

Expert Round Table
on Ultrasound in ICU

International expert statement on training standards for critical care ultrasonography

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Round table participants and affiliations are given in Appendix

Expert Round Table
on Ultrasound in ICU (✉)
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Abstract Training in ultrasound techniques for intensive care medicine physicians should aim at achieving competencies in three main areas: (1) general critical care ultrasound (GCCUS), (2) “basic” critical care echocardiography (CCE), and (3) advanced CCE. A group of 29 experts representing the European Society of Intensive Care Medicine (ESICM) and 11 other critical care societies worldwide worked on a potential framework for organizing training adapted to each area of competence. This framework is mainly aimed at defining minimal requirements but is by no means rigid or restrictive: each

training organization can be adapted according to resources available.

There was 100% agreement among the participants that general critical care ultrasound and “basic” critical care echocardiography should be mandatory in the curriculum of intensive care unit (ICU) physicians. It is the role of each critical care society to support the implementation of training in GCCUS and basic CCE in its own country.

Keywords Ultrasound techniques · Echocardiography · Training · Competence

Introduction

Critical care ultrasonography, including general ultrasonography and echocardiography, is routinely used in intensive care units (ICU) of many hospitals worldwide, where it is often regarded as a first-line diagnostic tool [1–5]. Although the usefulness of ultrasound in the ICU environment is widely acknowledged [6–13], physicians who want to become proficient in ultrasound techniques often struggle to obtain adequate training. One of the difficulties is that teaching of these techniques has not yet been incorporated into the formal training curriculum of intensive care medicine, and to date only a few countries have developed specific programs for this purpose. Recently, a comprehensive list of competencies required by intensive care physicians using ultrasonography has been formulated and published in a competence statement emanating from two critical care societies [14]. These

competences cover the fields of abdominal, pleural, lung, and vascular ultrasound (general critical care ultrasonography, GCCUS) as well as cardiac examination (critical care echocardiography, CCE). CCE was divided into “basic” and “advanced” levels of knowledge. However, to date, no consensus and no published guidelines exist on how to achieve such competencies in critical care ultrasonography.

A round table was organized during the 23rd European Society of Intensive Care Medicine (ESICM) annual meeting in Vienna (October 2009) with the aim of elaborating such guidelines for training of intensive care physicians in critical care ultrasonography. This document, the result of that meeting, has been endorsed by thirteen critical care societies from around the globe. The proposed guidelines represent a framework for ultrasound education which may be adapted to the local conditions in individual countries.

Round table organizing principles

Eleven critical care societies from five continents were invited by the European Society of Intensive Care Medicine (ESICM) to send one or two experts in critical care ultrasonography (general ultrasonography and/or echocardiography) to participate in the round table. Twenty-nine experts participated and were charged with preparing a preliminary consensus on training standards in ultrasonography for ICU physicians. Four working groups were created to prepare the grounds for a consensus on the following issues:

1. How to achieve competence in general critical care ultrasonography
2. How to achieve competence in basic critical care echocardiography
3. How to achieve competence in advanced critical care echocardiography
4. How to deliver teaching and how to organize certification

The distribution of experts among groups was decided according to their specific competence and with the aim of having a balanced distribution between ESICM and invited experts. Seven to eight experts per group worked on a list of questions aimed at covering the key aspects of each topic. The questions were sent to the experts prior to the round table. Each expert was asked to respond to the questions related to his/her designated topic, and the results were collated by a designated “leader” in each working group. Each group leader prepared a pre-consensus statement based on those answers. These pre-consensus statements were presented, discussed, and amended during the plenary round table. Each point was submitted to a vote to assess the degree of consensus for this specific statement. Each statement represents the consensual response to one question. For the sake of simplicity, responses to all questions have been pooled under two main paragraphs: (a) how to achieve competence in general critical care ultrasound and basic critical care echocardiography, and (b) how to achieve competence in advanced critical care echocardiography.

All experts agreed that the foundation document for the present statement was the Société de Réanimation de Langue Française (SRLF)/American College of Chest Physicians (ACCP) competence statement [14] which describes the competencies required for critical care ultrasonography and echocardiography.

Statements

Preliminary general statements

All experts (100%) agreed upon the facts that:

- Basic-level critical care echocardiography and general critical care ultrasound should be a required part of the training of every ICU physician.
- Advanced-level critical care echocardiography is an optional component of the training of the ICU physician.

How to achieve competence in general critical care ultrasonography (GCCUS) and basic critical care echocardiography (CCE)

1. Theoretical program:

Course design should include specific learning goals that are described in the ACCP/SRLF competence statement [14]. The minimum number of hours for course design required to teach GCCUS [15] and basic CCE [16, 17] is 10 h each, to be divided between lectures and didactic cases with image-based training (100% agreement).

