello B, Pancu D, Melanson S *et al*. Can cardiac sonography and capnography be used independently and in combination to predict resuscitation outcomes? *Acad Emergency Med* 2001;**8**:610–5.
54. Prosen G, Krizmaric M, Zavrsnik J, Grmec S. Impact of modified treatment in echocardiographically confirmed pseudo-pulseless electrical activity in out-of-hospital cardiac arrest patients with constant end-tidal carbon dioxide pressure during compression pauses. *J Int Med Res* 2010;**38**:1458–67.
55. Plummer D, Brunette D, Asinger R, Ruiz E. Emergency department echocardiography improves outcome in penetrating cardiac injury. *Ann Emerg Med* 1992;**21**:709–12.
56. Tomruk O, Erdur B, Cetin G, Ergin A, Avcil M, Kapci M. Assessment of cardiac ultrasonography in predicting outcome in adult cardiac arrest. *J Int Med Res* 2012; **40**:804–9.
57. Volpicelli G, Elbarbary M, Blaivas M, Lichtenstein DA, Mathis G, Kirkpatrick AW *et al*. International Liaison Committee on Lung Ultrasound (ILC-LUS) for the International Consensus Conference on Lung Ultrasound (ICC-LUS). International evidence-based recommendations for point-of-care lung ultrasound. *Intensive Care Med* 2012;**38**:577–91.
58. Gargani L. Lung ultrasound: a new tool for the cardiologist. *Cardiovasc Ultrasound* 2011;**9**:6.
59. Cortellaro F, Ferrari L, Molteni F, Aseni P, Velati M, Guarnieri L *et al*. Accuracy of point of care ultrasound to identify the source of infection in septic patients: a prospective study. *Intern Emerg Med* 2017;**12**:371–8.
60. Volpicelli G, Lamorte A, Tullio M, Cardinale L, Giraudo M, Stefanone V *et al*. Point-of-care multiorgan ultrasonography for the evaluation of undifferentiated hypotension in the emergency department. *Intensive Care Med* 2013;**39**:1290–8.
61. Nolan JP, Hazinski MF, Aickin R, Bhanji F, Billi JE, Callaway CW *et al*.; On behalf of the ERC Guidelines 2015 Writing Group. European Resuscitation Council guidelines for resuscitation 2015. Section 1. Executive summary. *Resuscitation* 2015;**95**:1–80.
62. Link MS, Berkow LC, Kudenchuk PJ, Halperin HR, Hess EP, Moitra VK *et al*. Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2015;**132**:S444–64.
63. Narasimhan M, Koenig SJ, Mayo PH. Advanced echocardiography for the critical care physician: Part 1. *Chest* 2014;**145**:129–34.
64. Flato UA, Paiva EF, Carballo MT, Buehler AM, Marco R, Timerman A. Echocardiography for prognostication during the resuscitation of intensive care unit patients with non-shockable rhythm cardiac arrest. *Resuscitation* 2015;**92**:1–6.
65. Neri L, Storti E, Lichtenstein D. Toward an ultrasound curriculum for critical care medicine. *Crit Care Med* 2007;**35**:S290–304.
66. Focused Echocardiography in Emergency Life Support (FEEL). Resuscitation Council (UK) https://www.resus.org.uk/information-on-courses/focused-echocardiography-in-emergency-life-support/ (28 January 2018, date last accessed).