

Echocardiography Training Pathway for Intensive Care Trainees: A Comparison with International Guidelines

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Abstract

Background

General ultrasonography and echocardiography are widely regarded as useful diagnostic tools in intensive care. Structured education has not been incorporated into many intensive care curriculums worldwide. A certified training program is recommended. The aim of this article is to outline the current training framework in the Republic of Ireland for critical care echocardiography and compare it to the most recent international guidance.

Aims

The aim of this article is to outline the current training framework in the Republic of Ireland for critical care echocardiography and compare it to the most recent international guidance.

Methods

A literature review was performed yielding 13 eligible articles, along with several websites.

Results

The international guidance relating to basic and advanced accreditation in critical care echocardiography is detailed. This is compared to the options of accreditation available in the Republic of Ireland. These include predominantly FUSIC, BSE ACCE, EACVI TTE, and EDEC.

Discussion

Formal teaching has not been incorporated into many intensive care curriculums throughout the world. Trainees face challenges in obtaining competency. In the Republic of Ireland, the options of accreditation meet the ESICM recommendations in terms of TTE accreditation. However, only one option incorporates TOE accreditation (EDEC). Training courses are available in the Republic of Ireland. However, challenges still exist. It is felt that Irish ICUs should continue to provide training programs under qualified supervision at a local level. Established local programs along with national courses would improve training and accessibility. In the future, fellowships in critical care echocardiography may be available in the Republic of Ireland, similar to those in the United Kingdom and Australia.

Background

General ultrasonography and echocardiography are widely regarded as useful diagnostic tools in intensive care ¹⁻⁴. However, structured education has not been incorporated into many intensive care curriculums throughout the world. Therefore, many trainee intensivists struggle to obtain competency ^{1, 5}. For example, an Australian survey quoted that 41% of intensivists were untrained in performing transthoracic echocardiography ⁶. Barriers included perceived lack of need for training, lack of equipment, and resistance from ultrasound providers⁶. Medicolegally, as critical care ultrasonography becomes more utilised, a balance must be maintained. On one hand some physicians voice their concerns over the risk of misdiagnosis. On the other hand, the benefits of ultrasonography in critical care may deem it “inexcusable” not to utilise ¹. A certified training program may be the best method going forward ^{1, 2}.

Aim

The European framework proposed by the European Society of Intensive Care Medicine (ESICM) ^{1, 2, 7} outlines the core competencies required for critical care ultrasound accreditation in multidisciplinary intensive care. Upon reading this, it was felt that there would be benefit in examining the current framework in the Republic of Ireland. The aim of this article is to outline the current training framework in the Republic of Ireland for critical care echocardiography accreditation and compare it to the most recent international guidance.

Methods

A literature review was performed 25th July 2023. A PubMed search, using the following MeSH terms was undertaken; "Critical Care", "Education, Medical", and "Echocardiography". Publications that outlined current accreditation structures and

guidelines, along with studies that were felt to be of benefit were included. After review of the abstracts, any article that was not deemed relevant or not written in English was excluded. Of note, any article that was only accessible through paid subscription was excluded, unless deemed a seminal text. To obtain up to date information in relation to the accreditation process, several websites were reviewed. This literature review was not pre-registered. A summary of included articles can be seen in Supplemental data 1.

Results

Thirty-three articles were found. Four additional articles were initially reviewed before the literature search commenced. This yielded 36 articles in total after duplicates were removed. Of these, 23 articles were removed (15 were not accessible, 7 were not relevant, and one was not written in English). Date of publication ranges from 1997 to 2022 (Figure 1.). Society websites reviewed included Joint Faculty of Intensive Care Medicine Ireland (JFICMI), Intensive Care Society (ICS), British Society of Echocardiography (BSE), European Society of Cardiology (ESC), and ESICM.

