Evidence-based training and certification: the ERS thoracic ultrasound training programme

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The new European Respiratory Society thoracic ultrasound training programme enables participants to gain competence in thoracic ultrasound through structured, evidence-based training with robustly validated assessments and certification https://bit.ly/3IYrQsW

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Abstract

Thoracic ultrasound has developed into an integral part of the respiratory physician's diagnostic and therapeutic toolbox, with high diagnostic accuracy for many diseases causing acute or chronic respiratory symptoms. However, it is vitally important that the operator has received the appropriate education and training to ensure a systematic and thorough examination, correct image interpretation, and that they then have the appropriate skills to integrate all the findings for patient benefit.

In this review, we present the new European Respiratory Society thoracic ultrasound training programme, including a discussion of curriculum development, its implementation, and trainee evaluation. This programme enables participants to gain competence in thoracic ultrasound through structured, evidence-based training with robustly validated assessments and certification. The training programme consists of three components: an online, theoretical part (part 1), which is accessible all year; a practical course (part 2), with four courses held each year (two online courses and two on-site courses); and an examination (part 3) comprising an objective structured clinical examination (OSCE), which is hosted each year at the European Respiratory Society Congress.

Introduction

Thoracic ultrasound (TUS) is now considered an essential component of many clinicians' routine practice, and it is seen as an accessible diagnostic supplement to conventional imaging such as chest radiography and computed tomography (CT) [1]. TUS, when performed by clinicians, has been proven to have a high diagnostic accuracy, can rapidly aid in clinical decision-making, and is said to improve procedural safety [2–4].

It has gained popularity among several clinical specialities, particularly respiratory and intensive care medicine, as it is noninvasive, free of radiation, repeatable, and easily performed at the bedside. The use of TUS increased during the coronavirus disease 2019 (COVID-19) pandemic. Despite the findings not being specific to COVID-19 infections, a higher ultrasound score with increasing pathological findings was

associated with a higher risk of unfavourable outcomes such as intensive care admission and the need for mechanical ventilation [5].

Unfortunately, in Europe, training and certification requirements have not kept pace with the rapid technical development and accessibility of ultrasound equipment. This has caused point-of-care ultrasound examinations to enter a top 10 list of medical technological hazards [6]. The reliability of TUS is operator-dependent, requiring an operator to have sufficient training to perform, interpret and integrate the findings into a clinical context. Poorly trained operators run the risk of overlooking important pathologies or reporting false findings that can lead to unnecessary and potentially harmful invasive diagnostic procedures or treatment.

Medical educational theory advocates for structured and evidence-based education, exceeding the conventional and more traditional apprenticeship model and the "see one, do one, teach one" model. Arbitrary certification requirements are inadequate because the performance of a certain number of procedures does not necessarily equate to competence [7, 8]. The European Respiratory Society (ERS) supports an evidence-based approach to training and certification, and offers competency-based training programmes in, for example, endobronchial ultrasound (EBUS) [9] and respiratory sleep medicine.

This review presents and discusses the educational aspects, development, validity evidence, and launch of a structured TUS training programme by the ERS.

Methods

To develop the TUS curriculum, the approach, methods and process were developed based on the ERS-developed educational harmonisation framework [10], which complies with Kern's six-step approach for curriculum development [11]. This approach was previously employed in the creation of the successful ERS EBUS training programme. The main concepts of these frameworks are:

1) To identify the need for a curriculum and the target audience.
2) To establish goals, objectives, and the content of the curriculum, as well as determine the educational strategies.
3) To implement, evaluate, and further develop the curriculum.

Identification of needs, target audience, and TUS task force group

In 2016, a Danish national general needs assessment identified focused ultrasound scanning of the lungs as one of the 11 technical procedures in pulmonary medicine that should be integrated into a simulation-based curriculum [12]. 2 years later, the ERS published the "Update of the ERS international Adult Respiratory Medicine syllabus for postgraduate training" and the *ERS Monograph* on "Thoracic Ultrasound", both establishing TUS as a core skill for respiratory physicians [1, 13]. A task force comprised of international clinicians was established to oversee the development of a TUS curriculum and training programme. Members included advanced TUS practitioners and educators with many years of experience in delivering TUS teaching, medical and simulation educational experts, and those who helped to develop the successful ERS EBUS programme [9].