2. Format of the theoretical training:

Both standard lecture format and Internet-based learning have advantages. Therefore, ideally both Internet-based learning and lecture format should be available to trainees, potentially in a blended fashion to allow them to take advantage of both [18, 19] (100% agreement). Lectures can include didactics and illustrative interactive cases.

3. Required number of examinations to be performed by the trainee:

There was no consensus on this issue. No data in the literature identify a specific number of studies that need to be performed to reach the desired level of competence in GCCUS. Regarding basic CCE, however, review of the literature suggests that 30 fully supervised transthoracic echocardiographic (TTE) studies is a reasonable training target to achieve competence in image acquisition [17, 20–22]. Tutored TTEs should be preferably performed in unstable patients to increase the probability of encountering abnormal findings. Trainees should learn GCCUS and/or basic CCE with a locally qualified physician supervisor. This supervisor determines when the trainee has acquired competence in the practical bedside aspects of GCCUS and/or basic CCE. The lack of consensus regarding numerical requirements can be compared to training in many other ICU techniques such as bronchoscopy or endotracheal intubation, for which no widely accepted quantitative targets have yet been established.

4. How many cases of each clinical syndrome should be examined by the trainee?

There was no consensus on this issue. It is not reasonable to expect that each trainee will encounter all important clinical situations during the time course of his/her training in GCCUS and/or basic CCE. Therefore, a comprehensive panel of important abnormal images with their clinical scenarios must be part of the didactic cases and interactive image interpretation sessions that are integral to training course design. This exposes the trainee to a wide variety of abnormal images in order that they are prepared for clinical situations. Abnormal images and their clinical scenarios may be presented in interactive lecture format, or through Internet-based methods.

5. Is there a place for hands-on training on normal volunteers?

During initial practical training, hands-on training with normal volunteers is a convenient and effective method to teach key elements of image acquisition such as transducer manipulation, standard views, spatial orientation, and normal anatomy (100% agreement).

6. What should be the format for documenting practical training in image acquisition and interpretation?

Each trainee should maintain a logbook of their scanning activity that includes reports of ultrasound studies performed and/or interpreted. Trainees should write reports of their image interpretation, and the reports be cosigned by both trainee and supervisor to attest that the findings have been verified by a physician who is qualified in GCCUS and/or basic CCE (100% agreement).

7. Where should practical training take place, and who should supervise practical training in image acquisition and interpretation?

Initially, practical training may use normal models under the supervision of hands-on training faculty. In addition, training in GCCUS and/or basic CCE requires a component of bedside scanning in the ICU under the direction of a supervisor who is competent in GCCUS and/or basic CCE. The supervisor for practical training should be a locally qualified physician who regularly performs GCCUS and/or basic CCE in the ICU environment (100% agreement). It is mandatory that a dedicated ultrasound machine be available in every ICU where training occurs.

8. Should training in basic CCE be limited to transthoracic echocardiography (TTE), or should it include training in transesophageal echocardiography (TEE)?

Basic CCE relies mainly on TTE examinations. Training in TEE is an optional component of basic CCE. Basic CCE using TEE may have utility, especially in specific clinical settings (e.g., post cardiac surgery,

trauma centers), but its use is limited to those units that are equipped with TEE capability. Therefore, training in TEE is not a mandatory component of basic CCE. Some reports suggest that limited TEE training may yield useful information in the ICU setting [20, 23]. TEE may thus be taught as part of basic CCE if the technology is available.

9. Should basic CCE and GCCUS require certification?

Formal certification is not required (100% agreement) but is available in some countries. Competence-based training in basic CCE and GCCUS should be included in the curriculum of any intensivist. Trained intensivists may proceed towards further training to reach competence in advanced CCE.

How to achieve competence in advanced critical care echocardiography (CCE)

Intensivists who want to achieve competence in advanced CCE must be trained to basic-level CCE as a prerequisite (100% agreement).

1. Theoretical program:

Course design should include specific learning goals as described in the ACCP/SRLF competence statement [14]. The minimum number of hours for course design required to teach advanced CCE is 40 h, to be divided between lectures and didactic cases with image-based training (100% agreement).

2. Format of the theoretical training:

Both standard lecture format and Internet-based learning have advantages. Therefore, Internet-based learning and lecture format should be available to trainees, potentially in a blended fashion to allow them to take advantage of both (100% agreement). Lectures can include didactics and illustrative interactive cases.

