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European Resuscitation Council Guidelines for Resuscitation 2015 Section 10. Education and implementation of resuscitation

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Introduction

The chain of survival[1] was extended to the formula of survival[2] because it was realised that the goal of saving more lives relies not only on solid and high quality science but also the effective education of lay people and healthcare professionals.[3] Ultimately, those who are engaged in the care of cardiac arrest victims should be able to implement resource efficient systems that can improve survival after cardiac arrest.

This chapter incorporates the 17 key educational PICO-questions (Population–Intervention–Control–Outcome) that where reviewed by the Education, Implementation and Teams (EIT) Task Force of the International Liaison Committee on Resuscitation (ILCOR) from 2011 to 2015. This evidence review and evaluation process followed the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) process described in the Consensus on Science and Training Recommendations 2015 (CoSTR).[4] It summarises the new treatment recommendations for training and implementation. This chapter also covers the ERC basic principles of training and teaching of basic life support as well as advanced level life support. There is a strong focus on non-technical skills teaching (e.g. communication skills, team and leadership training). The ERC portfolio of courses is also included in this chapter, which ends with an outlook about educational resuscitation research and future course developments.

Delays in providing training materials and freeing staff for training were cited as reasons for delays in the implementation of the last guidelines.[5–7] Therefore the ERC has carefully planned the translation and dissemination process for these guidelines and the teaching material for all courses to facilitate the implementation of the 2015 guidelines on resuscitation in a timely manner. This chapter provides the basis of a successful educational strategy for improved CPR education.

Summary of changes since the 2010 ERC guidelines

The following is a summary of the most important new reviews or changes in recommendations for education, implementation and teams since the ERC 2010 Guidelines:

Training

- High fidelity training manikins provide greater physical realism and their use is popular with learners. They are, however, more expensive than standard lower fidelity manikins. In centres that have the resources to purchase and maintain high fidelity manikins, we recommend their use. The use of lower fidelity manikins however is appropriate for all levels of training on ERC courses.
- Directive CPR feedback devices are useful for improving compression rate, depth, release, and hand position. Tonal devices improve compression rates only and may have a detrimental effect on compression depth while rescuers focus on the rate. There is no current evidence to link tonal device use with improved outcomes following an ERC course.
- The intervals for retraining will differ according to the characteristics of the participants (e.g. lay or healthcare). It is known that CPR skills deteriorate within months of training and therefore annual retraining strategies may not be frequent enough. Whilst optimal intervals are not known, frequent ‘low dose’ retraining may be beneficial.

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- Training in non-technical skills (e.g. communication skills, team leadership and team member roles) is an essential adjunct to the training of technical skills. This type of training should be incorporated into life support courses.
- Ambulance service dispatchers have an influential role to play in guiding lay rescuers how to deliver CPR. This role needs specific training in order to deliver clear and effective instructions in a stressful situation.

Implementation

- Data-driven performance-focused debriefing has been shown to improve performance of resuscitation teams. We highly recommend their use for teams managing patients in cardiac arrest,
- Regional systems including cardiac arrest centres are to be encouraged, as there is an association with increased survival and improved neurological outcome in victims of out-of-hospital cardiac arrest.
- The use of innovative technologies and social media can be beneficial for the deployment of rapid responders to victims of out-of-hospital cardiac arrest. Novel systems are also being developed to alert bystanders to the location of the nearest AED. Any technology that improves the delivery of swift bystander CPR with rapid access to an AED is to be encouraged.
- "It takes a system to save a life". [http://www.resuscitationacademy.com/] Healthcare systems with a responsibility for the management of patients in cardiac arrest (e.g. EMS organisations, cardiac arrest centres) should evaluate their processes to ensure that they are able to deliver care that ensures the best achievable survival rates.