Finally, after working on the training programme, the ERS statement on TUS from 2021 confirmed the growing evidence supporting the use of TUS and underlined the importance of evidence-based training and certification [14].

Establishment of objectives and content, and determination of educational strategies

To gather information about current training programmes, educational strategies and methods of assessment, a literature search was undertaken based on members' existing knowledge of the topic and through reference screening, but without the use of a structured or evidence-based approach [15]. Medical educational theory and research in other educational areas suggested training would be optimal using a three-step approach, structured to have gradually increasing complexity [15–17]. Accordingly, the task force ratified a programme structure beginning with theoretical learning to establish the basic principles of TUS. This would be followed by a practical component, ensuring acquisition of ultrasound skills following hands-on training, and the creation of a TUS portfolio. The programme would end with an objective structured clinical examination (OSCE) for final certification and confirmation of TUS competencies (figure 1). The approach aligns with the framework for the assessment of clinical competencies proposed by Miller [18], which recognises the need for consecutive development when learning a new skill, with increased complexity when moving from the basics at the bottom of the pyramid towards the complexity at the top.

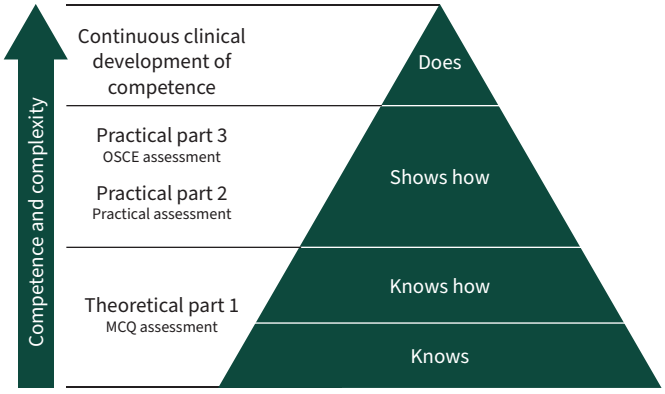

FIGURE 1 Thoracic ultrasound training programme according to Miller's pyramid. Reproduced and modified from [18]. The Creative Commons license does not apply to this content. Use of the material in any format is prohibited without written permission from the publisher, Wolters Kluwer Health, Inc. Please contact permissions@lww.com for further information. OSCE: objective structured clinical examination; MCQ: multiple choice question.

As well as basic theoretical knowledge and the ability to practically perform the ultrasound examination being key objectives for learners, the task force also agreed that the training programme should prioritise the integration of TUS findings into a clinical context, driven by its real-world use which sees it complement other diagnostic tests, clinical examinations and patient history. Thereby, the goals of the training programme are broad, whereas the objectives for each specific part and module of the programme are clear and measurable; striving for competence-based training, that accommodates trainees' different learning paces but ensures specific minimum requirements for each part. This structure advocates for mastery learning and the principles of "excellence for all", meaning that all trainees can learn the established goals and objectives to a high standard with minimal variation of the learning outcomes, but that individual trainees have different learning paces and prerequisites [19].

The curriculum evolved through several rounds of feedback and assessment by the task force, who needed to reach consensus at each stage to ensure that the objectives and content were robust across institutions and countries [11, 20].

The TUS curriculum and training programme structure

The TUS training curriculum comprises three units that cover the fundamentals of the topic required for clinical practice. As need and/or new evidence evolves over time, the number and content of the units are anticipated to adapt and expand. A complete list of the TUS curriculum topics, including specific learning objectives for knowledge, skills and attitude, is included in the supplementary material, with an overview presented in table 1.

The content of the curriculum is delivered *via* a training programme, which is split into three parts: theoretical, practical, and final assessment (see figure 1). Part 1 (theory) comprises a package of six online educational modules, covering basic physics and principles, focused TUS, basic chest sonography, ultrasound-guided procedures, and basic cardiac ultrasound (table 2). The educational programme is open to all for whom it is of interest, and for the part 1 there is no maximum number of participations. The anticipated time to complete the six modules is estimated to be between 12 and 20 h, ending with a timed, 30-question multiple-choice assessment required for part 1 certification, and for continuation to part 2.