3. What is the required number of examinations to be performed by the trainee?

Trainees must acquire competencies in TTE and TEE (100% agreement). There was a consensus that TEE is mandatory for advanced CCE. Review of the literature suggests that 150 fully supervised TTE studies and 50 fully supervised TEE studies are a reasonable training target to achieve competence in image acquisition and interpretation [24, 25]. Trainees should learn advanced CCE with a locally qualified physician supervisor. Using validated scoring system to evaluate acquisition of competencies at bedside has been proposed [23]. A maximum period of 2 years is recommended to collect the appropriate number of echocardiographic studies.

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4. How many cases of each clinical syndrome should be examined by the trainee?

There was no consensus on this issue. It is not reasonable to expect that each trainee will encounter all important clinical situations during the time course of his/her training in advanced CCE. Therefore, a comprehensive panel of important abnormal images with their clinical scenarios must be part of the didactic cases and interactive image interpretation sessions that are integral to training program design. This exposes the trainee to a wide variety of abnormal images in order that they are prepared for clinical situations. Abnormal images and their clinical scenarios may be presented in interactive lecture format, or through Internet-based methods. Both TTE and TEE illustrative examples must be integrated in the training program.

5. What should be the format for documenting practical training in image acquisition and interpretation?

Each trainee must maintain a logbook of their scanning activity that includes reports of studies performed and/or interpreted. Trainees should write reports of their image interpretation, and the reports be cosigned by trainee and supervisor to attest that the findings have been verified by a physician who is qualified in advanced CCE.

6. Where should practical training take place, and who should supervise practical training in image acquisition and interpretation?

By definition, trainees have first to become competent in basic CCE. For that, practical training may initially use normal models under the supervision of hands-on training faculty. Subsequent training in advanced CCE requires bedside scanning by both transthoracic and transesophageal routes in the ICU under the direction of a supervisor who is competent in advanced CCE. The supervisor for practical training should be a locally qualified physician who regularly performs advanced CCE in the ICU environment (100% agreement). It is mandatory that a dedicated ultrasound machine with both transthoracic and transesophageal probes be available in every ICU where training occurs.

7. Should advanced CCE require certification?

A process of certification, accreditation, or delivery of a diploma validating the acquisition of competence is essential for recognition by colleagues/hospital administration. This may be more true in some countries than others, but the more difficult the access to ultrasound for ICU physicians, the more important the "official" recognition of competence (100% agreement).

Medicolegal perspective

Medicolegal issues related to the practice of ultrasound techniques are a frequent concern of ICU physicians engaging in the training process. Therefore, round table participants debated the matter, and their opinion is summarized as follows:

Medical practitioners owe a duty of care to their patients, arising from contract and/or tort laws, to provide a standard of care expected of a practitioner in the same position. Should it fall below this expected standard of care, it will be regarded as a breach of duty and according to the law the practitioner is liable for breach of contract, or is regarded as negligent or displaying professional misconduct. As ultrasound moves from an optional to an indispensable tool in the management of certain conditions in the critical care environment, practitioners have to ensure they have the required skills and experience to enable them to perform and interpret the studies competently. Although physicians applying ultrasound raise concerns about the medicolegal implications should their diagnosis or resultant management be incorrect, the opposite also has to be considered: When the considerable benefits it confers to patients are well known, not utilizing ultrasound in the management of patients could be considered inexcusable. Examples include assistance with vascular access, cardiac assessment, and ultrasound-guided paracentesis.

A structured certification program is probably the best approach to equip practitioners with the necessary skills and knowledge. Although from the medicolegal perspective, competence rather than certification is important, the latter greatly assists in achieving relevant standards of practice [26].

Summary

Training in ultrasound techniques for intensive care medicine physicians should aim at achieving the competencies defined in the ACCP/SRLF statement. These competencies can be divided into three main areas: (1) general critical care ultrasound (GCCUS), (2) "basic" critical care echocardiography (CCE), and (3) advanced CCE. The above-mentioned statements provide a potential framework for organizing training adapted to each area of competence. This framework is mainly aimed at defining minimal requirements but is by no means rigid or restrictive: each training organization can be adapted according to resources available. There was 100% agreement among the participants that general critical care ultrasound and "basic" critical care echocardiography should be mandatory in the curriculum of ICU physicians. It is the role of each critical care society to support the implementation of training in GCCUS and basic CCE in its own country.

