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European Resuscitation Council Guidelines 2021: Education for resuscitation

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Abstract

These European Resuscitation Council education guidelines, are based on the 2020 International Consensus on Cardiopulmonary Resuscitation Science with Treatment Recommendations. This section provides guidance to citizens and healthcare professionals with regard to teaching and learning the knowledge, skills and attitudes of resuscitation with the ultimate aim of improving patient survival after cardiac arrest.

Keywords: Resuscitation, Education, Simulation, Faculty development, Technology enhanced learning, Basic and advanced life support

Introduction and scope

This chapter provides evidence-based guidance to citizens and healthcare professionals (HCPs) with regard to teaching and learning the knowledge, skills and attitudes of resuscitation with the ultimate aim of improving patient survival after cardiac arrest. The guidance addresses the second key component of the Utstein formula of survival, namely 'educational efficiency' (Fig. 1).[1] As educational approaches are the critical links between scientific findings and their implementation into practice, we present the components of education in resuscitation in more detail, based upon the original formula of survival (Fig. 2). The effects of educational interventions in

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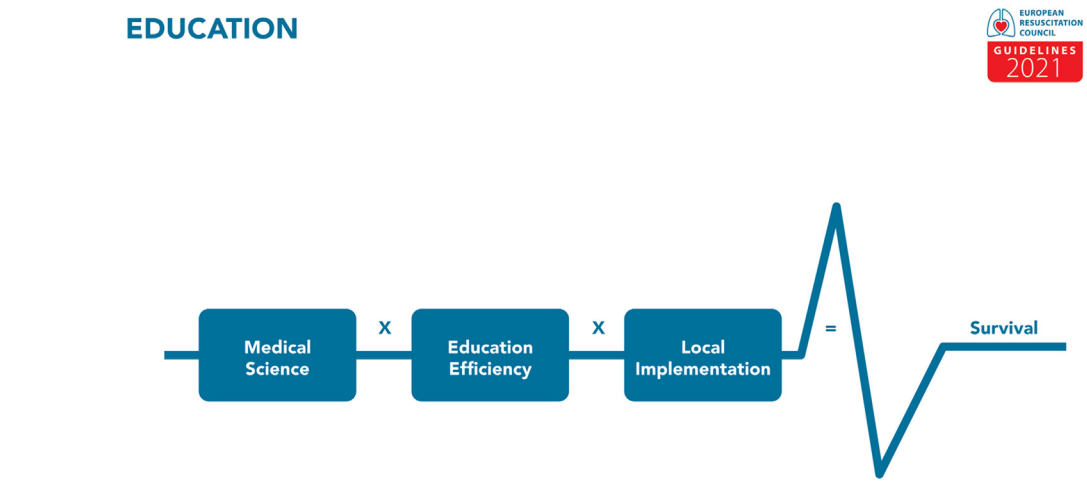

Fig. 1 – The Utstein formula of survival.

resuscitation are maximised by incorporating educational theory. This chapter addresses education in all settings where people may teach and learn resuscitation, including every level from basic to advanced life support and for all ages of learners as well as all ages of cardiac arrest victims. Key stakeholders to be targeted include governmental (healthcare, education, etc.) and political authorities who manage national and/or regional healthcare systems.

The basic principles of medical education adopted for the ERC resuscitation courses encapsulate learning theories and teaching strategies to build an educational framework for the different types of learners and approaches to teach resuscitation. These guidelines address the teaching of different target groups, as well as the learning of skills to provide high-quality resuscitation. Over the last decade, technology and simulation to educate resuscitation have gained

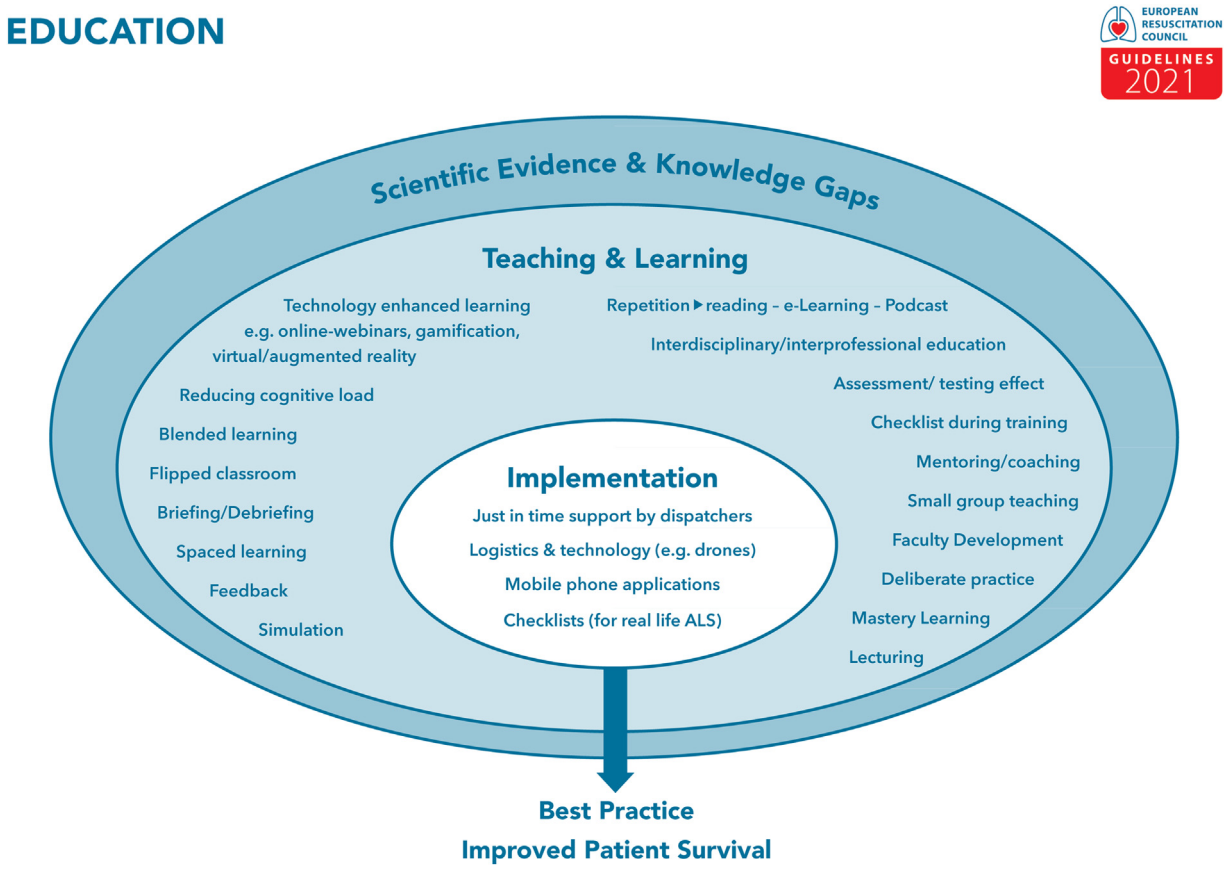

Fig. 2 – ERC educational approach to best practice and improved patient survival.

increasing importance promoting changes in the way ERC courses are taught. Therefore, this chapter highlights faculty development which needs to be implemented by each teaching institution. The chapter ends with a view on the outcome of resuscitation education, encountered research gaps, and future direction of resuscitation education. A summary of the educational strategies referred to in this chapter is presented in Fig. 2. The recently published ERC COVID-19 Resuscitation guidelines include recommendations for resuscitation education during the pandemic.[2] These COVID-19 guidelines are constantly updated, based on evolving knowledge and experience with the disease. These changes and guidance on restarting ERC courses are accessible via the ERC web page (www.erc.edu).

For the purpose of this chapter, the term CPR relates to the specific technical skills of cardiopulmonary resuscitation (e.g. performance metrics of CPR), whilst resuscitation is used as a generic term covering the broader range of skills and interventions. The term bystander is used to describe rescuers who happen to be at the scene to provide help, and the term first responder is used for those who have additional training and are alerted to attend the scene of a resuscitation. Healthcare Professionals (HCP) are defined as those who work in any healthcare sector. Finally, any form of resuscitation education beyond BLS (defined as initiating the chain of survival, chest compression, ventilation, use of an AED) is described generically as advanced life support (neonatal, paediatric and adult