Article not in English (n = 1)

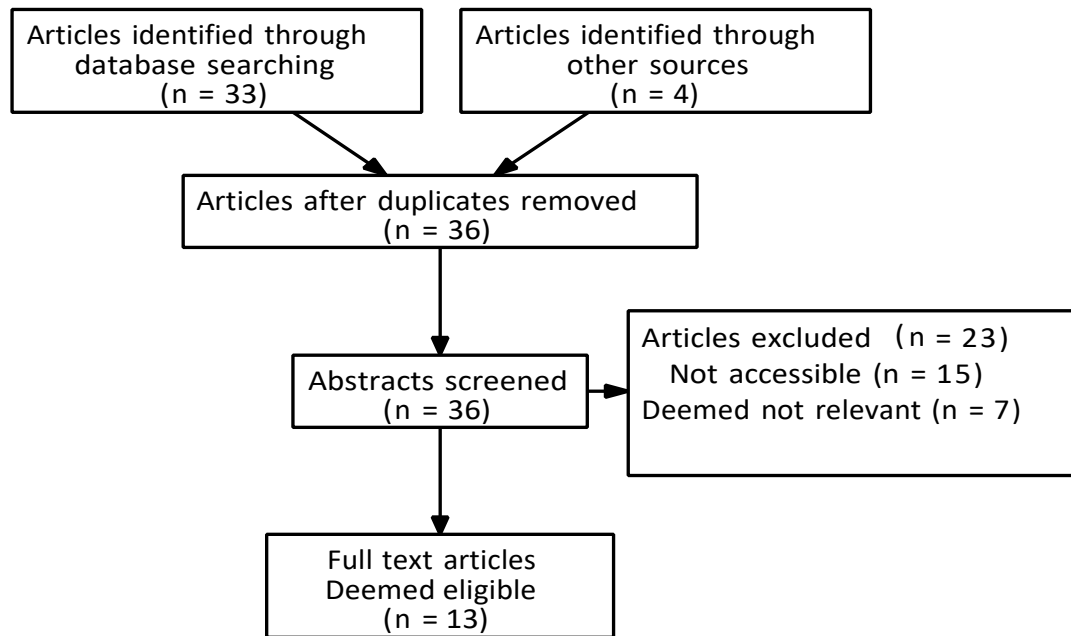


Figure 1. PRISMA (preferred reporting items for systematic reviews and meta-analyses) flow diagram ⁸.

International framework

As per the ESICM, critical care ultrasound education should be delivered focussing on three main areas: general critical care ultrasound, basic critical care echocardiography (BCCE) , and advanced critical care echocardiography (ACCE). The expert panel advised that general

critical care ultrasound and BCCE should be part of the intensive care curriculum and should be supported by each country's respective intensive care society or credentialing body with input into the curriculum^{1, 4, 9}. ACCE was deemed an additional training component, as it is more complex³, and more difficult to integrate into an intensivist training program^{1, 7}. Although training in transoesophageal echocardiography is advised as part of Level 2 training, the ESICM appreciates that this may be limited by lack of available equipment in some centres^{1, 7}. BCCE and ACCE are summarised in Table 1.

<u>Category</u>	Basic Critical Care Echocardiography	Advanced Critical Care Echocardiography
<u>Purpose</u>	Rapid assessment and specific clinical questions	Comprehensive assessment for detailed diagnosis and management
<u>Scope</u>	- Limited basic views - Measurements include only TAPSE, MAPSE, RVSD, and RVDD. - Two modalities only: 2D Doppler and M mode - Immediate, actionable information	- Full set of standard views and measurements - Advanced imaging techniques and calculations - Include using <i>tissue</i>, <i>colour</i> Doppler and <i>pulsed wave</i> Doppler
<u>Training Requirements</u>	- Fewer studies and shorter supervised practice - Brief, focused training sessions or short courses	- Extensive training, often involving a formal fellowship - Training in advanced imaging techniques and complex pathologies
<u>Assessment</u>	Competency confirmed through practical demonstration under supervision	Formal, with standardised testing and certification processes (exams, and observed structured clinical examinations)
<u>Pathologies Assessed</u>	- Basic cardiac function (global eyeball assessment of ejection fraction estimation) - Pericardial effusion - Gross ventricular size and	- Valvular function and pathology - Quantitative ventricular function (strain imaging, tissue Doppler) - Congenital heart disease

	function - Large pleural effusions - Fluid status and volume responsiveness	- Complex hemodynamic states - Pericardial diseases
<u>Equipment</u>	- Simpler, portable ultrasound machines - Basic software and fewer advanced imaging modalities	- High-end ultrasound machines with advanced software capabilities - Includes 3D echocardiography, speckle tracking, contrast imaging
<u>Clinical Context</u>	- Immediate bedside decision-making - Often used by non-cardiologist (intensivists, emergency physicians)	- Comprehensive diagnostic evaluation and management planning - Typically performed by cardiologists or specialised intensivists

Table 1. Comparison of Basic Critical Care Echocardiography and Advanced Critical Care Echocardiography¹⁰.