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Conflict of interest B. Cholley has worked as a consultant or lecturer for Philips Healthcare (fees being paid to his department) but has no conflict of interest related to the topic of this conference. A. Vieillard Baron has received honoraria as a lecturer at ultrasound symposia, and funding from various industrial partners to develop a website in critical care ultrasound. P. Vignon has worked as a consultant or lecturer for Philips Healthcare but has no conflict of interest related to the topic of this conference. Y. Beaulieu declares to work part-time as director of ultrasound education for a company called CAE Healthcare, providing training solutions on bedside ultrasound including e-learning curriculum and an ultrasound simulator. He receives a salary for that role from CAE Healthcare. R.C. McDermid has received honoraria from ICCU Imaging, a company involved in ultrasound training. S. Alhamid, M. Balik, R. Breittkreutz, J.-L. Canivet, P. Doelken, H. Flaatten, H. Frankel, M. Haney, A. Hilton, E. Maury, P.H. Mayo, A.S. McLean, C. Mendes, M.R. Pinsky, J. Poelaert, S. Price, D. Schmidlin, M. Slama, D. Talmor, J. M. Teles, G. Via, G.Voga, P. Wouters, and T. Yamamoto have no financial conflicts of interest to declare.

Appendix

Organizing Society:

European Society of Intensive Care Medicine (ESICM)

Participating Societies:

American College of Chest Physicians (ACCP); American Thoracic Society (ATS); Asia Pacific Association of Critical Care Medicine (APACCM); Australia and New Zealand Intensive Care Society (ANZICS); Brazilian Association of Intensive Care Medicine (AMIB); Canadian Critical Care Society (CCCS); European Society of Anaesthesiology (ESA); European Society of Intensive Care Medicine (ESICM); Japanese Society of Intensive Care Medicine (JSICM); Pan Arab Federation of Societies of Anaesthesia, Intensive Care and Pain Medicine (PAFSA); Société de Réanimation de Langue Française (SRLF); Society of Critical Care Medicine (SCCM).

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Endorsement

The content of this manuscript has been officially endorsed by the following societies:

American College of Chest Physicians (ACCP)
American Thoracic Society (ATS)
Australia and New Zealand Intensive Care Society (ANZICS)
Asia Pacific Association of Critical Care Medicine (APACCM)
Brazilian Association of Intensive Care Medicine (AMIB)

Canadian Critical Care Society (CCCS)
Czech Society of Anaesthesiology and Intensive Care Medicine (ČSARIM)
European Association of Cardiothoracic Anaesthesiologists (EACTA)
European Society of Anaesthesiology (ESA)
European Society of Intensive Care Medicine (ESICM)
Japanese Society of Intensive Care Medicine (JSICM)
Soci t  Fran aise d'Anesth sie-R animation (SFAR)
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References