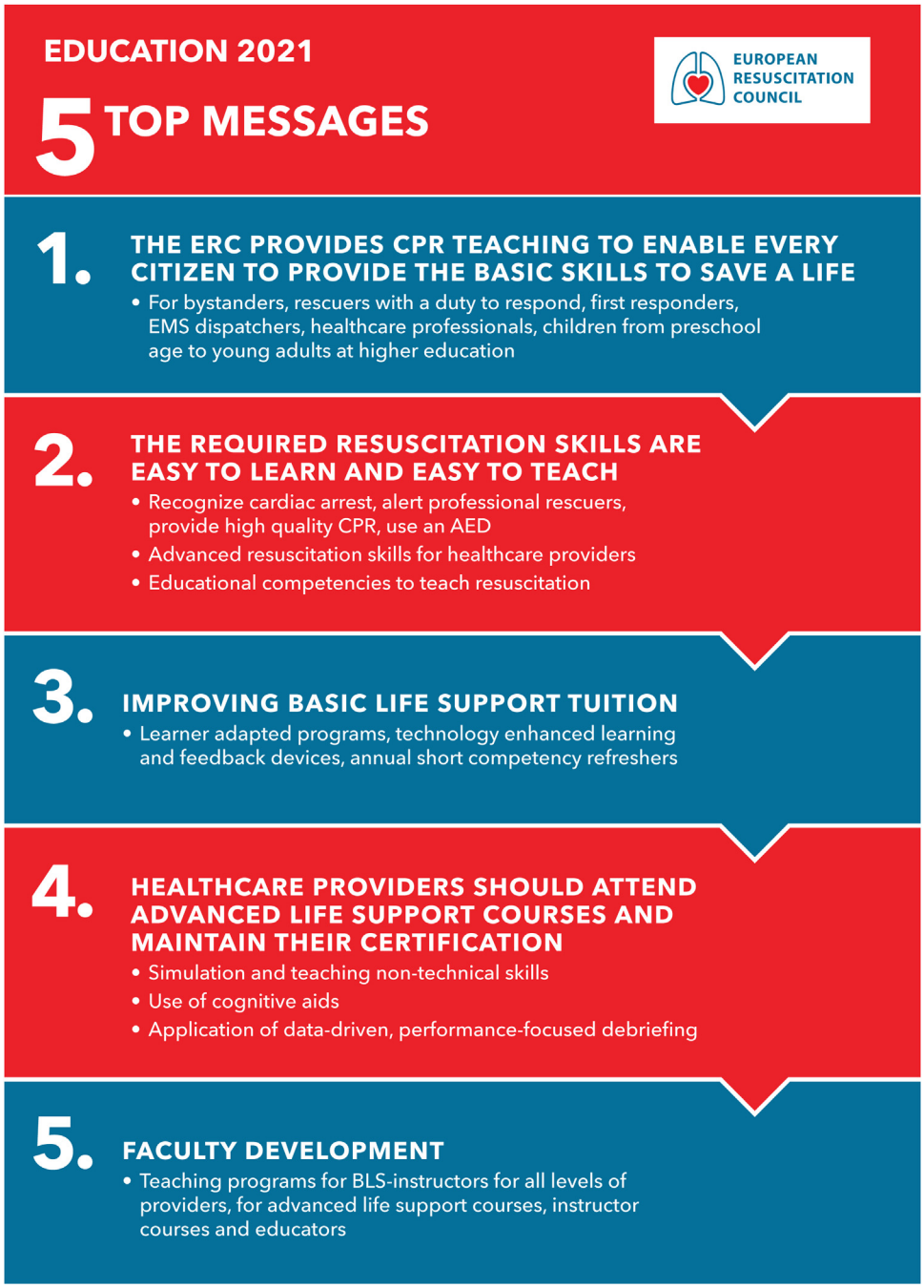

Fig. 3 – Education summary infographic.

EDUCATION

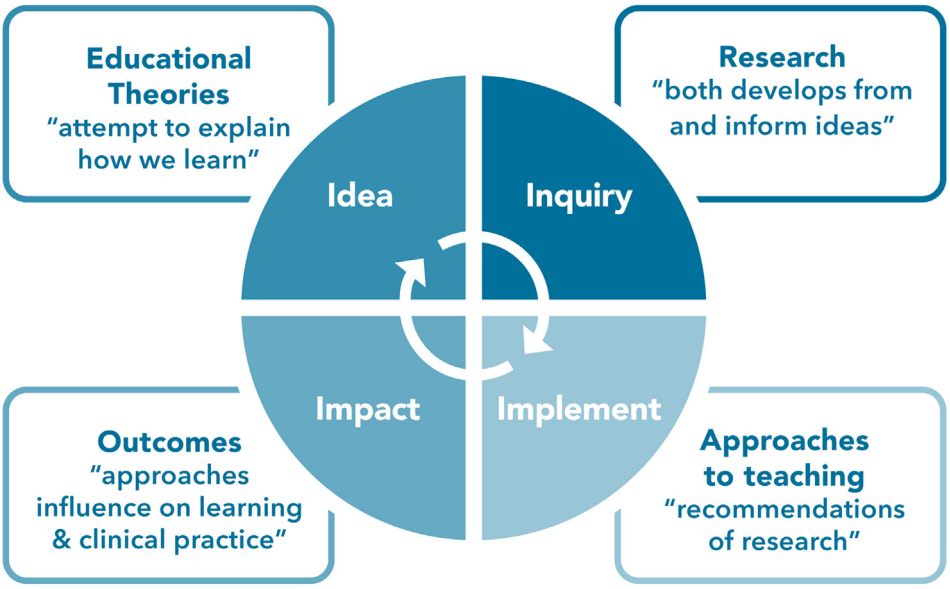

Fig. 4 – Approaches to educate resuscitation.

life support). Where the term 'ALS' is used, this refers specifically to the ERC Advanced Life Support course.

These guidelines were drafted and agreed by the Education Writing Group members. The methodology used for guideline development is presented in the Executive summary.[2a] The guidelines were posted for public comment in October 2020. The feedback was reviewed by the writing group and the guidelines was updated where relevant. The Guideline was presented to and approved by the ERC General Assembly on 10th December 2020.

Key messages from these guidelines are presented in Fig. 3.

Concise guideline for educational practice

The principles of medical education applied to resuscitation

The ERC, as a scientific based organisation, grounds its guidelines on current medical evidence. The same applies for the ERC education guidelines for resuscitation. The ERC approach to education can be grouped into 4 themes (4 'I's): (1) Ideas (theories of education and how we learn), (2) Inquiry (research which both develops from and informs the ideas mentioned), (3) Implementation (approaches based on the research), and (4) Impact (outcome of these educational approaches both for learning and clinical practice) (Fig. 4).

Resuscitation education for different target groups

Every citizen should learn to provide the basic skills to save a life. Those with a duty to respond to emergencies need to be competent to perform resuscitation, depending on the level of rescue they provide, from BLS to advanced life support, for children and/or adults, according to the current ERC guidelines. Resuscitation competencies are best maintained if training and retraining is distributed over time, and frequent retraining is suggested between two and twelve months. For HCPs, accredited advanced life support training is recommended, as well as the use of cognitive aids and feedback devices during resuscitation training. Specific team membership and team leadership training should be a part of advanced life support courses, and data-driven, performance-focused debriefing needs to be taught.

Key points in resuscitation education for bystanders and first responders are:

- enhance willingness to perform CPR;
- reinforce the chain of survival;
- teach resuscitation using feedback devices;
- distribute resuscitation training over time (spaced education);
- maintain resuscitation competencies by frequent retraining.

Key points in resuscitation education for HCPs are:

- teach every HCP high-quality CPR (from BLS to advanced life support level, children and/or adults, special circumstances depending on the workplace and patient mix);
- teach accredited advanced life support courses and include team and leadership training in such courses;
- use cognitive aids;
- teach and use debriefing.

Teaching the skills to perform high-quality resuscitation

Teaching the technical skills to perform resuscitation on every given level is very important. Equally important, however, is the teaching of human factors: e.g. communication, collaboration in teams and with different professions, awareness of the critical situation, etc. Human

factors are crucial to achieving high-quality CPR and good clinical practice. Teaching these factors will increase the willingness of trained responders to help victims in a life-threatening situation, improve the initiation of the chain of survival by starting BLS and gives participants of CPR courses the confidence to attempt resuscitation whenever needed.

Technology enhanced education to teach resuscitation

Learning CPR can be supported by the use of smartphones, tablets, etc. by using apps and social media, as well as feedback devices. These learning modalities may be teacher independent. They improve retention and facilitate competency assessment in CPR. Gamified learning, (e.g. virtual and augmented reality, tablet apps simulating monitors, etc.) may engage many learners. Virtual learning environments are recommended to be used for pre-course e-learning, as part of a blended learning approach, or for self-learning options of learning independent of time and location for all levels of CPR courses.

Simulation to educate resuscitation

High as well as low fidelity simulation in resuscitation education facilitates contextualised learning for a variety of learners. It integrates technical and non-technical skills and considers the environment or context of specific learner groups and the different levels of expertise. Hence, simulation provides the opportunity to learn to deal with human factors in critical situations. Specific team or leadership training should be included in advanced life support simulation. Profound learning occurs during the reflection phase in the debriefing of a simulated resuscitation.

Faculty development to improve education

In many areas of education, the quality of the teacher has a major impact on learning, and this can be improved by training and ongoing faculty development. The evidence for these effects in resuscitation training is scarce and many recommendations on faculty development are therefore extrapolated from other areas. Three aspects of faculty development are important: selection of suitable instructors, initial instructor training, and maintenance and regular update of their teaching quality.

Effect of resuscitation education on outcome

Accredited ALS training and accredited neonatal resuscitation training (NRT) for HCPs improve the outcome of patients. The effect of other life support courses on patient outcome is less clear, but it is reasonable to recommend other accredited life support courses. Further research is needed to quantify their actual impact on patient outcomes.

Research gaps and future directions in educational research

There is a lack of high-quality research in resuscitation education to demonstrate whether CPR training improves process quality (e.g. compression rate, depth or fraction) and patient outcomes (e.g. return of spontaneous circulation, survival to discharge or survival with favourable neurological outcome). Successful strategies to improve educational efficiency from the wider medical education literature should be considered to study their value for resuscitation education. Contextualised and tailored CPR training can prevent the decay of resuscitation competency. There is a potential for resuscitation courses to become less generic and to focus more on individual needs of the learner. Future research areas include investigating optimal training and support provided to resuscitation trainers and the role of education in reducing emotional and psychological trauma to the rescuer.