Critical Care Echocardiography differs from cardiology-based echocardiography in two ways. Firstly, the intensivist images patients at the bedside, in the intensive care unit (ICU). These patients are generally haemodynamically unstable, and the findings are interpreted in the clinical context. The exam may be as limited as required to reach the diagnosis. Secondly, the exam is integrated into an immediate management plan. Serial exams aid in assessing each therapeutic change⁷. Therefore, a strong cognitive base is essential. Understanding of a large variety of pathophysiological processes specific to critical care is important⁷.

BCCE is aimed at performing goal-directed examination^{3,9}. As per the BSE, BCCE is aimed to be utilised by clinicians from a wide variety of specialties. Practitioners should be able to achieve and maintain a high level of echocardiography in order to rule out immediately reversible pathology in a timely manner¹¹. The ESICM advises that theoretical training should consist of a minimum number of hours of coursework attended. A mixture of both online and traditional lecture format should be accessible to trainees. A literature review suggested that a minimum of 30 fully supervised cases is a suitable target¹. This includes unstable patients, as there may be a higher probability of encountering abnormal findings. Examples of BCCE programs exist in several countries¹².

In 2021, Rajamani et al performed a systematic review on the methodologic quality of guidelines for training in BCCE ¹³. Twenty-four guidelines were included. A multidisciplinary team assessed each guideline's level of detail using AGREE-II critical appraisal tool. Only one guideline was deemed to have adequate detail. Overall, the authors state that their appraisal demonstrated the deficiencies in the guidelines' creation process. Further evaluation is required to determine the validity of the recommendations ¹³. In 2022, the same group published a Delphi process consensus statement on the criteria, processes, and determination of competency in relation to BCCE training ¹⁴. Twenty-one experts were included. Agreement was reached on the following recommendations: mandatory introductory training, mentored formative training, summative assessment for competence, and final cognitive assessment should all be included ¹⁴.

In terms of ACCE ¹, competence in BCCE and specialty training in critical care should be a prerequisite ⁷. A minimum of forty hours of theoretical coursework (both online and traditional lecture format) is advised ⁷ (however, in practice, this may be significantly more), along with a set number of echocardiography exams (TTE and transoesophageal echocardiography (TOE)) over a maximum period of two years ¹. The use of a validated scoring system should be utilised to assess the clinician.

The creation of an effective local training program is challenging due to the lack of literature on the subject ⁷. One example in Australia compared the echocardiography acquisition skills and interpretation between trainees and experts after a mandatory training program in BCCE was implemented ¹⁵. The program spanned a year, and 30 scans were required (directly supervised and reviewed shortly after). Twenty minutes of coursework per week was undertaken. Seven trainees were included in the analysis. This study demonstrated that trainees were able to assess left ventricular function with similar accuracy to expert operators after the implementation of this program. However, other measurements demonstrated a more varied concordance. Further research is required. In the United States of America, a prospective, single-centre, observational study was carried out assessing the effect a 60-minute transthoracic echocardiography session had on the level of knowledge and skills of intensive care trainees (n = 31) ⁵. A significant improvement was demonstrated via MCQ and practical assessment (p < 0.001).

For local training programs in both BCCE and ACCE, supervision by recognised expert critical care faculty is advised ^{1, 7}. Each study should be performed and interpreted by the trainee ^{1, 7}. A selection should be directly supervised by expert faculty. Thereafter, the images recorded should be reviewed by expert faculty. However, if the trainee is still not competent, further studies may be required.

In terms of transoesophageal echocardiography, a proportion should be performed in critically ill patients. Again, the full study (including probe insertion) and interpretation

should be performed by the trainee ^{1, 7}. Simulators may be used for training but cannot be counted as a full study. Apart from congenital cardiac disease, the trainee should have an excellent understanding of standard cardiology textbooks ^{1, 7}. However, further reading is required for the common conditions in critical care. A reading list should be incorporated into local training programs ^{1, 7}.

