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ORIGINAL ARTICLE

Focused echocardiography entry level: new concept of a 1-day training course

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ABSTRACT

Aim. We describe a training programme for non-specialists in focused echocardiography in the periresuscitation setting which represents an entry level in echocardiography training (©FEEL) for emergency and critical care medicine physicians.

Methods. A prospective observational study based upon the development of a periresuscitation echocardiography training programme developed for novice practitioners (N=15 courses).

Results. The programme enables novice echocardiographers to be able to perform a focused echocardiogram in an ALS-compliant manner, and interpret the findings in the context of the clinical scenario. It is based on the concept of blended learning, incorporating a combination of e-learning, web-based teaching and reading selected literature, and attendance at a course. The course comprises 4-hours of theory and 4-hours of hands-on training.

Conclusion. Periresuscitation echocardiography, performed safely, within the competence of practitioners in an ALS-compliant manner is a potentially valuable skill to be acquired by physicians caring for the critically ill, regardless of the environment in which they work, or their level of seniority. This newly-developed blended learning periresuscitation echocardiography programme (©FEEL) may serve as entry level in peri-resuscitation echocardiography for both emergency physicians and critical care practitioners.

Key words: Acute lung injury - Acute respiratory distress syndrome - Respiratory mechanics - Diagnostic techniques and procedures - Lung compliance.

In Emergency and Critical Care Medicine ultrasound can be used as a simple diagnostic tool at the patient's bedside. Indeed, point-of-care ultrasound reduces number of viable diagnoses when used on arrival in the emergency department (ED) in patients with undifferentiated hypotension.[1] Further, echocardiography may diagnose cardiac pathology in critically ill shocked patients, leading to therapeutic interventions.[2, 3]

Periresuscitation echocardiography training

Periresuscitation scenarios occur in many settings: pre-hospital, the ED/shock room, medical outreach, or the intensive care unit (ICU). Focused transthoracic echocardiography (TTE) can detect important pathology in a manner analogous to the use of the ECG in diagnosing arrhythmias.[2-4] Focused TTE in periresuscitation can identify potentially treatable causes (tamponade, myocar-

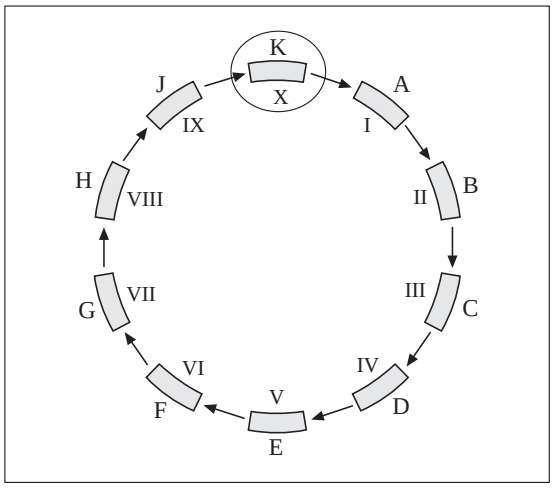

Figure 1.—Schematic view of HOT organization and rotation of groups. The details of the rotation must be planned prior to the course; participants are divided into groups with names, *e.g.* cities or wine brands or capital letters (as in Figure). Roman numbers; equate to the name of the station.

dial insufficiency in pulmonary embolism, hypovolemia and tension pneumothorax) when other techniques are more time consuming or non-diagnostic.[4] Indeed, several guidelines now suggest focused imaging as an early diagnostic step in investigation of the unstable patient,[5, 6] *e.g.* TTE in pulmonary embolism.[7]

The concept of focused emergency TTE is gaining wider acceptance,[5, 7-9] although this represents a paradigm shift in the application of echocardiography.[9] Debate continues regarding who should perform focused echocardiography in the periresuscitation setting. As emergency physicians (EPs) and critical care physicians (CCPs) are the key players in such time sensitive scenarios it is appropriate that they should receive training in periresuscitation echocardiography, however, most European training schemes to date do not include this as a core competency.[5] Training programmes for focused echocardiography are, however, emerging. Proposals may be more sophisticated, but do not provide data on the outcome or sustainability of learning.[5]

As future need for such will inevitably increase, we here describe a training programme for Focused Echocardiography (Entry Level, ©FEEL) aimed at EPs and CCPs based on the principle of blended learning.