Evidence informing the guidelines

The principles of medical education applied to resuscitation

The Utstein formula of survival in resuscitation demands that educators “create learning experiences highly likely to result in acquisition and retention of skills, knowledge and attitudes needed for good performance.”[1] The ERC Education for Resuscitation guidelines use a framework which draws on four components (idea, inquiry, implementation, impact) to achieve this objective.

1. Idea – the theories of education and how we learn

Many educational theories arise from sociology, psychology, anthropology, neuroscience, and more recently the growth of new technologies. All these theories attempt to explain how we learn and therefore how we should teach.[3] There is no single theory which encapsulates the many disciplines involved in education. However, there is a commonality among the theories which can arguably be encapsulated in five main paradigms (Fig. 4).

a. Behaviourism assumes that learners are like a piece of blank paper, with learning occurring as response to the application of a stimulus. Learning is an externally driven activity resulting in a change in the individual's behaviour. It results from the repeated application of the stimulus or reinforcement whether positive or negative i.e. punishment or reward. There is no consideration of the individual's mental state or ability. The main proponent of behaviourism is Skinner.[4]
b. Cognitivism argues that learning is more than a response to a stimulus and focuses on the mental activities which enable learning. These processes govern how knowledge is received, organised, stored and retrieved. Memory, attitudes and beliefs play an important role in cognitive theory. Internal processing in the brain is the main focus of cognitivism, not so much the response. Cognitivist approaches emphasise the need to make learning meaningful and to relate new knowledge to previous existing knowledge.[5–7] Cognitive Load Theory is based on how we acquire and store different types of knowledge. It distinguishes between biologically primary knowledge (that which we have evolved to learn), and biologically secondary knowledge (which is more recently required by society for cultural reasons). Secondary knowledge is harder to acquire. Because of the way in which information is processed, the working memory can become overloaded and instructional design should therefore be based on managing the cognitive load.[8]
c. Constructivism focuses on the individual's experience of the world and how they construct meaning from reflecting on this. Constructivism calls for real life experiences to enable the learner to construct new competencies building on their own prior experiences. Learners are active participants in their learning. An example is Bruner's Discovery Learning.[9] Students are placed in problem solving situations where they must construct meaning

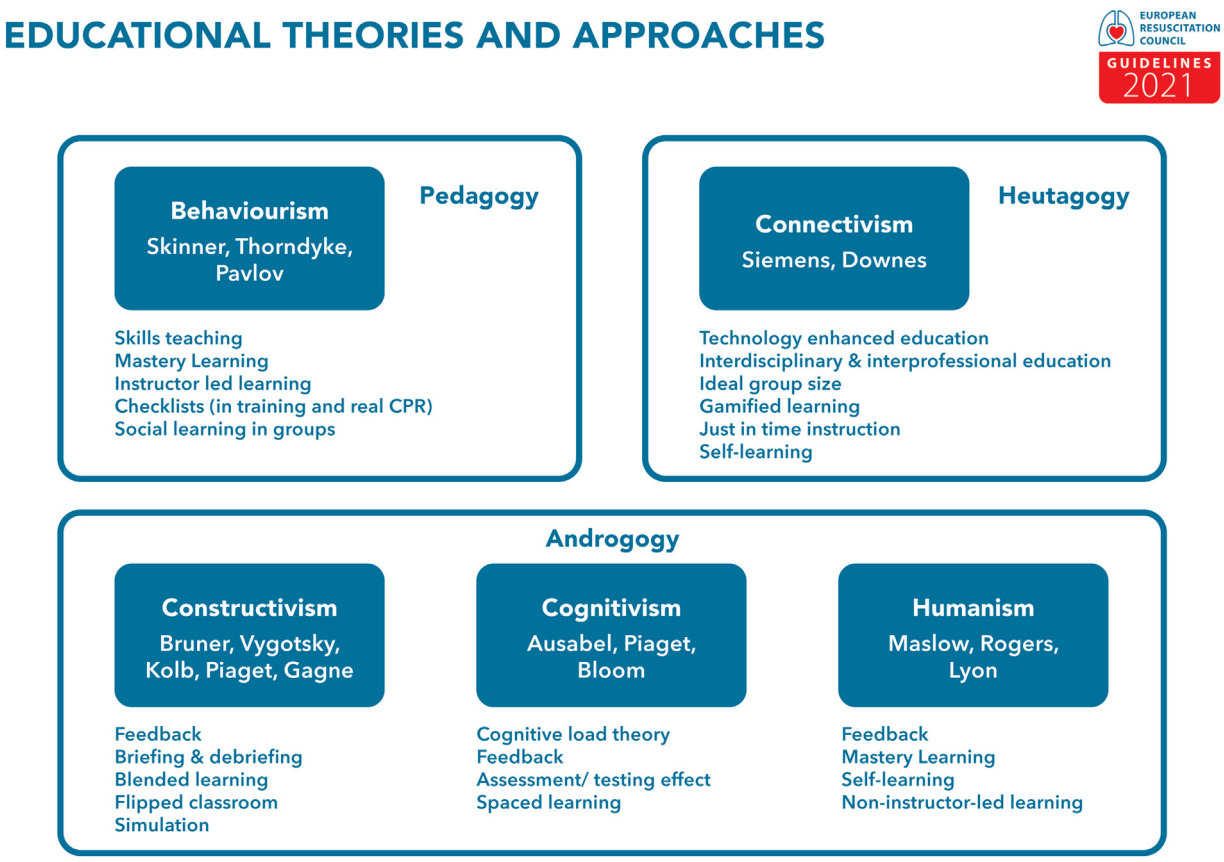

Fig. 5 – Educational theories and approaches.

by drawing on past experience and knowledge to create new knowledge. Vygotsky argued that the social context surrounding the learner impacts on their learning as they learn from their interaction with others.[10] This 'social constructivism' is the key to what we can learn on our own and what we can learn when guided and supported by a knowledgeable partner, the difference between the two is referred to as the "Zone of Proximal" development. Bruner developed Vygotsky's ideas describing the support and help from the skilled partner as scaffolding, initially used to support the learner through the zone of proximal development, but gradually withdrawn as the student progresses.

d. Humanism sees learning as a personal act to achieve fulfilment. Learning is student centred and personalised, it is not just about intellect but about the whole person, their needs and journey to self-actualisation. Attention should be paid to the dignity and emotions of the learner more than the intellect.[11,12]
e. Connectivism is a 21st century learning theory based on the idea of learning through communities and networks. Heavily influenced by the rise of the internet and digital platforms, connectivism sees learning as no longer about the individual but about connections with technology and others. It moves away from the cognitive view of internal processing and instead relies on a network of people or technology to store, access and retrieve knowledge.[13]

The application of these theories to advanced life support courses in particular have been described in a narrative review (Fig. 5).[14]

Beside these theories three concepts describe how people learn: pedagogy, androgogy, and heutagogy.[15,16] These concepts focus on the relationship between learner and teacher, which has been described as a continuum[17]:

- Pedagogy involves teacher-centred learning: the student is the recipient of what the teacher wants the student to learn.
- Androgogy involves student-centred learning: the student and teacher negotiate the learning.[18]
- Heutagogy means self-discovery and therefore involves student-led learning: the student determines what they want to learn.[19]

Peer-to-peer learning, referred to as paragogy has been described in recent years.[159] Initially the peer-to-peer learning theory came from connectivists' on-line education and has developed beyond online to any peer-to-peer education and also successfully in resuscitation training.[20]

The ERC's approach to education demonstrates the move along this continuum, with the introduction of the virtual learning environment (CoSy – https://cosy.erc.edu/), modular education (standardisation vs. individualisation of CPR training), life-long learning, blended learning and hands-on face-to-face courses, feedback methods to support CPR teaching and learning, coaching, and recertification. The ERC is moving from didactic teaching and utilising approaches based on research culminating into a connected system where the individual learners determine what and when they wish to learn.

2. Inquiry – the research which both develops from and informs the ideas mentioned

The ERC education guidelines use the existing evidence from educational research to inform the approach to education. It is important that all aspects of educational delivery are subjected to the

same academic scrutiny as the clinical scientific guidelines. This guidance is produced following a series of systematic and narrative reviews of the international literature to inform best educational practice. For more detailed information consult the ILCOR Consensus of Science and Treatment Recommendation (CoSTR) publication for 2020.[21]

3. Implementation – the approaches based on the research

This guideline on education for resuscitation discusses a number of approaches based on the fundamental theories of education (Fig. 4). The specifics with regard to implementation are also covered in more detail in the Chapter Systems Saving Lives of these ERC guidelines.[22]

4. Impact – the outcome of these educational approaches both for learning and clinical practice

Research has revealed that almost any approach to learning may work.[23] It is important to move away from merely identifying the effect of different approaches to identifying the impact each approach has relative to another. Hattie compared this approach to clinical practice where treatments are constantly monitored to ensure they are leading to success and evidence is the key to adaptive professional decision making.[23] Following a meta-analysis of 800 studies, he identified the ten most effective factors that influence learning: (1) student self-reporting grades, (2) formative evaluation, (3) teacher clarity, (4) reciprocal teaching (where students become the teacher in a small group), (5) feedback, (6) teacher–student relationships, (7) meta-cognitive strategies (to help students understand the way they learn), (8) self-verbalisation/questioning, (9) teacher professional development, and (10) problem-solving teaching. A consequence is that learning becomes visible when teachers see the learning through the eyes of their students.[24] The teachers develop an approach to their teaching which encompasses having the right mindset, being a cooperative and critical planner, being an adaptive learning expert and a receiver of feedback. In the end, the role of teachers is to know their impact and to help students become their own teachers.