An important aspect to examine is how competence is determined ⁷. The collection of the appropriate skills, behaviour and knowledge enabling a trainee to perform a specific task adequately and in a qualified manner defines competence. One approach involves the trainee achieving a set number of images and interpretation under expert supervision within the department they are working. A certain amount of theoretical coursework must be undertaken also. This is both a simple and informal method. However, without formal assessment, it may be difficult to ensure competence. The other (advised) approach is for the trainee to undergo a formal competency assessment after they have achieved the set number of studies and coursework ⁷.

For both BCCE and ACCE, a locally qualified supervisor should be available ¹. It may not be possible to encounter every pathology. Therefore, abnormal images along with discussion around the corresponding clinical scenario should be included in the theoretical coursework. Involvement of the cardiology department may also be incorporated ⁷. A logbook should be maintained by each trainee and signed off by a competent supervisor. Scanning should take place in ICU with a dedicated US machine, and a competent supervisor. Although formal certification is not deemed essential for BCCE, it is deemed essential for ACCE ^{1, 7}.

Echocardiography Education Framework in the Republic of Ireland in 2024

The overseeing body in the Republic of Ireland is the JFICMI Irish Intensive Care Core Training Echocardiography & Ultrasound Committee.

Basic Critical Care Echocardiography education in the Republic of Ireland

In the Republic of Ireland, the JFICMI states that BCCE is desirable for one-year trainees and mandatory for trainees on the two-year program ¹⁶. The Focused Ultrasound in Intensive Care (FUSIC) Heart pathway is recommended ¹⁶.

The FUSIC Heart pathway is endorsed by JFICMI. The ICS and BSE act as the certifying bodies ¹⁶. To complete this certificate, trainees must either complete the online lectures provided by ICS or attend an approved FUSIC course. An up-to-date list of courses may be found on the ICS website. Trainees must acquire and report upon a minimum of 50 echocardiography scans. Ten scans must be directly supervised by the mentor. There should be no more than 10 normal scans. Scans that are not directly supervised should be reviewed by the mentor

afterwards. Strict anonymisation of patient details must be maintained when storing images digitally and reporting using the logbook template. ICS emphasise that these scans should not influence clinical intervention. Twelve months is the maximum amount of time advised to complete the set number of scans, although a period of extension is allowed in some cases. FUSIC includes 4 main views (parasternal long axis, parasternal short axis, apical 4 chamber, and subxiphoid) ¹⁷. However, imaging of the inferior vena cava, pleural pathology and several other measurements are included in the curriculum ¹⁷.

Ideally, each trainee has a local mentor. However, ICS appreciates that this may not always be possible, and a mentor can travel if required. The trainee undergoes a formal assessment to complete the certificate. This is carried out by the supervisor. The ICS has published a list of mentors and supervisors online ¹⁶. Mentors can be any healthcare professional registered with the ICS, with suitable experience and regularly practises ultrasound in ICU. They must be accredited in FUSIC Heart a minimum of 12 months and be able to demonstrate competence to the local supervisor. Each unit offering FUSIC Heart pathway certification should have a nominated supervisor. The supervisor must have a higher qualification in echocardiography. This includes any of the following three: ACCE accreditation in transthoracic echocardiography (BSE or European Association of Cardiovascular Imaging (EACVI)), European Diploma in Advanced Critical Care EchoCardiography (EDEC), or regular sessional commitments to TTE as a cardiologist ¹⁷. A summary of the JFICMI pathway for trainees can be seen in Figure 2 ¹⁸.

1. Evidence of pre-reading (<i>modules available online</i>)
2. Accredited BCCE course (<i>FUSIC Heart Course/EGLS course</i>)
Or
Register and engage with FUSIC Heart online
3. Find a mentor who works with a supervisor
4. Upload cases for discussion with mentor (<i>proof of archiving</i>)
5. Triggered assessment with mentor and supervisor
6. Send proof to FUSIC administration

Figure 2: FUSIC Heart Credentialing Pathway 2020 ¹⁸.

BCCE: Basic Critical Care Echocardiography; FUSIC: Focused Ultrasound in Intensive Care; EGLS: Echo Guided Life Support.

Advanced Critical Care echocardiography education in the Republic of Ireland

There are three options for ACCE training in Republic of Ireland. These include:

- British Society of Echocardiography Advanced Critical Care Echocardiography (BSE ACCE)
- European Association of Cardiovascular Imaging Transthoracic Echocardiography (EACVI TTE)
- European Diploma of Echocardiography (EDEC)

Table 2. demonstrates a comparison between all three.