Focused Echocardiography (Entry Level, ©FEEL)

The aim of the course is to enable novice echocardiographers to be able to perform a focused echocardiogram in an ALS-compliant manner, and interpret the findings in the context of the clinical scenario. It comprises pre-course material, a one-day course (lectures and hands-on training) followed by supervised practice under a mentor. "*Learning is not a spectator sport. Students do not learn much just by sitting in classes listening to teachers, memorizing pre-packaged assignments, and spitting out answers*".[10] Therefore, programme design employs blended learning – a combination of e-learning, web-based teaching and reading selected literature, and attendance at a course. Blended learning, in contrast to more traditional learning methods,[10-12] aims to empower and activate the trainee thereby stimulating the learning process (Figure 1). It includes problem-based approaches, increased interaction between instructors and trainees and a minimal amount of time in lecture-based teaching.[10-12]

Precourse materials

Prior to the course trainees receive the slide set and relevant references, including papers, books and echo/ultrasound websites.[13-16] In a manner similar to the ALS, a precourse quiz is included, and is returned at the time of course attendance registration and may influence trainees CME credits. For ©FEEL-UK™ it will be available through official college sites in 2009.

©FEEL course requirements

Faculty and staff

One course director plus a course organizer are mandatory, with the support of a course secretary. For hands-on training (HOT) sessions, a session organizer(s) is (are) required to time rotations and ensure trainees rotate to the correct stations, and at least one instructor is required for each station. Models and patients (*i.e.* with chronic pericardial collection/severely impaired ventricular function) are also required. In view of potential organizational issues, an additional two

TABLE I.—*Example of a Focused echocardiography entry level (©FEEL) time table from ©FEEL-UK™. For the UK format, these will be available through official UK College and society sites. Pathology related to focused echocardiographic evaluation in life support contains predominantly periresuscitation diagnoses.*

Time	Programme item
8 A.M.–8.30 A.M.	Registration
8.30 A.M – 8.45 A.M	Welcome & introduction
8.45 A.M – 9.05 A.M	Sonoanatomy including knobology
9.05 A.M – 9.45 A.M	Ventricular function and sonopathology
10.00 A.M – 10.25 A.M	Coffee
10.30 A.M – 12.40 A.M	HOT-1 – 10 stations
12.40 A.M – 1.25 P.M	Lunch
1.30 P.M – 2.00 P.M	Focused echocardiographic evaluation in life support as ALS-conformed algorithm
2.00 P.M – 4.00 P.M	HOT-2 – 10 stations including tests
4.10 P.M – 4.20 P.M	Coffee
4.20 P.M– 4.40 P.M	Echo guided-pericardiocentesis
4.40 P.M– 4.55 P.M	Pitfalls
4.55 P.M– 5.15 P.M	Local implementation and organisation
5.15 P.M – 5.30 P.M	Certificates and close

models and instructors than the maximum number of stations running at any one time should be available.

©FEEL course echocardiography machines

Echo machines should be appropriate for emergency use, be equipped with convex ultrasound probes and best with ECG cables and should equal the number of stations. Support from a number of manufacturers is advised to allow trainees experience with a range of different machines.

Materials for trainees

On the day of the course trainees receive folders with a printed timetable and a schedule for the HOT sessions. Further supplementary material *i.e.*, course evaluation forms, a reference sheet for sonoanatomy and attendance certificates are also supplied.

Course lectures

The on-site course comprises 4 hours of theory and 4 hours HOT. Theory is provided in prewritten, standard lectures, with lecture notes, each lasting a maximum of 20 minutes duration in a manner analogous to ALS (Table I). Session chairs should facilitate discussion at the end of each lecture. An informal quiz is undertaken following the lecture on "sonoanatomy". In order to enhance learning and sustainability of knowledge gain (Figure 1) case presentations are strongly encouraged (Figure 1, Table I).

Hands-on training

HOTs are organized in a rotation system, where after a defined time frame (10 to 15 minutes) trainee groups move to the next station (Figure 1A). Each station teaches different tasks (Table II). The ©FEEL HOT sessions are designed for small group teaching with a maximum of three trainees, allowing 4-5 minute teaching per trainee per station. As training progresses during the day, the duration of each session progressively shortens, and it is essential that trainees remain within their allocated group (Table III). The aims of the specific HOT sessions are shown in Table II.