Resuscitation education for different target groups

Initially CPR was taught to HCPs and to first responders such as first aiders and rescue organisations. Subsequently, evidence emerged about the importance of system intervention to foster early resuscitation attempts as a key to increasing survival after cardiac arrest. This has led to the expansion of CPR education to larger population groups: from children and their teachers, from citizens and bystanders, from organised First Responder programmes, to HCPs at different levels of response and duty (e.g. prehospital Emergency Medical Services (EMS) personnel and dispatchers, as well as in-hospital ward staff, intensive care unit and emergency department physicians and nurses). The specific educational needs of these groups lie on a continuum depending on individual and organisational CPR competency needs (e.g. from basic to advanced levels). The required competency level determines the CPR training interval, frequency, duration, and need for retraining, along with the required teaching equipment for the level of training and assessment.

Bystanders and first responders

The primary goals of resuscitation training for non-HCPs (ranging from children in different age groups to bystanders and first responders) are to increase CPR rates, effective BLS and AED use, and timely EMS activation for out-of-hospital cardiac arrest. Enhancing willingness to perform CPR as part of the CPR teaching programme in this population may have a direct impact on survival rates for out-of-hospital cardiac arrest.[21] Furthermore, an essential part of bystander CPR education is the recognition of cardiac arrest (unresponsiveness, not breathing normally), alerting the EMS, and the performance of BLS (which includes the use of an AED) according to the ERC Guidelines 2020.[25]

The evidence identified in the ILCOR CoSTR suggests that the use of feedback devices that provide directive feedback on compression rate, depth, release, and hand position can be of benefit during bystander and professional CPR training (weak recommendation, low-certainty evidence). In the absence of such devices, tonal guidance including music or metronomes may be used but they only improve compression rate.[21] The ILCOR CoSTR for spaced learning (education or retraining separated by longer periods of time) identified 17 studies (13 randomised studies, 4 cohort studies). A narrative synthesis of these findings showed that spaced learning seems to be more effective than massed learning (education provided close together in time) leading to a weak recommendation, based on very-low-certainty evidence supporting the use of spaced learning.[21,26] The recommendation for increased use of spaced learning in resuscitation education is valid for non-HCPs as well as for HCPs. The ILCOR systematic review found insufficient data to suggest for or against the use of cognitive aids in non-HCP training.[21] A further ILCOR CoSTR found insufficient evidence to recommend an optimum interval or method for BLS retraining for non-HCPs. BLS skills decay within 3–12 months after initial CPR education but evidence suggests that more frequent (re)-training improves CPR skills (weak recommendation, very-low-certainty evidence), responder confidence, and willingness to perform CPR leading to a weak recommendation, based on very-low-quality evidence supporting frequent re-training.[21]

The KIDS SAVE LIVES programme initiated by the ERC has a key strategic aim to target as many children as possible worldwide with CPR education in schools.[27,28] The CPR competencies should be adapted to the age of the students from preschool to university level due to their differing abilities to perform the skill and understand the underpinning theory.[29–33] Teachers are very supportive about BLS training, but often lack proper content knowledge.[34,35] Teachers only need to learn the specific skills of resuscitation that they will subsequently teach to their students as they are already experts in teaching.[36] Including such resuscitation teaching into curricula of teachers' education is highly recommended.[33] No evidence exists about which educational strategy to teach school children is the most effective.[37] Therefore, the format of teaching CPR will vary depending upon local requirements and circumstances. One example of a successful approach to teaching school children is of medical students acting as resuscitation teachers. This is very effective for both schoolchildren and the medical students themselves.[38–40] The medical students improved their own resuscitation competencies, they learned at the same time how to act as future CPR instructors, and they improved community CPR education.

Healthcare professionals at different levels of response and duty

High-quality resuscitation education is mandatory for HCPs at all levels from BLS to advanced life support, for children and/or adult resuscitation, depending on their workplace requirements for CPR competencies. BLS education for HCPs is, in principle, no different from teaching resuscitation to non-HCPs, but in special

circumstances specific competencies need to be added to the standard BLS teaching (e.g. neonates, COVID-19, specific in-hospital settings such as operating rooms, etc.). The ILCOR CoSTR identified that the provision of accredited adult ALS education for HCPs is recommended as such courses improve patient outcome (weak recommendation, very-low-certainty evidence).[21,41] An evidence update in the ILCOR CoSTR supports that low-fidelity manikins are suggested as acceptable for standard advanced life support training in an educational setting.[21] High-fidelity manikins might also be used for resuscitation education if the infrastructure, trained personnel, and resources to maintain the programme are available. The ILCOR systematic review on specific team and leadership training suggests bases on a very-low-certainty evidence to include such training as part of advanced life support training for HCPs.[21] In contrast an ILCOR systematic review on the use of cognitive aid did not find evidence for its use in bystanders or first responders resuscitation education, indirect evidence from clinical trauma care and from full-scale simulation suggests that cognitive aids (e.g. checklist, flow-charts, mnemonics, etc.) should be used during resuscitation training of HCPs.[21] An ILCOR CoSTR weak recommendation based on very-low-certainty evidence suggests that data-driven, performance-focused debriefing should be used by rescuers after every resuscitation. Therefore, we suggest such debriefing needs to be integrated into advanced life support education for HCPs during training and as a teaching goal to be applied during real resuscitation of cardiac arrest victims.[21,42]

Dispatcher education to provide high-quality CPR

To identify a cardiac arrest situation by means of a phone call is not always easy. Dispatchers accurately identify cardiac arrest in about 70% of cases.[43,44] If the suspected diagnosis of cardiac arrest is wrong, patients will receive inappropriate chest compressions or CPR is not started.[45] Other significant challenges for dispatchers are the identification of agonal breathing,[46] how to engage bystanders to deliver CPR and increase their willingness to perform CPR, and how to shorten the time to initiation of chest compressions.[43,44] Programmes that improve the quality of telephone-assisted CPR and the feedback from physicians to dispatchers have improved the outcome of cardiac arrest patients.[47] Specific training of dispatchers on how to deliver telephone-assisted CPR can lead to improved cardiac arrest recognition, reduction of misinterpretation of agonal breathing, increased rate of patients receiving chest compressions, and a shorter time until the first compression is delivered.[48] Even short simulation-based training sessions can improve cardiac arrest recognition rates, and the speed with which CPR is started.[49]

No structured course to educate dispatchers exists, and EMSs tend to teach their dispatchers via in-house training programmes. It is suggested that any dispatcher education needs to cover the most challenging tasks for dispatchers when confronted on the phone with a possible cardiac arrest situation: (1) recognition of the cardiac arrest, (2) enhance the willingness of rescuers to perform CPR and warn rescuers about their safety, (3) provide instructions to perform chest-compression-only CPR, (4) make rescuers aware when an AED might be available and to use the AED when it arrives, and (5) how to help the EMS to reach the location of the incident. Finally, the value of debriefing of dispatchers after such telephone instructions and how to receive feedback from the EMS personnel attending the cardiac arrest should be included in dispatcher education.

Teaching the skills to perform high quality resuscitation

To improve patient survival from cardiac arrest, essential core skills in resuscitation need to be defined and learned. The learning goals for advanced life support education include all defined BLS competences and advanced competencies such as airway management and vascular access. Over the past few years, the importance of human factors has been increasingly recognised.

Educational goals in BLS

Independent of the background of the rescuer (e.g. bystander, first responder, HCP), BLS education needs to teach effective chest compressions and the safe use of an AED. In paediatric BLS, ventilation skills should be taught together with chest compressions. Studies show that chest compressions can be taught from childhood but the effectiveness of chest compressions depends on the physical abilities of the rescuer, which should be taken into account when teaching children.[30,31] Evidence exists that the use of feedback devices during CPR education can improve the quality of chest compressions during training,[21] but unfortunately this does not lead to improved patient outcomes.[50] Because of their user-oriented design, even an untrained user including children can follow the instructions to use an AED safely.[51] Rescuer safety is a key point for AED training.

Traditionally BLS courses teach mouth-to-mouth/nose and mouth-to-mask ventilation for every rescuer, and ventilating the lungs is an important skill to be learnt particularly in certain circumstances (e.g. children, drowning, or asphyxia). In some patients (e.g. infection risk) bag-mask ventilation is preferable, and this situation introduces a new skill set to be learnt for many non-HCPs and most HCPs. They may not be as competent as those HCP who use bag-mask ventilation in daily clinical practice. With that we emphasis the value of potentially providing some degree of ventilation of the lungs which in turns is better than no ventilation.

Performing two-person ventilation, one holding the mask with two hands (two-hand mask ventilation), and the other squeezing the bag may improve the seal of the mask and the chance of effective oxygenation and ventilation and therefore is the recommended technique.[2,52] It is reasonable to recommend teaching this relatively simple technique of bag-mask ventilation to first responders and HCPs who normally provide BLS, especially when there is a risk of spreading infection (e.g. during a COVID pandemic). In contrast to mouth-to-mouth ventilation, the practice of bag-mask ventilation during training on manikin carries no risk of infection. Learners of BLS and advanced life support courses need to understand how to avoid injury and which measures should be applied to minimise infection risk.[2] BLS courses should include teaching potential rescuers how to communicate effectively with the EMS dispatcher providing and receiving adequate information to avoid unnecessary delay in initiating resuscitation. First responders might obtain insights in how to conduct structured hand-over communication to EMS or to other HCPs.