	BSE ACCE	EACVI TTE	EDEC*
Timescale	24 months	12 months	24 months
Studies required	• 250 comprehensive echocardiograms performed and reported • 5 detailed video cases submitted (including all images and measurements)	• 250 comprehensive echocardiograms reported • 6 detailed video cases submitted (including all images and measurements – not the same as BSE standard)	• 100 TTE • 35 TOE
Examination	• Two-part written exam: - Theory - Reporting • In person viva including: - Logbook - Video cases - Practical skills station	• Two-part written exam: - Theory - Reporting	• Two-part written exam: - Theory - Reporting • In person viva on mannikin • Attendance at mandatory ESICM

			courses
Approximate cost**	- £275 for process - £70 for BSE membership	- €660 (less for ESC members)	- ESICM member €800 - Non-ESICM member €1300

Table 2. Comparison of the three training options for ACCE accreditation available in the Republic of Ireland ¹⁶.

*BSE ACCE: British Society of Echocardiography Advanced Critical Care Echocardiography; EACVI TTE: European Association of Cardiovascular Imaging Transthoracic Echocardiography; EDEC: European Diploma in Advanced Critical Care EchoCardiography; BSE: British Society of Echocardiography; TTE: Transthoracic Echocardiogram; TOE: Transoesophageal Echocardiogram; ESC: European Society of Cardiology. **as per JFICMI, BSE, EACVI, EDEC (2023) ^{11, 16, 19, 20}.*

British Society of Echocardiography Advanced CCE (BSE ACCE)

The BSE offers an ACCE accreditation in BSE ACCE. Candidates must hold BSE membership (approximately £70). Trainees must be overseen by a mentor. The accreditation process includes both a written exam (multiple choice question (MCQ) and “best answer”) and practical assessment. The maximum amount of time to complete the logbook is 24 months. However, extension applications can be made through their website. Exam fees are approximately £275 (accreditation process + booking fee) ¹¹.

The mentor must be an experienced echocardiographer with the ability to guide trainees in the accreditation process. It is advantageous if the mentor is BSE accredited. However, this is not essential. They should be aware of the training syllabus and the assessment criteria. Once competency is felt to be successfully achieved, the mentor must complete the curriculum-based competency tool. If it is not possible to locate a mentor, the BSE encourages trainees to contact them for support ¹¹.

In terms of the written exam, two sittings are offered per year (Spring and Autumn). Locations include the Republic of Ireland, along with the United Kingdom and others. The exam is divided into a theory section (MCQ) and image reporting. The pass mark is approximately 70% and 60%, respectively. Candidates must pass both sections. There is no limit for re-attempts ¹¹.

The practical assessment is offered up to five times per year. The three components include: the 250-case logbook, practical scanning assessment, and a viva on 5 video cases. This exam must be attended within 26 months of commencing the accreditation process ¹¹. The full training syllabus can be accessed online via the BSE website ¹¹.

As per the BSE, training in emergency echocardiography should be managed by an emergency echocardiography lead. This member of staff should be accredited to BSE Level 1 or 2. It is their responsibility to ensure ongoing staff training, maintenance of equipment and teaching coordination. If this person is not a cardiologist, a representative from the cardiology department should be involved ²¹.

BSE ACCE is mutually recognised by ESC, the Australian Working Group of Echocardiography, and the Working group on echocardiography and imaging modalities in cardiology, Croatian Cardiac Society ¹⁹.

European Association of Cardiovascular Imaging Transthoracic Echocardiography (EACVI TTE)

Similar to BSE ACCE, the certification program that EACVI offers is divided into two parts - exam and logbook. This accreditation is open to all healthcare professionals. The cost of accreditation is approximately €660. However, there are fee reductions depending on ESC membership. The examination has two parts. This is divided into image reporting and theory (all single best answer (SBA)). The exam is offered twice per year via an online proctored platform. The logbook is commenced after successful completion of the exam. It must be submitted within one year. However, it is possible to apply for an extension. EACVI TTE is mutually recognised by the BSE, the Australian Working Group of Echocardiography, and the Working group on echocardiography and imaging modalities in cardiology, Croatian Cardiac Society. If an individual has already obtained accreditation in TTE with any of these bodies, a logbook may not be required ¹⁹.