ROLE OF INSTRUCTORS

Instructors receive a structured briefing before HOTs as their primary role is to act as coach, not demonstrator. Specific instructions include: 1) no more than 1 minute of demonstration; 2) guidance by verbal cues only; 3) encouragement by positive feedback; and 4) supportive interaction *e.g.* showing newly gained technical

TABLE II.— *Hands-on training (HOT) order and tasks for the ©FEEL-UK™ edition. Note modifications for HOT-2. When models are lacking, one more Laptop station (as in V) could be added. Station VII could be organized in a room with projection to visualize better for all trainees in the group. The use of an ultrasound simulator (X) depends on availability and can add optionally to the ALS-training. EmEchoSimTest™ is available in courses run by the authors to support and assess trainees learning gain in the context of periresuscitation care diagnoses. ©FEEL-D™ and ©FEEL-IT™ include optional tasks on pleural and central vessels depending on trainees' progress on cost of one station with cardiac views. ALS: advanced life support; IVC: inferior vena cava; LAX: long axis; SAX: short axis; LVEF: left ventricular ejection fraction; LV: left ventricle; RV: right ventricle.*

	Probe position	Model/Patient and position	Teaching task
Station 1st HOT			
I	Parasternal, LAX, SAX	Model, left-lateral	Anatomy, eyeballing LV
II	Apical 4 chamber view	Model, left-lateral	4-chamber-view, sonoanatomy, relation LV:RV size
III	Subcostal LAX	Model, supine	Anatomy, 4-chamber-view, atypical
IV	Subcostal SAX and IVC	Model supine	Sonoanatomy, RV, IVC, transversal and longitudinal
V	—	Laptop with projection (optional)	Identification of sonoanatomy or pathology in still images and clips
VI	Parasternal, LAX	Model, supine	Anatomy, trouble shooting
VII	Apical 4-chamber-view	Patient 2, supine beamer projection (optional)	Eyeballing LVEF, sonoanatomy
VIII	Parasternal, SAX	Model, supine	Sonoanatomy
IX	Subcostal, LAX	Model, supine	Time measurement (10 sec shots)
X	Simulated subcostal	Mannequin, supine	ALS-training with and without 10 sec focused echocardiography
Station (2nd HOT)			
I	Parasternal, LAX, SAX	Model, left-lateral	Quantitative LV measurement, LV diameter
II	Apical 4 chamber view	Model, left-lateral	4-chamber-view, sonoanatomy, relation LV:RV size
III	Subcostal, paraternal	Model, supine	Trouble shooting
IV	Subcostal SAX and IVC	Model supine	Sonoanatomy, RV, IVC, transversal and longitudinal
V	Parasternal SAX	Patient 1, reduced LVEF, varying positions	Probe orientation, identification of pathology
VI	Parasternal LAX	Model, supine	Identify structures
VII	Parasternal or apical 4-chamber-view	Patient 2, supine beamer projection (optional)	Eyeballing LVEF, sonoanatomy
VIII	—	Up to 4 Laptops	EmEchoSimTest™ Identify pathology and self-testing
IX	Subcostal, LAX	Model, supine	Time measurement (10 sec shots)
X	Simulated subcostal	Mannequin, supine	ALS-training with optional Ultrasound simulator

TABLE III.— *Organization example of ©FEEL hands-on training (HOT) taken from ©FEEL-UK™. Listing provides rotations of each group for morning and afternoon HOTs. Discipline and good management skills are required by organizers. Note that time is also asynchronous and at the beginning of the HOT slightly longer (14 min) than in the middle (12 min) and end (10 min), because trainees already gained knowledge and can perform studies faster.*

Time	Group/station	Frankfurt (I)	London (II)	Milan (III)	Madrid (IV)	Paris (V)	Bukarest (VI)	Budapest (VII)	Aarhus (VIII)	Oslo (IX)	Vienna (X)
Morning HOT-1											
11030 - 1044	I	1	2	3	4	5	6	7	8	9	10
1045 - 1059	II	2	3	4	5	6	7	8	9	10	1
1100 - 1114	III	3	4	5	6	7	8	9	10	1	2
1115 - 1130	IV	4	5	6	7	8	9	10	1	2	3
1130 - 1142	V	5	6	7	8	9	10	1	2	3	4
1142 - 1154	VI	6	7	8	9	10	1	2	3	4	5
1154 - 1206	VII	7	8	9	10	1	2	3	4	5	6
1206 - 1218	VIII	8	9	10	1	2	3	4	5	6	7
1218 - 1228	IX	9	10	1	2	3	4	5	6	7	8
1228 - 1238	X	10	1	2	3	4	5	6	7	8	9
Afternoon HOT-2											
1400 - 1415	I	1	2	3	4	5	6	7	8	9	10
1415 - 1430	II	2	1	4	3	6	5	8	7	10	9
1430 - 1445	III	3	4	5	6	7	8	9	10	1	2
1445 - 1500	IV	4	3	6	5	8	7	10	9	2	1
1500 - 1512	V	5	6	7	8	9	10	1	2	3	4
1512 - 1524	VI	6	5	8	7	10	9	2	1	4	3
1524 - 1536	VII	7	8	9	10	1	2	3	4	5	6
1536 - 1548	VIII	8	7	10	9	2	1	4	3	6	5
1548 - 1558	IX	9	10	1	2	3	4	5	6	7	8
1558 - 1608	X	10	9	2	1	4	3	6	5	8	7