Education about communication during BLS is important in order to overcome barriers that rescuers might experience in performing CPR.[53] There are three main barriers: personal factors (emotional barriers, most often “panic”, but also socio-economic factors, and physical factors like “ability to place the patient flat”); CPR knowledge (skill deficits, fear of causing injury or doing something wrong); and procedural issues (communication and language barriers, and recognition of cardiac arrest).[21,54] A narrative synthesis summarised the following factors that increase rescuers’ willingness to perform

CPR (despite dispatcher instructions, community initiatives, and social media technologies): prior CPR training, community CPR awareness programmes, chest compression only programmes in mass training, and CPR-trained rescuers with a higher educational degree. Mouth-to-mouth ventilation was not a barrier for bystanders to perform CPR, although this study pre-dated the COVID-19 pandemic.[21] Addressing these barriers and enablers to starting CPR might increase the willingness to help those in a life-threatening situation. Finally, BLS education has an important role to play in encouraging the broader participation of rescuers in community programmes that aim to provide help for people in life-threatening situations (e.g. first aid, first responder resuscitation, public AED programmes, schoolchildren CPR programmes) which was summarised in a ILCOR CoSTR narrative review.[21,55]

The duration of BLS courses is a matter of debate. There is no one duration that fits all learners, as this depends on the previous resuscitation education of the rescuers, the specific learning goals for a given group of learners, and local social and cultural educational factors. Examples range from very short BLS introductory sessions to 2-h courses and traditional BLS courses for non-HCPs of 4 h.[56,57] Some of the theory in these courses could be taught online as part of a blended learning approach to save the face-to-face time for hands-on training.

Educational goals in advanced life support

All of the aforementioned BLS skills are an integral part of advanced life support education and need to be adapted to the target group of patients (e.g. neonatal, children, adults, trauma). Specific learning goals for advanced life support are airway management, manual defibrillation, vascular access, a structured approach to managing the critically ill patient, application of advanced resuscitation approaches for special situations and circumstances, as well as the treatment of peri-arrest arrhythmias and immediate post-resuscitation care. The teaching of these competencies can take more time and effort depending on the learners' profession and clinical duties and need to be adapted to their learning needs and level of previous competencies. For this reason, the ERC advanced life support courses have implemented a modular approach to adapt to the needs of the course participants.

A specific characteristic of ERC ALS courses is the integration of leadership and team training as detailed described in an ILOCT CoSTR systematic review, which includes the importance of human factors during resuscitation.[21,58,59] Theoretical and practical human factors competencies in resuscitation can be taught in scenario-based simulation sessions highlighting the importance of these human factors such as situation awareness, team and task management, and decision-making.

There is no evidence about the best way to teach these non-technical skills. Teaching approaches need to consider local social and cultural factors as well as the previous awareness of the ALS course participants. The use of briefing and debriefing was addressed in an ILCOR CoSTR systematic review encouraging the application of supportive, correcting and constructive feedback during ALS education.[21] Based on very low-certainty of evidence a weak recommendation was issued to use data-driven performance-focused debriefing of rescuers in- and out of hospital. The application of closed-loop communication in a team is a suitable way for the learners to integrate these behaviours into their clinical practice.[60] The increased application of human factors during patient care may reduce medical errors and improve patient safety.

How to teach these skills?

There are a variety of ways to learn the theory of the resuscitation skills behind the aforementioned competencies. Examples include reading a manual, following an interactive e-learning programme,[61,62] or participating in a workshop or an internet-based webinar.[63] A blended learning approach has become common for resuscitation training.[64] No specific didactic approach is superior to another in teaching skills. The factors that influence skills teaching the most are the degree of instructor engagement with the content and with the learners, and the degree of truthful feedback on the performance.[65] Hands-on workshops on CPR skills using low- or high-fidelity manikins, interactive video-based self-learning,[66] internet-based e-learning, scenario simulation and reflection on practice during case discussions are all ways to teach and learn these competencies. The different ERC courses put the concept of blended learning into practice by using all of these different educational modalities. For more details please visit the ERC website and the ERC virtual learning environment CoSy (www.erc.edu or https://cosy.erc.edu/en/login)

The use of cardiac arrest scenario simulation seems to be a suitable strategy for the education of human factors.[67] Instructors need to appreciate the value of the debriefing as learning happens during the phases of reflection on the experience. At the same time cardiac arrest simulation may provide opportunities for learners to develop and apply new strategies to improve on earlier performance.

Traditionally, resuscitation education is commonly delivered during teaching events or courses at a single period of time and without interruption, also called massed learning.[68] Evidence from an ILCOR CoSTR suggests that spaced learning (training or retraining distributed over time) can improve CPR skill performance between course conclusion and 1 year after a course compared to massed learning (very-low certainty of evidence).[21,26] Moreover, 'rapid cycle deliberate practice' has been shown to be a very effective educational strategy to improve team performance in simulated resuscitation education.[69–71] Rapid cycle deliberate practice divides complex parts into easier individual skills. These skills are repeated as often as needed with corrective feedback 'rapid cycles' until the expected level of performance is obtained, and the next level of skill difficulty is approached. This allows individualised feedback on improvements adjusted to the level of the learner's competency.

These educational strategies move resuscitation education away from single course events to learning distributed over time. Following these principles, the ERC has developed a life-long-learning (LLL) strategy enabling all persons educated in resuscitation to maintain their resuscitation competencies as long as they pass recertification modules every 6–12 months (Fig. 6).

Formative assessment with corrective feedback is needed to provide an external view of the given performance to the learner beyond self-assessment of competencies. Training and assessing the competencies of a rescuer to provide high-quality CPR guarantees that adequate help will be provided whenever needed.

An ILCOR CoSTR systematic review issued a weak recommendation based on very low-certainty of evidence to provide standardised ALS courses with properly trained instructors as such ALS courses have been shown to improve patient outcomes.[21,41] Peer-teaching was also reported as a highly effective educational strategy for BLS[20,72,73] as well as for advanced resuscitation programmes.[74]

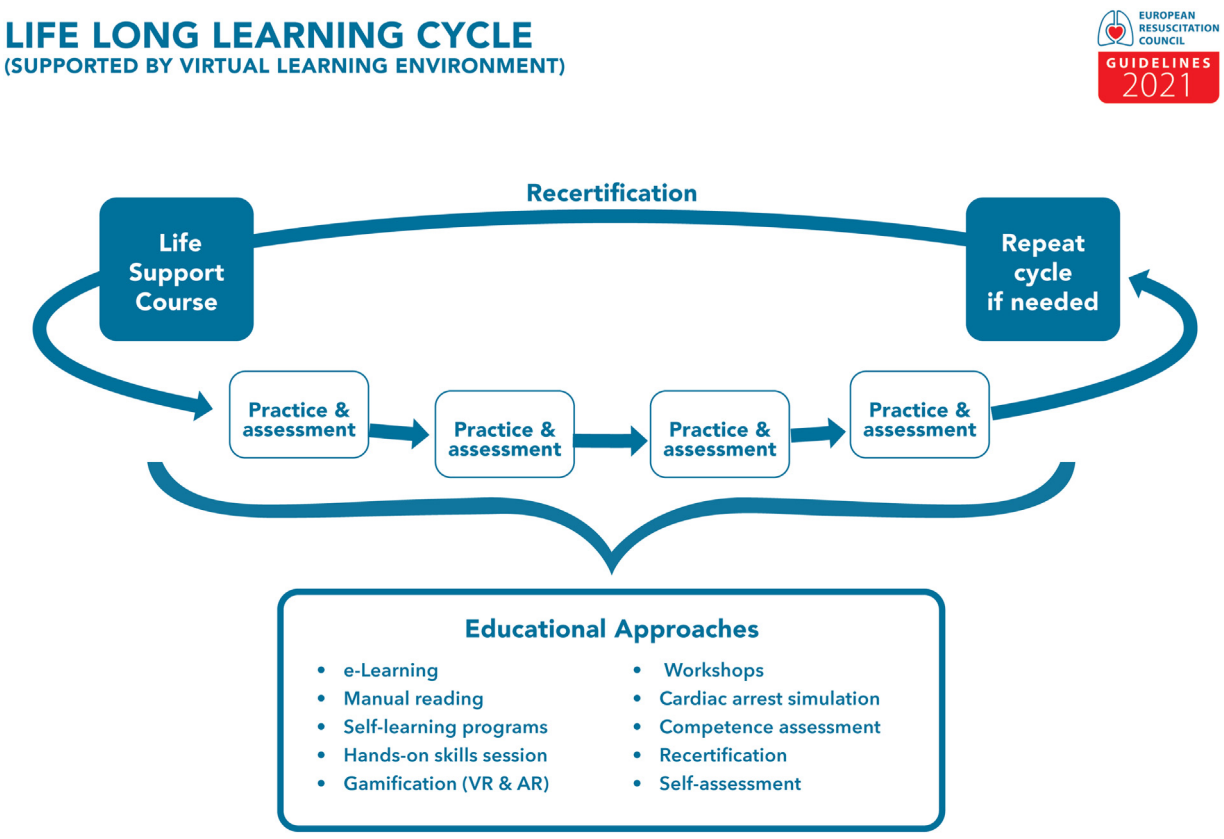

Fig. 6 – Life Long Learning (VR = virtual reality, AR = augmented reality).