The logbook must contain 250 cases that have been assessed and signed by the trainee's supervisor. The cases must be obtained within a 12-month period. Six TTE detailed video cases must also be provided. No specific requirements exist regarding supervisor eligibility. EACVI TTE certification is not essential. The ESC states that the supervisor should be experienced in echocardiography. They are required to sign a letter of support and sign off the trainee's logbook. However, there is no requirement to provide any evidence of supervisor qualification ¹⁹.

EACVI is mutually recognised by BSE, the Australian Working Group of Echocardiography, and the Working group on echocardiography and imaging modalities in cardiology, Croatian Cardiac Society ¹⁹.

European Diploma in Advanced Critical Care EchoCardiography (EDEC)

The ESICM offers an accreditation in ACCE in the form of EDEC. To be eligible to register, a trainee must be a recognised intensivist (no longer in training). Proof of attendance at a basic echocardiography course in the past 2 years must be provided. They must have a mentor and supervisor to validate the TTE and TOE reports. Supervisors must be approved by the EDEC committee. Any clinician practising in ICU, cardiology, anaesthesia, or emergency medicine, that has previously been accredited in TTE or TOE may apply to become a supervisor. A list of approved supervisors is available on the ESICM website. The supervisor is responsible for validating the trainee's logbook. A printed and signed letter confirming this must be submitted. The supervisor may work with a local mentor. However, the supervisor must ensure that the mentor is competent in facilitating the trainee. They can be a clinician or echocardiography technician ²⁰.

To complete the diploma, three components must be achieved. These include the following. The candidate must complete a logbook (100 TTE and 35 TOE). They must pass the exam. They must collect 40 'points' (learning components). These courses should be attended in the first 12 months of registering²⁰.

The logbook should include a minimum of 100 TTE cases and 35 TOE cases. The logbook will be assessed by the EDEC committee. The trainee must attend some mandatory courses. These include online courses and advanced courses at ESICM annual congress. A points system is available on the ESICM website. A total of 40 points must be obtained for successful accreditation ²⁰.

The exam and logbook must be completed within a 24-month period from enrolment. The exam may be sat once the trainee has obtained 30 TTE and 10 TOE reports. The examination is divided into three parts. These include a theoretical written part (MCQ), a practical reporting part (SBA), and a practical objective structured clinical exam (OSCE) performed on a mannikin. Fees are €1300 (€800 for ESICM members) ²⁰.

All imaging that is recorded for logbooks (BSE ACCE, EACVI TTE, EDEC) should be anonymised ^{11, 19, 20}.

Discussion

It is possible to achieve accreditation in BCCE in the Republic of Ireland, via the FUSIC HEART pathway. Although BCCE accreditation is deemed essential as part of ICU training by JFICMI ¹⁶, challenges exist in providing these accreditations at a local level ^{1, 5}. The challenges faced

by trainees may include perceived lack of need for training, lack of equipment, and resistance from ultrasound providers ⁶. Obtaining a mentor and/or supervisor is an essential component. A list of qualified mentors/supervisors is available on most accrediting bodies websites. However, it still may not be possible to find a suitable mentor/supervisor. Frequent rotation of trainees may also pose a challenge to training in echocardiography.

Three methods of accreditation in ACCE in Ireland exist. Only EDEC includes TOE, which is recommended by ESICM ¹. It is possible to obtain accreditation in the Republic of Ireland. However, accredited trainers are not available throughout all units, which poses a challenge.

Accreditation pathways for both BCCE and ACCE in Ireland are provided by external governing bodies. No national accreditation body currently exists. This is similar to other countries, in which BSE or ESC are the overseeing accrediting societies. Although BCCE and ACCE (TTE and TOE) accreditation pathways are described throughout the included literature, a further “expert level” is sometimes mentioned. However, this is beyond the scope of this review.

Several overseas fellowships dedicated to training in critical care echocardiography exist. Examples include the Alfred Hospital in Melbourne ²² and Oxford University Hospitals Trust ²³. In these fellowship posts, trainees have regular protected training time under direct supervision, attend cardiology echocardiography review meetings, and practice daily scanning in the ICU. Some fellowships include contributing to in-house echocardiography services, integrated with cardiology. Accreditation in ACCE is much more achievable as a result.