1. Cholley BP, Vieillard-Baron A, Mebazaa A (2006) Echocardiography in the ICU: time for widespread use!. *Intensive Care Med* 32:9–10
2. Breikreutz R, Walcher F, Seeger FH (2007) Focused echocardiographic evaluation in resuscitation management: concept of an advanced life support-conformed algorithm. *Crit Care Med* 35:S150–S161
3. Beaulieu Y (2007) Bedside echocardiography in the assessment of the critically ill. *Crit Care Med* 35:S235–S249
4. Beaulieu Y (2007) Specific skill set and goals of focused echocardiography for critical care clinicians. *Crit Care Med* 35:S144–S149
5. Kaplan A, Mayo PH (2009) Echocardiography performed by the pulmonary/critical care medicine physician. *Chest* 135:529–535
6. Khoury AF, Afridi I, Quinones MA, Zoghbi WA (1994) Transesophageal echocardiography in critically ill patients: feasibility, safety, and impact on management. *Am Heart J* 127:1363–1371
7. Heidenreich PA, Stainback RF, Redberg RF, Schiller NB, Cohen NH, Foster E (1995) Transesophageal echocardiography predicts mortality in critically ill patients with unexplained hypotension. *J Am Coll Cardiol* 26:152–158
8. Poelaert JI, Trouerbach J, De Buyzere M, Everaert J, Colardyn FA (1995) Evaluation of transesophageal echocardiography as a diagnostic and therapeutic aid in a critical care setting. *Chest* 107:774–779
9. Huttemann E, Schelenz C, Kara F, Chatzinikolaou K, Reinhart K (2004) The use and safety of transoesophageal echocardiography in the general ICU—a minireview. *Acta Anaesthesiol Scand* 48:827–836
10. Beaulieu Y, Marik PE (2005) Bedside ultrasonography in the ICU: part 2. *Chest* 128:1766–1781
11. Beaulieu Y, Marik PE (2005) Bedside ultrasonography in the ICU: part 1. *Chest* 128:881–895
12. Stanko LK, Jacobsohn E, Tam JW, De Wet CJ, Avidan M (2005) Transthoracic echocardiography: impact on diagnosis and management in tertiary care intensive care units. *Anaesth Intensive Care* 33:492–496
13. Orme RM, Oram MP, McKinstry CE (2009) Impact of echocardiography on patient management in the intensive care unit: an audit of district general hospital practice. *Br J Anaesth* 102:340–344
14. Mayo PH, Beaulieu Y, Doelken P, Feller-Kopman D, Harrod C, Kaplan A, Oropello J, Vieillard-Baron A, Axler O, Lichtenstein D, Maury E, Slama M, Vignon P (2009) American College of Chest Physicians/La Societe de Reanimation de Langue Francaise statement on competence in critical care ultrasonography. *Chest* 135:1050–1060
15. Chalumeau-Lemoine L, Baudel JL, Das V, Arrive L, Noblinski B, Guidet B, Offenstadt G, Maury E, Maury E, Guglielminotti J, Alzieu M, Guidet B, Offenstadt G (2009) Results of short-term training of naive physicians in focused general ultrasonography in an intensive-care unit. *Ultrasonic examination: an alternative to chest radiography after central venous catheter insertion?* *Intensive Care Med* 35:1767–1771
16. Manasia AR, Nagaraj HM, Kodali RB, Croft LB, Oropello JM, Kohli-Seth R, Leibowitz AB, DelGiudice R, Hufanda JF, Benjamin E, Goldman ME (2005) Feasibility and potential clinical utility of goal-directed transthoracic echocardiography performed by noncardiologist intensivists using a small hand-carried device (SonoHeart) in critically ill patients. *J Cardiothorac Vasc Anesth* 19:155–159
17. Vignon P, Dugard A, Abraham J, Belcour D, Gondran G, Pepino F, Marin B, Francois B, Gastinne H (2007) Focused training for goal-oriented hand-held echocardiography performed by noncardiologist residents in the intensive care unit. *Intensive Care Med* 33:1795–1799
18. Price S, Via G, Sloth E, Guarracino F, Breikreutz R, Catena E, Talmor D (2008) Echocardiography practice, training and accreditation in the intensive care: document for the World Interactive Network Focused on Critical Ultrasound (WINFOCUS). *Cardiovasc Ultrasound* 6:49
19. Breikreutz R, Uddin S, Steiger H, Ilper H, Steche M, Walcher F, Via G, Price S (2009) Focused echocardiography entry level: new concept of a 1 day training course. *Minerva Anesthesiol* 75:285–292
20. Benjamin E, Griffin K, Leibowitz AB, Manasia A, Oropello JM, Geffroy V, DelGiudice R, Hufanda J, Rosen S, Goldman M (1998) Goal-directed transesophageal echocardiography performed by intensivists to assess left ventricular function: comparison with pulmonary artery catheterization. *J Cardiothorac Vasc Anesth* 12:10–15
21. Melamed R, Sprenkle MD, Ulstad VK, Herzog CA, Leatherman JW (2009) Assessment of left ventricular function by intensivists using hand-held echocardiography. *Chest* 135:1416–1420
22. Vignon P, Mücke F, Bellec F, Marin B, Croce J, Brouqui T, Palobart C, Senges P, Truffy C, Wachmann A, Dugard A, Amiel J-B (2011) Basic critical care echocardiography: validation of a curriculum dedicated to noncardiologist residents. *Crit Care Med* 7 [Epub ahead of print]

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23. Charron C, Prat G, Caille V, Belliard G, Lefevre M, Aegerter P, Boles JM, Jardin F, Vieillard-Baron A (2007) Validation of a skills assessment scoring system for transesophageal echocardiographic monitoring of hemodynamics. *Intensive Care Med* 33:1712–1718
24. Ryan T, Armstrong WF, Khandheria BK (2008) Task force 4: training in echocardiography endorsed by the American Society of Echocardiography. *J Am Coll Cardiol* 51:361–367
25. Quinones MA, Douglas PS, Foster E, Gorcsan J 3rd, Lewis JF, Pearlman AS, Rychik J, Salcedo EE, Seward JB, Stevenson JG, Thys DM, Weitz HH, Zoghbi WA (2003) ACC/AHA clinical competence statement on echocardiography: a report of the American College of Cardiology/American Heart Association/American College of Physicians-American Society of Internal Medicine Task Force on Clinical Competence. *J Am Coll Cardiol* 41:687–708
26. Huang SJ, McLean AS (2010) Do we need a critical care ultrasound certification program? Implications from an Australian medical-legal perspective. *Crit Care* 14:313 [Epub ahead of print]