Technology-enhanced education to teach resuscitation

Over the past few years, many new technologies have become available to teach CPR but their actual impact on teaching and learning is less clear. Access to medical content has never been easier because of the ubiquitous availability of the internet. Virtual learning environments (VLE) support medical education and, since 2015, CoSy has been established as the virtual learning environment of the ERC and as part of all the ERC courses. Smartphones and tablets can perform multiple tasks and they change how we teach and learn CPR: they can be turned into a compression feedback device or become a simulated monitor. An ILCOR CoSTR systematic review based on low-certainty evidence suggests that real-time feedback from apps provided during CPR teaching improves skill performance with visual and/or audio prompts.[21] Serious games on mobile devices engage CPR learners differently than traditional class room teaching (e.g. https://life-saver.org.uk Resuscitation Council UK; http://sauveune-vie.be University of Liege, Belgium; www.ircouncil.it/relive/Relive and www.ircouncil.it/picnic both Italian Resuscitation Council, or https://www.erc.edu/news/a-breathtaking-picnic-app via the ERC website).[32,75–77] Therefore, such devices and programmes should be included in future CPR educational approaches and combined with face-to-face education.

The easily accessible and large variety of social media platforms have the potential to teach large audiences in a variety of settings, times and remote areas. Social media enable the instantaneous addition of comments or content and promote immediate communication and learning,[78] but little is known about the effect of social media on the teaching and learning of resuscitation. A small study reported the usefulness of an instant messaging app (Telegram) in maintaining BLS theory amongst medical students.[79] Twitter was reported to promote learning during courses and was able to track CPR training barriers.[80] YouTube contains many videos about CPR education, but these videos provide insufficient information about BLS and advanced life support in adults and children according to current CPR guidelines.[81,82] In a systematic review of freely available mobile phone applications (Apps) giving instructions to perform adult CPR, only 15% adhered to current AHA or ERC guidelines.[83]

Free open access medical education (FOAMed) is a dynamic collection of resources.[84] FOAMed (e.g. Twitter, blogs, etc.) promotes clinical concepts, evidence-based medicine, and circulates conference material, but erroneous content can be spread rapidly and widely, even after a fast correction.[85] VLEs give learners the flexibility to adapt their time and location for learning and most participants have a positive attitude towards their use.[86] The evidence about the use of e-learning to teach BLS is not overwhelming. Most studies compare standard courses with e-learning. In a randomised controlled trial Castillo et al. compared an ERC standard 4-h BLS-course with blended learning (2-h virtual training and 2-h in-person instruction) and found no difference in high-quality CPR or BLS-knowledge 9 months later.[87] Others implemented blended learning in their BLS courses for bystanders and HCPs using a virtual reality headset and quality CPR real-time feedback and BLS-manikin practice.[88] Adding e-learning to paediatric BLS improved outcomes of practical skill acquisition in medical students at the end of the course.[64] There is insufficient evidence to suggest for or against blended BLS learning.

A blended learning approach including e-learning and reduced face-to-face teaching time for the ALS course was found to be as successful as standard face-to-face courses, especially for those participants who liked the teaching format of e-learning.[89–91] An ILCOR CoSTR systematic review strongly recommends based on very-low- to low-certainty evidence the provision of e-learning as part of a blended learning approach to reduce face-to-face training time in ALS courses (Fig. 6).[21]

Simulation to teach resuscitation

Simulation in resuscitation education is widely used and is a well-established educational strategy. It facilitates contextualised learning relating to each learner's real-world setting from first responder to complex resuscitation teams. Simulation includes the teaching of technical skills (e.g. airway management, defibrillation, etc.) and human factors (e.g. non-technical interpersonal and cognitive skills). Advanced life support teaching includes simulation of peri-arrest and cardiac arrest situations. Simulation enables crisis resource management targeting specific team or leadership behaviour during CPR. Simulation equipment encompasses part task trainers for BLS and complex high-fidelity technology in advanced life support education. Taking into account these characteristics, learning objectives need to be defined for the participating individuals or teams, as well as choosing the adequate equipment. An ILCOR CoSTR evidence update supports that simulation-based education of resuscitation in situ (directly at the workplace of individuals) or in a dedicated simulation centre might be included within the continuous education programmes of life support courses.[21] The learning from a simulation experience is greatly enhanced during the cognitive reflective debriefing of a simulated resuscitation.

Fidelity of simulation

The fidelity of simulation manikins, compared to real humans, can be scored from low to high. Low-fidelity manikins or part-task trainers, provide training opportunities for basic procedures and skills (e.g. airway management using heads, chest compressions and ventilations using BLS torsos) without any further technologically advanced features. High-fidelity manikins comprise computer-controlled simulators offering different features (e.g. physical findings, displaying vital signs, specific sounds, procedural realism to interventions like airway management or vascular access) resembling actual patients. The use of high-fidelity manikins can provide more intense engagement with the learner and improve the consistency of the learning experience. Furthermore, regardless of the fidelity of the manikin, the relevance of the simulation setting is of critical importance to engage learners and promote learning.[92,93]

A systematic review compared the use of high versus low-fidelity manikins during resuscitation training on patient outcomes, skill performance or cognitive knowledge.[94] An ILCOR CoSTR evidence update in 2020 found that the high-fidelity group demonstrated moderately improved skills immediately following course completion and improved knowledge retention 6 months later.[21,94,95] There was no benefit for high-fidelity manikin use for knowledge at course completion, skill performance at 1 year or between course conclusion and 1 year. Therefore, the selection of adequate equipment remains a question of simulation objectives and resources, taking into account first the educational purpose and second the level of competencies of the participating individuals. Bases on very-low certainty of evidence the ILCOR CoSTR 2020 issued a weak recommendation to use high-fidelity manikins when the training site has the infrastructure, trained personnel, and resources to maintain the programme.[21] In cases where high-fidelity manikins are not available, it is suggested that the use of low-fidelity manikins is acceptable for advanced life support training in an educational setting (weak recommendation based on low-quality certainty of evidence). Additionally, modern tablet-based simulation apps combined with the use of low-fidelity manikins may be a suitable alternative at reasonable cost for simulation during resuscitation education.

Teaching of human factors

Simulation provides the opportunity to experience the effect of human factors on performance and to learn how to improve specific non-technical skills in a simulated critical situation of a cardiac arrest. Human factors include interpersonal and cognitive factors, such as effective communication, situational awareness, leadership and team collaboration, task management, and decision making. Teamwork and leadership are increasingly recognised as important factors contributing to patient safety and outcome in healthcare.[96] Moreover, leadership during resuscitation is associated with better team performance.[97] Additionally, an observational study of video-recorded in-hospital ALS situations suggests that good non-technical skills may be associated with improved performance of technical skills such as chest compression quality, ventilation quality, and defibrillation quality.[98] Leadership and team training can be taught using various methods, such as e-learning, video-based training, instruction, demonstration using role models, or by means of simulation with or without specific checklists (e.g. Team Emergency Assessment Measure (TEAM-tool)).[99] However, the use of checklists and assessment tools need to be validated before use in order to be capable of specifically targeting the respective skill sets corresponding to the learning objectives.[100] Leadership and team training, as well as human factors education, may be delivered in dedicated sessions as an add-on to courses, as well as incorporated as a longitudinal theme throughout. However, an ILCOR CoSTR systematic review identified a lack of evidence in terms of effectiveness and efficiency of team and leadership training when comparing different teaching modalities.[21] In the absence of randomised controlled trials, the effect of specific leadership and team training on patient outcomes remains unclear. Studies have so far mainly focused on HCPs, but human factors training as well as team and leadership training should extend to include first responders or bystanders as well. In summary, it is suggested that specific team and leadership training should be integrated as part of advanced life support courses for HCPs (very low certainty of evidence). Hence, team and leadership should be addressed as a core competency alongside technical skills when educating resuscitation.

Briefing and debriefing of resuscitation performance

Briefing and debriefing represent two vital aspects relating to simulation training and to actual resuscitation practice. Briefing is defined as a review and communication of pertinent facts about the resuscitation before the event.[101] It sets out a framework for professional resuscitation teams to prepare the roles and tasks within the resuscitation team and before patient contact and performance. Debriefing is a discussion, reflection and analysis of a performance between individuals after resuscitation or training with the aim of improving future performance.[102,103] Specifically, the critical insights and reflection on the performance after a simulation or

real cardiac arrest are critically reviewed and this is a crucial aspect in the learning process.

The characteristics of debriefing include: (1) a facilitator (who may or may not have been a member of the resuscitation team, and with or without dedicated training on how to perform a debriefing) and the participants (individuals up to an entire team or care unit); (2) the format (individual feedback, or involving parts of or a whole group session); (3) the content (quality of care, e.g. guideline, protocol or process adherence; objective CPR quality metrics such as chest compression rate and depth, flow fraction; human factors and emotional aspects); (4) the timing (immediately after the event –hot debriefing; later in time–cold debriefing); (5) the duration (from a few minutes up to a longer extent).[104–107] Due to difficulties in self-assessment and recall of events, the use of objective recorded CPR data may contribute to an unprejudiced review during the debriefing and many defibrillators/monitors already offer such options.[108–110]

A systematic review of the impact of briefing and debriefing on resuscitation performance compared to no briefing or debriefing revealed, firstly, that no evidence was identified relating to briefing before cardiac arrest. Secondly, CPR quality metrics on debriefing after in-hospital cardiac arrest in adults[111,112] and children,[113] and after adult out-of-hospital cardiac arrest could be analysed.[114] All studies included data-driven performance-focused recordings of different sources in the debriefing. The meta-analysis demonstrated significant effects of data-driven debriefing on survival to discharge, return of spontaneous circulation, and chest compression depth. There was no significant effect demonstrated on survival with favourable neurological outcome, chest compression rate and chest compression fraction in the ILCOR systematic review.[21] It is suggested that data-driven, performance-focused debriefing of rescuers after in- and out of hospital cardiac arrest should be the standard of care for both adults and children (based on very-low certainty of evidence).