For high-stake and summative assessments, solid validity evidence needs to be explored to ensure that the test actually measures what it is supposed to measure, that the internal consistency reliability is high enough, and to establish a credible pass/fail score. For part 1, the initial 30 multiple-choice questions (MCQ) have been tested using recognised validity frameworks [21]. As a part of the continuous improvement and development of the course, the task force will continue to expand the bank of MCQs, ensuring variability in the test from course to course. When more questions are added, item analysis will be undertaken to ensure a continued evidence-based approach.

TABLE 1 Overview of the European Respiratory Society thoracic ultrasound curriculum

Unit 1: Thoracic ultrasound fundamentals
Physics and basic principles
Indications for ultrasound examination (and procedure)
Planning the procedure
Patient preparation
Technique and protocol
Basic ultrasound-guided procedures:
Thoracocentesis (pleural aspiration/drainage); and
Tube thoracostomy (chest-drain insertion)
Reporting and documentation
Unit 2: Ultrasound assessment of thoracic structures
The chest wall
The pleural surfaces and cavities
The lungs
The diaphragm
The mediastinum
Unit 3: Basic ultrasound assessment of related structures
The lower neck (*e.g.* lymph node assessment, cranial part of the oesophagus)
The upper abdomen
The heart

TABLE 2 Structure of the thoracic ultrasound (TUS) training programme

	Part 1	Part 2		Part 3
Aim and content	To give the trainee knowledge in and understanding of: • Ultrasound physics, basic TUS, basic chest sonography, ultrasound-guided procedures, and basic cardiac ultrasound • Identify patients eligible for ultrasound examination, prepare and plan the examination • Interpret ultrasound images and identify sonopathological signs	To further develop theoretical knowledge and give the trainee practical skills, so he/she is able to: • Adjust and optimise the ultrasound images • Perform a TUS examination and assess thoracic structures • Have basic knowledge to assess related structures including the lower neck, upper abdomen, and heart • Have basic understanding and skills in ultrasound-guided procedures, *e.g.* real-time ultrasound-guided pleural aspiration		To assess and certify trainees in all aspects of basic TUS including: • Theoretical knowledge *cf.* part 1 content • Practical skills *cf.* part 2 content • Ability to perform the ultrasound examination, interpret the findings, and put the results into patient context • Establish a diagnosis, as well as differential diagnoses, and reflect on the treatment and/or management of the patient
Time	Estimated 12–20 h	2-day on-site course	1-day online course	60-min assessment at the ERS Congress
Educational strategy	Theoretical online modules including text, ultrasound images, dynamic ultrasound clips, and continuous formative assessments	Practical, hands-on course with a focus on practical skills The trainees scan simulated patients, patients with sonographic pathologies, and a simulator with several different pathological cases The trainee to instructor ratio is 3:1	Online and interactive course with live demonstrations and breakout group discussions	Objective structured clinical examination (OSCE) including six stations of 9 min in length
Description	No prerequisites are needed for registration for part 1	To register for part 2, trainees must have completed part 1		To register for part 3, trainees must have completed parts 1 and 2, and have trained in TUS in their clinical daily life

The part 2 (practical) component of the programme was originally intended to be delivered as a 2-day, hands-on course featuring clinical observation, active training on simulated patients, scanning real patients with sonographic pathologies, and simulation-based training. The structure of this course was based largely on a successful model developed in Odense, Denmark, with sessions delivered by a broad, multidisciplinary clinical faculty. To increase the time available for the development of practical skills, and to ensure sufficient experience for each trainee, courses were to be set up with multiple opportunities for hands-on training over the 2 days. The student to instructor ratio was set at 3:1 to ensure close supervision of each trainee, with evidence showing a strong correlation between the time given for hands-on training and competence [22]. At the end of the 2 days, a pass/fail practical examination was to be held for participants, based on the course material [23].

However, due to the impact of the COVID-19 pandemic (lockdowns and the risk of disease spread in particular), the part 2 material was adapted into an online, interactive course to ensure TUS education remained accessible despite restrictions imposed by local, national and international regulations. A survey among pulmonologists following COVID-19 found that respondents felt well-trained in handling COVID-19-positive patients, but 36.3% responded that they had performed procedures that they did not feel competent with as a direct result of the pandemic [24]. Although it was acknowledged by the task force that online TUS courses cannot completely replace in-person courses, through the use of interactive features like live demonstrations, short lectures with time for debate, interactive question and answer sessions, and break-out sessions with case discussions, the course remained feasible and its content remained relevant to participants. Two on-site and two online part 2 courses are held per year, for the on-site courses there is a limit of 18 course participants whereas the online course can hold up to 50 participants. As for most multistep educational programmes, a drop out from part 1 to part 2 is expected, as well as a drop out from part 2 to part 3. This is an important topic of evaluation in the ERS TUS task force and educational office.