Several courses exist for both BCCE and ACCE in the Republic of Ireland. There are currently three courses offered in Dublin, one in Galway, and one in Limerick. There are several ICUs offering training in BCCE and ACCE. The ongoing establishment of well-organised training programs in Irish ICUs with appropriate qualified supervision appears to be the best way forward. The continuation of regular courses in both BCCE and ACCE in the Republic of Ireland would allow trainees to attend without the need to travel abroad, improving accessibility. The JFICMI foresees a possible expansion of opportunities in critical care ultrasound training in the Republic of Ireland. Examples include lung and abdominal point of care ultrasound training ¹⁶.

Echocardiography is a useful diagnostic tool in intensive care. However, formal teaching has not been incorporated into many intensive care curriculums throughout the world. Trainees face challenges in obtaining competency. Currently, the options of accreditation meet the ESICM recommendations in terms of TTE accreditation. However, only one option incorporates TOE accreditation (EDEC). Several hospitals in the Republic of Ireland currently

offer local training and courses in BCCE and ACCE, although challenges still exist. A list of appropriate mentors and supervisors can be accessed via each accrediting body's website. It is felt that Irish ICUs should continue to provide training programs under qualified supervision at a local level. Established local programs along with national courses would improve training and accessibility to trainees in the Republic of Ireland. In the future, fellowships in critical care echocardiography may be available in the Republic of Ireland, similar to those in the United Kingdom and Australia.

Declarations of Conflicts of Interest:

None declared.

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Acknowledgements

We would like to acknowledge all clinicians involved in creating this article. We would also like to acknowledge all authors of the published guidelines and articles that have been referenced in this piece.

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Supplemental data 1: Article summaries.

Author	Year	Article type	Main points
Expert Round Table on Ultrasound in ICU	2011	Expert statement	- General critical care ultrasound and BCCE should be mandatory parts of intensive care training - Each country's respective critical care society should support such training - ACCE is an optional component of intensive care

			training
Wong et al	2020	ESICM recommendations	• Expert recommendations in relation to critical care ultrasound in general, including echocardiography, thoracic and abdominal ultrasound amongst others
Messina et al	2022	Narrative review	• Narrative review of the multiple uses of ultrasound by intensivists • Examples of echocardiography accreditation options internationally
Lau and Swanevelder	2011	Editorial	• Highlights the increasing use of general ultrasound and echocardiography by anaesthesiologists and intensivists • Describes the benefits of echocardiography in intensive care and the challenges to training
Kuza et al	2018	Single centre prospective trial	• After a 60-minute training session in transthoracic echocardiography, intensive care trainees demonstrated an improvement in both knowledge and ultrasound skills (n = 42) • Trainees that had never performed transthoracic echocardiography before showed the most

			improvement
Yang et al	2016	Web-based survey	• A web-based survey of 69 intensive care units demonstrated that 94% performed transthoracic echocardiography, whilst 33% performed transoesophageal echocardiography • Forty one percent of intensivists were untrained in echocardiography • Perceived barriers to training included lack of organised training, lack of time, perceived lack of need for training, insufficient equipment, and resistance from ultrasound providers
Expert Round Table on Echocardiography in ICU	2014	International consensus	• Guidance specifically relating to ACCE • Acknowledges that ACCE takes significantly more training than BCCE • Recommendation that TOE is included as part of ACCE
Schmidt	2014	Editorial	• Describes the benefits of intensivist accreditation in ACCE • Describes the importance of training pathways
Nanjayya	2019	Recommendations	• Defines the different levels of critical care

			echocardiography • This includes BCCE, ACCE (both TTE and TOE), and Expert level • Recommends minimum training standards for Australia and New Zealand
Marum and Price	2011	Review article	• This article outlines the FADE (Fast Assessment Diagnostic Echocardiography) program in Portugal.
Rajamani et al	2021	Systematic review	• The methodological appraisal of BCCE training guidelines demonstrated widespread deficiencies in formulation process. However, the impact of this requires further evaluation
Rajamani et al	2022	Delphi Process Consensus Statement	• The lack of studies evaluating BCCE training is highlighted • Outlines recommendations on BCCE training • However, these recommendations must undergo prospective validation
Brooks et al	2020	single-center, prospective reliability study	• A 12-month focused cardiac ultrasound course was delivered to seven trainees, in an Australian ICU • Assessment of LV function correlated well with expert interpretation