Faculty development to improve education

For general education, the work of Hattie (using a meta-analysis of 800 studies) related the strongest effect sizes for learning achievement to the individual instructional quality of the teacher.[24] Another systematic review of 38 meta-analyses evaluated factors correlating with achievement in higher education and emphasises the importance of teacher training.[115] The authors found strong associations of learners' achievement with social interaction within courses and stimulation of meaningful learning by setting learning tasks which require the students to actively process the content.[115] The review concluded that it was much more important *how* a method was applied than *what format* of instruction was used. Teachers whose students showed high achievement after being taught invested much effort in designing the microstructure of their courses, establishing clear learning goals, and employing feedback practices.[115]

Although these are strong arguments for faculty development in general, there is much less evidence on faculty development specifically in medical education and very little in the field of resuscitation education.[116] The outcome of interventions in faculty development can be assessed at various levels looking at the effect on the faculty trained (e.g. the acquisition of teaching skills), on the learners (encompassing both the acquisition and the implementation of the taught skills) and on the outcomes learners achieve when they applied the learned skills in practice.

Low quality evidence is available in relation to outcomes at the level of the faculty trained[117,118] and at the level of learners trained by trained faculty.[119] For instance, one randomised controlled study on CPR training for medical students found little difference between those instructed by trained instructors and those trained by untrained instructors.[119]

When looking for evidence for resuscitation training, observational studies have shown that BLS courses for laypersons had deficits in instructor quality, and in the way content was delivered. These findings call for improved strategies to train BLS instructors.[120–123] No data are available for faculty development interventions related to patient outcomes.

In this section, three aspects of faculty development will be discussed: the selection of instructors, the initial instructor training, and the maintenance of skills.

Selection of instructors

Resuscitation education aims to teach the management of cardiac arrest, an uncommon event for many HCPs and which most non-HCPs who learn CPR will rarely encounter. Various target groups of learners have to be educated including clinicians in acute care specialties, first responders, HCPs with various levels of resuscitation practice and bystanders, including children. For these purposes, instructors with different expertise and with different backgrounds have to be recruited. Many instructors for BLS courses will not have a professional background in healthcare (e.g. schoolteachers, lifeguards, volunteer members of First Aid or charity organisations).

Only one randomised controlled trial on CPR training for schoolchildren looked into CPR trainer selection and found that schoolteachers were superior to HCPs in transferring knowledge while being equally successful in teaching skills.[124]

Since resources for faculty training are limited, it is important to select individuals who already show supportive attitudes, intrinsic motivation, appropriate communication skills, and enthusiasm for the content to be taught. The availability of instructors differs according to the type of courses. BLS instructors teach relatively simple "basic" but lifesaving skills. These lifesaving skills can be learnt from an engaged person, who can enthusiastically teach these competencies, with relatively little content expertise. For teaching children (e.g. in the KIDS SAVE LIVES programmes) schoolteachers are suggested to be most appropriate. Besides their teaching competencies, instructors should also be aware of being role models and change agents. They need to have an appreciation of affective learning and motivational skills as well as being aware of the educational outcomes most relevant to their learners (i.e. in which situations learners will have to apply the learned content), as well as its impact on patient outcome.

Within the ERC advanced life support courses, the faculty recognises instructor potential based upon specific criteria to suitable course candidates who show excellent knowledge, skills and personality traits believed to be conductive for facilitating learning.

Instructor training

No study addressed specific formats about how to teach a CPR instructor. A recent systematic review on faculty development programmes in medicine found various approaches to teacher training to be effective including seminars, workshops, series of

teaching sessions, and fellowships.[116] Most of the studies only addressed observed teaching performance and not the effect of the teacher training on the learning achievement of their students. An effective approach emerging from this review was to utilise practical learning formats coupled with constructive feedback, commonly referred to as experiential learning.[125–128] Instructor training should cover all the teaching methods applied in the courses for which the instructors are being educated. First of all, instructors should have appropriate content knowledge to sufficiently explain the details and the evidence behind the taught CPR competencies to the level appropriate for their learners. Initial training programmes for resuscitation instructors should utilise formats based on evidence from educational theory, applying outcome-based, meaningful teaching and learning activities. Essential educational elements of resuscitation instructor training should be the teaching of practical CPR skills, the facilitation of interactive small group learning and the use of basic presentation skills. Instructors should be able to provide a structured teaching session which builds on the pre-existing knowledge of the learners. In addition, instructors should develop an understanding of which learner outcomes have the strongest impact on patient outcomes (e.g. initiating CPR, chest compression quality, etc.).

Educational content of the training should cover how to establish competency-(outcome)-based teaching and learning settings, to provide constructive feedback, and to conduct valid assessments to guide teaching and for certification.

Advanced life support instructors should also have appropriate content knowledge to explain all the details and the evidence behind the taught resuscitation competencies. Not only for the more complex teaching contexts (e.g. training of HCP teams, who routinely deal with resuscitation), competencies of future instructors should include how to support the development of human factors (non-technical skills, communication and interprofessional team collaboration), how to debrief effectively and how to use feedback devices during resuscitation training.[21,129,130]. Many different strategies to provide feedback, to debrief and to teach teamwork have been described, however it is not known which method works best for resuscitation instructor training.

Resuscitation instructors for non-HCPs need to be able to educate learners to be motivated to help and to be able to perform BLS to a level that improves patient outcomes. As large numbers of such BLS instructors are required to teach whole populations, these instructors are often non-HCPs themselves and a high level of content expertise cannot be expected. These BLS instructors should be able to demonstrate and perform the actions and skills of CPR according to the current guidelines perfectly and answer questions relating to the information provided in the teaching materials. Studies indicate that instructors delivering courses for non-HCPs may have deficits in key content knowledge and are therefore unable to assess the competence of their learners reliably.[121,123] As they are not content experts they need to use national or international checklists as the basis for the assessment. Effective learning is important to increase self-efficacy and motivation to intervene promptly in an emergency.[131] All these aspects need to be addressed specifically during the education of BLS instructors for non-HCPs.

Teaching resuscitation skills to children may require a specific set of teaching competencies and there is evidence that schoolteachers are as effective as HCPs in teaching CPR skills whilst potentially achieving better transfer of knowledge to their students.[28,124] A potential solution could be that both HCPs as content experts and qualified schoolteachers as teaching experts could be involved in faculty development programmes for CPR instructors who teach schoolchildren.

Finally, formative assessment of instructor competence is necessary before teaching on actual courses. When starting to teach, a valuable step is that of instructor-candidate status, when the future instructor teaches on courses under supervision with immediately available peer support and feedback.

Maintenance of competencies/continuous professional development

Once instructors have been trained, it is essential for them to maintain their competencies and to keep up with the developments in resuscitation and education science. The aim is to promote self-directed, continuous professional development, and to avoid individuals “doing their own thing”. Continuous Professional Development is equally important for ERC instructors, course directors and educators.

No study addressed the question how competencies of instructors might best be maintained over time. To promote self-directed, lifelong professional development, a number of strategies have been proposed based on limited evidence including reflective practice, peer coaching and establishing communities of practice.[68]

Deliberate reflective practice describes the process of self-reflection on one's own performance with the intention to further improve performance.[132] There are important obstacles to the development of reflective practice in medicine. Foremost is the difficulty some HCPs have with self-assessment.[133] There is also confusion about the concept of reflective practice and a dearth of experienced reflective practitioners to act as role models.[134] All of these problems need to be addressed if reflective practice is to be implemented effectively into faculty development for resuscitation training.[135] Structured faculty evaluation tools might be useful for this.

Peer coaching provides a valuable perspective from outside, promotes mutual learning between peers and strengthens communities of practice.[42,136] Peer coaching may be encouraged within instructor teams and therefore easily performed, and this is a common situation in advanced life support courses. It can also be done as a mutually planned observation of two instructors. This requires a climate of mutual trust between instructors and may be the first step towards the development of communities of practice. Communities of practice may influence the practice of teaching by sharing aims and views on teaching.[137] Collaborations may be established, e.g. to share teaching material, or to establish peer coaching. Also, new information may be spread more quickly, and in a standardised manner. For communities of practice, organisational support is essential; one example of a supporting tool is the ERC VLE ‘CoSy’. Other approaches to establish communities of practice are ‘instructor groups’ or the organisation of ‘instructor days’ to support ongoing continuous professional development. Instructors, course directors and educators should view themselves as members of a community of practice. Web-based formats for interaction and networking may be helpful to avoid individuals ‘doing their own thing’ (Fig. 7).

Effect of resuscitation education on outcome

Adult ALS training

The ERC has a long history of delivering accredited life support training covering the care of neonatal, paediatric, and adult patients.