Following the part 2 course, independent of whether it is undertaken online or on-site, participants are to complete self-directed, local training and create a portfolio of ultrasound cases and clips in an online platform. At least 25 ultrasound scans are required, and the cases are peer-reviewed by fellow course participants and course faculty. For certification of part 2, the online or on-site course is to be completed, 25 cases must be uploaded, and at least 10 peer reviews must be completed.

To gain final, overall TUS certification, an OSCE assessment must be successfully completed. This OSCE is held yearly at the ERS Congress and makes up part 3 of the TUS programme. To be eligible, participants must have completed both parts 1 and 2.

The OSCE was developed specifically for the ERS TUS programme using accepted educational principles and through gathering of multicentre validity evidence. It comprises four practical stations (image optimisation and knobology, pleural effusion, interstitial syndrome, and pneumothorax) and two theoretical stations where participants answer a series of MCQs based on ultrasound images and clinical information [25].

Implementation, evaluation, and further development

As the quality of implementation directly affects training programme outcomes, implementation research is gaining prominence within the fields of medical education and course development [26, 27]. Several frameworks have been proposed, including those useful to planning and assessing quality of implementation, *e.g.* identification of stakeholders and an implementation team, determining institutional and organisational back-up, planning course and curriculum monitoring and evaluation [28]. The ERS education team, along with members of the ERS TUS task force group, served as an implementation team and assigned dedicated time for the realisation of the training programme with well-defined roles and responsibilities. Parts 1 and 2 were implemented in 2019 and, following delays resulting from the COVID-19 pandemic, part 3 was implemented in 2022. At the time of writing, a total of four online part 2 courses have been delivered since early 2020. Feedback from participants has been positive and, as we move into the post-pandemic period, it has been decided that two in-person courses and two online courses will be held each year, increasing both flexibility and access to as wide a group of learners as possible.

The task force remains committed to keeping content and educational strategies up to date, with the training programme thoroughly evaluated after each part by both trainees and faculty. Additionally, the task force meets regularly to review the existing curriculum and to determine if new curriculum modules are needed. New faculty members are being continuously invited to ensure uniformity and generalisation beyond the institutions that developed and started the programme, thereby ensuring the TUS programme

remains current and of relevance to the whole ERS community. Following last year's part 2 courses and the first part 3 OSCE, survey data were collected on the number of ultrasound examinations performed by trainees, their self-assessment and confidence, in order to evaluate trainee behaviour during the course. These data are soon to be published.

Conclusions and next steps

The ERS TUS task force has successfully developed a TUS educational programme based on structured and evidence-based frameworks for curriculum development and assessment of clinical competencies. The TUS training programme has been implemented with part 1 courses that are accessible all year, four part 2 courses (two on-site and two online) and one part 3 OSCE each year.

The ERS and the TUS task force group strive to continuously improve the training programme by keeping up to date with new research and new trends, and by monitoring course quality and feedback with a view to expanding the curriculum, improving the programme, and increasing the accessibility of TUS.

Conflict of interest: P.I. Pietersen reports receiving support for attending meetings and/or travel from Boehringer Ingelheim outside the submitted work. N.M. Rahman is on the editorial board of the ERS publication, *Breathe*. J.M. Wrightson reports receiving contributions towards attendance at European Respiratory Society annual congress by ERS in recognition for delivering educational activity, outside the submitted work. A. Farr is an employee of the European Respiratory Society. N. Tabin is an employee of the European Respiratory Society. M. Slavicky is an employee of the European Respiratory Society. C.B. Laursen reports receiving royalties as an author of book chapters/as a book editor from Munksgaard (publisher), outside the submitted work; and payment for lectures from AstraZeneca A/S for educational events/symposia/courses organised by AstraZeneca, outside the submitted work. The remaining authors have nothing to disclose.

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