Basic level training

Who to train

Basic Life Support (BLS) is the cornerstone of resuscitation and it is well established that bystander CPR is critical to survival in out-of-hospital cardiac arrests. Chest compressions and early defibrillation are the main determinants of survival from an out-of-hospital cardiac arrest and there is some evidence that the introduction of training for lay people has improved survival at 30 days and 1 year.[8,9]

For this reason a primary educational goal in resuscitation should be the training of lay people in CPR. There is evidence that training lay people in BLS is effective in improving the number of people willing to undertake BLS in a real situation.[10–12] The term 'lay people' includes a wide range of capabilities from those without any formal health care training to those with a role where it may be expected that they would provide CPR (e.g. lifeguards, first aiders). Despite the increase in access to training for lay people, there is still an unwillingness of some to perform CPR. The reasons identified for this include fear of infection, fear of getting it wrong, and fear of legal implications.[13]

Training of family members of high risk patients can reduce anxiety of those family members and the patient, improve emotional adjustment, and empower individuals to feel that they would be able to start CPR. For high-risk populations (e.g. areas where there is high risk of cardiac arrest and low bystander response), recent evidence shows that specific factors can be identified which will enable targeted training based on the community's unique characteristics.[14,15] There is evidence that likely rescuers in these populations are unlikely to seek training on their own but that they gain competency in BLS skills and/or knowledge after training.[16–18] They are willing to be trained and are likely to share training with others.[16,17,19–21]

Most research in the teaching of resuscitation has been based on training adult rescuers in adult resuscitation skills. However teaching children and young adults arguably requires different approaches, but more research is required into the best methods to teach these groups basic life support.[22]

One of the most important steps in increasing the rate of bystander resuscitation and improving survival worldwide is to educate all school children. The American Heart Association advocated compulsory resuscitation training in American schools in 2011.[23] Prior to this, the experience of teaching CPR to school children in Seattle over the last three decades has resulted in significantly higher bystander CPR rates and survival rate. Similarly, Scandinavian educational resuscitation school programs report significantly higher resuscitation rates.[24] This can be easily achieved by teaching children for just 2 h per year, beginning at the age of twelve.[22] At that age, school children have a positive attitude toward learning resuscitation and both medical professionals and teachers require training to enable them to maximise the potential of these children.[25] School children and their teachers are resuscitation multipliers in both private and public settings as the children have been shown to pass on their learning to family members. The proportion of trained individuals in society will markedly increase in the longer term, leading to an increase in the overall rate of lay resuscitation.[26]

Healthcare professionals working in a variety of settings including the community, emergency medical systems (EMS), general hospital wards, and critical care areas should all be taught CPR. Whilst low quality compressions are common both in terms of incorrect depth and rate, interruptions also contribute to ineffective CPR.[27] Given that poor performance is associated with lower survival rates, training on these components should be a core aspect of any resuscitation training.

It has been shown that well trained EMS dispatchers are able to improve bystander CPR and patient outcomes.[28] However there are concerns with their ability to recognise cardiac arrest particularly in relation to agonal breathing.[29] Consequently training of EMS dispatchers should include a focus on identification and the significance of agonal breathing,[30] and the importance of seizures as aspects of cardiac arrest. In addition EMS dispatchers need to be taught simplified scripts for instructing bystanders in CPR.[30]

How to train

BLS/AED curricula should be tailored to the target audience and kept as simple as possible. Increasing access to different modalities of training (e.g. the use of digital media, on line, instructor-led teaching) and self-directed learning, offer alternative means of teaching both lay and professional providers. The effectiveness of these different blended learning approaches remains unclear and further research is required not only to link the immediate outcomes of courses to the teaching approach but also ultimately to identify the impact on the outcome of real life cardiac arrest situations. Training should be tailored to the needs of different types of learners and a variety of different teaching methods should be used to ensure acquisition and retention of resuscitation knowledge and skills. Self-instruction programmes with synchronous or asynchronous hands on practice (e.g. video, DVD, on-line training, computer giving feedback during training) appear to be an effective alternative to instructor-led courses for laypeople and healthcare providers learning BLS skills.[31–35]

Those who are expected to perform CPR regularly need to have knowledge of current guidelines and be able to use them effectively as part of a multi-professional team. These individuals require more complex training including both technical and non-technical skills (e.g. teamwork, leadership, structured communication skills).[36,37]