skills/pitfalls or corrections from one trainee to another

VARIATIONS

The ©FEEL course was developed with input from experts in emergency medicine, intensive care medicine, echocardiography and education, and is now in its first final evolution. Thus, additional skill stations have been included in the course schedule: in ©FEEL-D™, ©FEEL-UK™ and ©FEEL-IT™ an ALS-ultrasound simulation station (Figure 2) [16] and EmEchoSimTest™ were introduced. Where ultrasound simulation models are not available, periresuscitation echocardiography should be taught using video clips whilst simulating the resuscitation scenario using a resuscitation dummy. These stations are best taught using the combination of a resuscitation officer together with an echo instructor. The debate regarding inclusion of non-cardiac imaging continues. Where time and trainee ability allow, central vessel and pleural scanning may be included (©FEEL-D™ and ©FEEL-IT™, Table II). These issues can be additional with respect to the scope of ©FEEL, and are covered in other international courses with other formats dedicated to overall ultrasound approach to the critical patient.[17]

Testing

Self-testing is performed at the end of certain lectures using video clips and preformatted answer sheets. Several stations contain practical skills which can be tested either within the station or a separate stage (Table II). Trainees receive scores, but more importantly they receive feedback from the station instructor. Finally, post-test evaluation and course feed-back/debriefing of all trainees and all staff is included.

Postcourse training

The aim of ©FEEL is to provide trainees with a structure within which they may obtain training

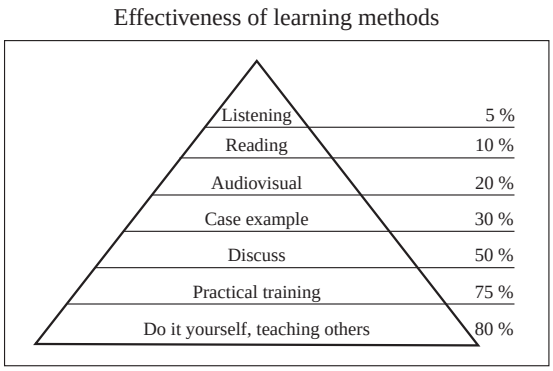

Figure 2.—Effectiveness of different learning methods after 1-2 weeks; traditional methods such as formal presentations are likely to be the least effective in comparison to more active methods shown on the lower part of the pyramid.12 Therefore, ©FEEL didactical design involves a wide variety of methods to activating trainees learning ability.

in periresuscitation echocardiography. Within the course, every trainee will obtain up to 50 focused cardiac views during HOT sessions. Following the course, they should perform a number of echo studies (>50) on Level 3 patients (*i.e.* in the UK, patients requiring advanced respiratory support alone or basic respiratory support together with support of at least two organ systems), whilst maintaining a logbook and under supervision. Upon completion of the logbook, the trainee receives a certificate of completion of the ©FEEL programme. ©FEEL reporting in a concise and reproducible manner is another important issue to be taught (Figure 3) both to help to standardize the examination and allow for subsequent comparison and transmission of clinically relevant findings.

Figure 3.—A, B) The Ultrasound Simulator is an optional method to enhance training during the ©FEEL course, reproducing real-time 3D views of the heart with both normal and peri-resuscitation findings as well as additional pathology; C) by using an electromagnetic tracking system, 3D/4D- volumes can be projected into a mannequin and examined near reality (Trademark by Schallware GmbH, Berlin, www.schallware.de); D) it can easily be integrated into an ALS-resuscitation megacode trainer.

Patient name ..... CRN .....
Date of study ..... DOB .....
Indication:
Cardiac arrest with CPR □ Peri-arrest □ Other .....
Quality of study ..... (2-optimal; 1-suboptimal; 0-inadequate)

WINDOWS USED:

Subcostal □	PLAX □	PSAX □	A4CH □
Findings			
Rhythm			
VF?		Yes ☐	No ☐
Cardiac motion detected?		Yes ☐	No ☐
PEA?		Yes ☐	No ☐
PseudoPEA?		Yes ☐	No ☐
Cardiac standstill?		Yes ☐	No ☐
Left heart			
LV severely dilated?		Yes ☐	No ☐
LV severely impaired?		Yes ☐	No ☐
LV severely underfilled?		Yes ☐	No ☐
Right heart			
RV severely dilated?		Yes ☐	No ☐
RV severely impaired?		Yes ☐	No ☐
Paradoxical septal motion?			
Pericardium			
Large PC collection?		Yes ☐	No ☐

Free text .....
.....
Outcome .....
.....
.....
.....