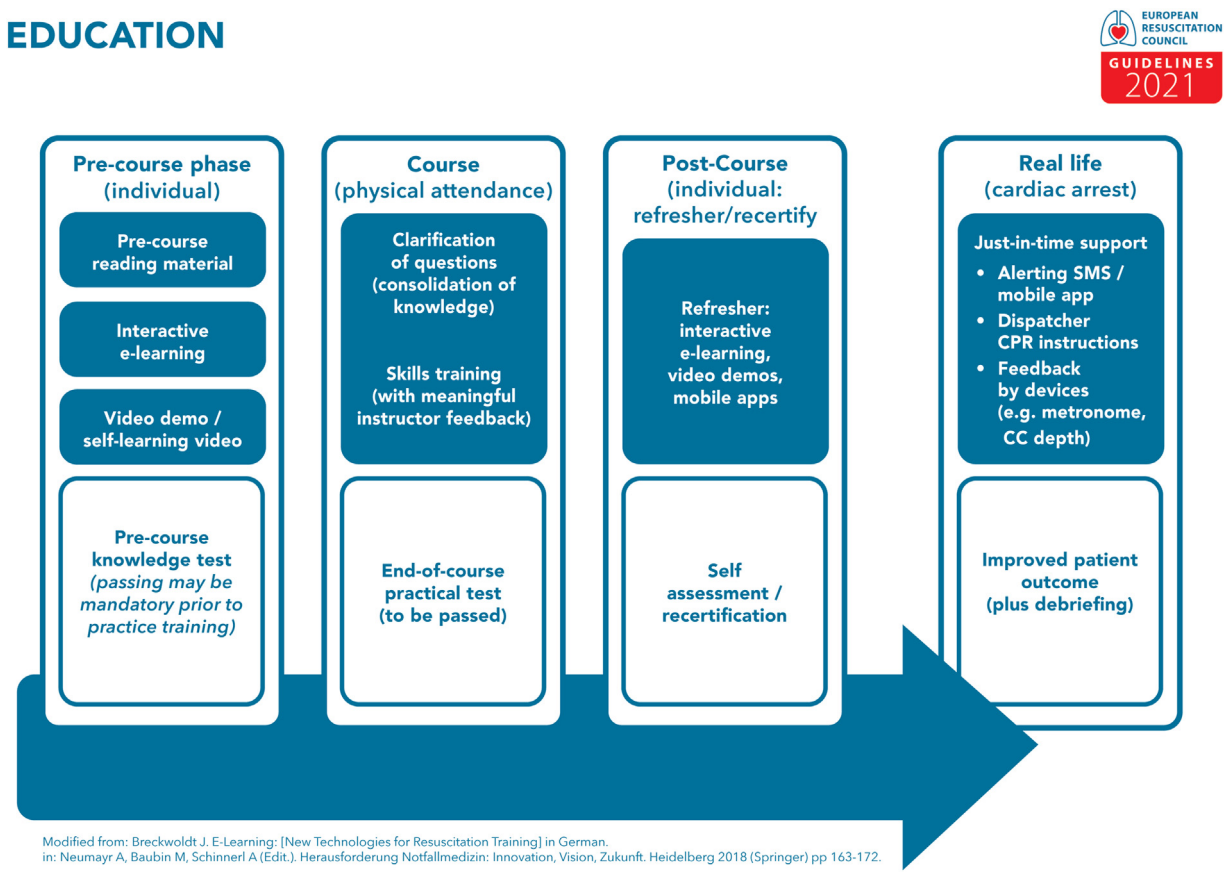

Fig. 7 – Resuscitation Competences–a continuum from BLS to ALS.

The delivery of these courses requires resources and depends on the available time for instructors and candidates to attend. It is therefore important to demonstrate the effect of these courses on patient outcomes.

A systematic review looked at whether prior participation of one or more members of the resuscitation team on an ALS course affected patient outcomes.[41] All studies of any language looking specifically at the American Heart Association Advanced Cardiac Life Support, Resuscitation Council UK ALS, ERC ALS and Australian Resuscitation Council ALS courses were included in the review. Eight observational studies were included in a meta-analysis.[138–145]

An ILCOR CoSTR systematic review found very-low quality evidence showing an association between advanced cardiac life support training and return of spontaneous circulation.[21,140–145] There is very-low quality evidence showing an association between advanced cardiac life support training and survival to hospital discharge or survival to 30 days.[138–140,142–145] There is very-low quality evidence showing no association between advanced cardiac life support training and survival to one year.[142,143] It can therefore be concluded that the prior participation of HCPs on an accredited ALS course has a positive impact upon patient outcomes.

Neonatal life support training

A systematic review and meta-analysis of the impact of neonatal resuscitation training on neonatal and perinatal mortality identified 20 trials with 1,653,805 births.[146] The authors concluded that neonatal resuscitation training versus control decreased the risk of stillbirths, 7-day neonatal mortality, 28-day neonatal mortality, and perinatal mortality. These analyses were based upon two randomised controlled trials.[147,148] In addition, the systematic review analysed 18 pre and post intervention studies and concluded that after neonatal resuscitation training there was a decrease in the risk of all stillbirths, fresh stillbirths, 1-day neonatal mortality, 7-day neonatal mortality, 28-day neonatal mortality, and perinatal mortality. The quality of evidence was deemed to be high for 7-day and 28-day neonatal mortality in the neonatal resuscitation training versus control analyses and moderate for perinatal mortality in the same analysis. All other analyses were stated to be based upon very-low quality evidence. The implications for practice from this review are that neonatal resuscitation training promotes better ante and peri-natal care leading to a reduced rate of stillbirths and improves the survival of new-born patients.

Other life support courses

The evidence from similar life support courses is also important. A systematic review of the impact of Advanced Trauma Life Support (ATLS) courses concluded that there was positive educational value for the course.[149,150] Unfortunately, high certainty evidence that the training reduced trauma mortality was lacking. This review identified only one prospective cohort study and six retrospective studies. Five studies showed no effect, one showed significant improvement, whilst one showed worse outcomes for trauma patients managed by ATLS certified doctors. A Cochrane review on ATLS training was unable to identify any controlled trials for this topic and claimed further

research.[151] Whilst the limited evidence for ATLS is neutral, it does not conflict with the evidence for ALS and neonatal resuscitation training.

In conclusion, the provision of accredited adult ALS training and neonatal resuscitation training is recommended for healthcare professionals.[21] In the absence of data to demonstrate harm, it is reasonable to recommend other similar accredited life support courses for healthcare professionals, such as advanced paediatric life support training, although further research is needed to quantify their actual impact on patient outcomes.

Research gaps and future directions in educational research

The aim of international resuscitation evidence evaluation is to critically appraise the most up to date science in education and implementation across all levels of providers.[152] The significance of educational research in resuscitation lies in implementing best educational practices for learners and instructors that leads to improved patient outcomes after cardiac arrest, which remains the utmost priority.

The American Heart Association expanded upon the Formula for Survival[1] in its resuscitation education science scientific statement, introducing new concepts from the wider medical education literature, and providing new strategies to improve educational efficiency in resuscitation training.[68]

There remains a lack of high-quality research in resuscitation education to demonstrate that training can improve process quality (e.g. compression rate, depth and fraction) and patient outcomes (e.g. return of spontaneous circulation, survival to discharge or survival with favourable neurological outcome). The optimal mode of delivery and frequency of retraining to maintain and prevent skill decay is not known.[21] Other knowledge gaps include the feasibility, learner preference, self-efficacy and cost-effectiveness of refresher training and spaced learning.[26,153]

There is a lack of research to support the most effective and efficient method to teach leadership and team performance, how to best integrate human factors and non-technical skills in medical education, choosing the most effective assessment tool based on the learning objectives, as well as finally exploring the value of simulation training on improving patient outcomes.

Strategies to improve educational efficiency may include redesigning resuscitation training courses with the learner in mind, as well as how to make the best use of new modalities of teaching using digital media, but there is insufficient evidence to guide us. More research is needed to identify the potential benefits of a blended learning approach across all course modalities for laypeople and healthcare professionals. Such research should not be limited to educational outcomes (e.g. knowledge, skills and participant satisfaction) but also outcomes such as cost-effectiveness and reduction in face-to-face time.

Recommendations for education research

Further research is needed to examine the impact of medical emergencies and resuscitation attempts on the emotional and psychological well-being of bystanders, first responders with a duty to respond, and HCPs. Education and training help reducing stress and cognitive load around resuscitation but this has not been fully explored.[154] The impact of interprofessional learning and gender differences in leading CPR teams are still not very well understood.[155,156]

Train-the-trainer programmes disseminate resuscitation education around the world improving instructor education.[157] Despite this, the development of existing instructors and educators involved in resuscitation training is an area in need of research, ranging from basic to advanced life support education. Feedback and debriefing form an important part of resuscitation training but effective feedback must be fit for purpose to be effective. There is an evident lack of research to guide and train instructors in delivering the most effective feedback.[158] Specific attention is required to develop a competent teaching faculty able to deliver a curriculum to learners effectively and in a contextualised manner.[68] Faculty development will also need to tackle the wide variability in instructor expertise and background.

Collaborators

The writing group like to thank Jasmeet Soar for his input on this educational chapter.

Conflicts of interest

RG declares his role as Editor of the journal Trends in Anaesthesia and Critical Care, associate editor European Journal of Anaesthesiology. He reports institutional research funding.

JB declares his role of Associate editor BMC and Notfall&Rettungsmedizin.

JY declares research grants from National Institute for Health Research and Resuscitation Council UK.

AL reports his role of Medical advisor for First on Scene training company.

AS declares Research funding EU for “I procure security project”.

LP-K is shareholder of Patientensicherheit.at OG.

FC declares partial ownership of a company of CPR training and simulation materials.

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