Supervisor comments .....
.....
.....
.....
Supervisor signature .....

Figure 4.—Proposed report sheet for the ©FEEL exam. Forms can be used for follow-up exams of a trainee and merged into a logbook. CPR; cardiopulmonary resuscitation, PEA; pulseless electrical activity, Peri-arrest, includes, hypotension, risk for resuscitation and postresuscitation or severe dyspnoea, shock of unknown origin. SIVC, short axis view of inferior vena cava, PLAX, PSAX, parasternal short and long axis, A4CH, apical four-chamber view, two, VF; ventricular fibrillation, RV: LV, right and left ventricle. PC; pericardial collection (effusion). Work sheet was developed in collaboration with WINFOCUS (world interactive network on critical ultrasound) [17] and allows for reproducible documentation of findings, inclusion in the patient record for subsequent comparison and transmission of clinically relevant information. Patient data and brief clinical description are relevant to traceability of document and interpretation of findings. Simplicity lies in the "tick-boxing" structure of the report and in the qualitative/semiquantitative nature of assessment, as taught in the FEEL approach. Pleural and vessel scanning is optional. Doubtfulness of findings and need for an Echo exam beyond the scope of FEEL should be stated.

Discussion

©FEEL has been shown to train novice echocardiographers to effectively diagnose/exclude major pathology associated with cardiac arrest without interrupting resuscitation.[4] In doing so, this removes the main concern of cardiologists and echocardiographers; namely that novice practitioners perform focused studies in an untrained manner, and the main concern of EP/CCM clinicians; that emergency echocardiography is generally not readily available from trained practitioners. It is important for all to recognize that the remit is limited, and that practitioners should not

practice out with their competencies.[5] Hence, the pitfalls and limitations lecture is crucial to ensure trainees know the limitations of their echocardiographic skills, and demonstrate where peri-resuscitation echocardiography lies within the full range of capabilities of the technique. ©FEEL is thus not an accreditation in echocardiography, nor does it give a novice practitioner the remit to perform focused studies where the patient is well in an attempt to make a diagnosis. A main limitation is the trainer to trainee ratio and the number of echo machines required. Unfortunately, in order for trainees to gain sufficient hands-on exposure to echo, there is no real possibility to change the ratios without significantly compromising training as the hands-on experience is a major strength of the programme.

Sustainability as a measure of teaching power remains yet unanswered. Shackford *et al.* reported for the Focused Abdominal Sonography for Trauma (FAST) exam [18] a minimum of 50 examinations (10% pathological) should be performed after attending a course in order to consolidate trainee knowledge. It is likely that a similar number of post-course studies will be required for ©FEEL. However, as echocardiography is more complex than FAST, the numbers of focused exams after a ©FEEL course remains to be defined.[5] A log-book (made of sheets based on Figure 3) should be used to document cases, and a local mentor to review studies and reports is required. As trainees learn at different rates, and therefore the trainee should only be deemed competent to perform peri-resuscitation echocardiography when he/she and the mentor are satisfied that this is the case. Re-certification has yet to be agreed, although the number of studies required to maintain competence is likely to be >30 per annum.

©FEEL was designed to be an entry level in terms of critical echocardiography. Thus, each lecture is designed to illustrate key issues and should not be cut or altered. With the number of modifications and feedback from international experts that has already been incorporated, it is likely that future modifications are likely to be small, and not have a major impact on programme, course and lecture content. Where trainees do wish to develop their skills further, this can be either by undertaking other courses in emergency scanning (FAST or FATE) or complementary courses such as abdominal and/or lung scanning. Where the trainee wishes to develop their echocardiographic skills further they should work towards accreditation [5] either as part of their training programme, or in a dedicated critical care echocardiography fellowship.

Conclusions

Periresuscitation echocardiography, performed safely and in an ALS-compliant manner is a potentially valuable skill to be acquired by physicians caring for the critically ill, regardless of the environment in which they work, or their level of seniority. This newly-developed blended learning peri-resuscitation echocardiography programme may serve as entry level in peri-resuscitation echocardiography for both EPs and CCPs.

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