Basic life support and AED curriculum

Lay people are not only capable of effectively learning CPR, but evidence shows that they can be taught to use AEDs.[38] The introduction of Public Access Defibrillator (PAD) schemes has demonstrated the effectiveness of lay people in performing defibrillation,[39] but the question remains whether lay people require training to use AEDs or can use them without any prior input.[40] The curriculum for basic life support and AED training should be tailored to the target audience and kept as simple as possible. Whichever modality is chosen for the teaching, the following should be considered as core elements of the BLS and AED curriculum:

- Willingness to start CPR, including an understanding of personal and environmental risk
- Recognition of unconsciousness, gasping or agonal breathing in unresponsive individuals by assessment of responsiveness, opening of the airway and assessment of breathing to confirm cardiac arrest.[41,42]
- Good quality chest compressions (adherence to rate, depth, full recoil and minimising hands-off time) and rescue breathing (ventilation time and volume)
- Feedback/prompts (human feedback within the CPR-team and/or from devices) during CPR training to improve skill acquisition and retention during basic life support training.[43]

Standard CPR versus chest compression-only CPR teaching

The role of standard CPR versus chest compression-only CPR is discussed in the BLS Chapter of these ERC guidelines.[42] A simplified, education-based approach is suggested to allow communities to train all citizens in CPR:

- All citizens should be taught how to perform chest compressions as a minimum requirement.
- Ideally, full CPR skills (compressions and ventilation using a 30:2 ratio) should also be taught to all citizens.
- When training is time-limited or opportunistic (e.g. EMS telephone instructions to a bystander, mass events, public campaigns, internet-based viral videos), it should focus on compression-only CPR. Local communities may want to consider their approach based on their local population epidemiology, cultural norms and bystander response rates.
- For those initially trained in compression-only CPR, ventilation may be covered in subsequent training. Ideally these individuals should be trained in compression-only CPR and then offered training in chest compressions with ventilation at the same training session.
- Those laypersons with a duty of care, such as first aid workers, lifeguards, and carers, should be taught standard CPR i.e. chest compressions and ventilation.
- For the resuscitation of children, rescuers should be encouraged to attempt resuscitation using whichever adult sequence they have been taught, as the outcome is worse if nothing is done. Non-specialists who wish to learn paediatric resuscitation because they have a responsibility for children (e.g. parents, teachers, school nurses, lifeguards), should be taught that it is preferable to modify adult basic life support and give five initial breaths followed by approximately 1 min of CPR before they go for help, if there is no-one to go for them.[44]

Basic life support and AED training methods

There are numerous methods to deliver basic life support and AED training. Traditionally, instructor-led training courses remain the most frequently used method for basic life support and AED training.[45] When compared with traditional instructor-led training, well designed self-instruction programmes (e.g. video, DVD, computer supported feedback) with shortened instructor coaching may be effective alternatives for laypeople and healthcare providers learning basic life support and, in particular, for the training of laypeople in AED skills. [18,33,34,46–49]

If instructor-led training is not available then self-directed training is an acceptable pragmatic option to use an AED. Short video/computer self-instruction (with minimal or no instructor coaching) that includes synchronous hands-on practice in AED use (practice-while-you-watch) may be considered as an effective alternative to instructor-led AED courses.[48,50,51]

Ultimately, it is known that rescuers can use AEDs without any formal training. It has been shown that the presence of a nearby AED is no guarantee of their usage.[52] The advantage of delivering training, therefore, is that it increases general awareness of their use and benefit, whilst also providing a forum to dispel common myths about their use (e.g. the belief that they may do harm).

Duration and frequency of instructor-led basic life support and AED training courses

The optimal duration of instructor-led BLS and AED training courses has not been determined and is likely to vary according to the characteristics of the participants (e.g. lay or healthcare; previous training), the curriculum, the ratio of instructors to participants, the amount of hands-on training and the use of end-of-course assessments. Most studies show that CPR skills decay within three to six months after initial training.[33,46,53–55] AED skills are retained for longer than BLS skills alone.[56,57]

Although there is some evidence that higher frequency, short burst training could potentially enhance BLS training and reduce skill decay, more studies are needed to confirm this.[53,55–57]

Current evidence shows that performance in the use of an AED (e.g. speed of use, correct pad placement) can be further improved with brief training of laypeople and healthcare professionals.[49,58–60] Brief bedside booster CPR training of 2 min has also been shown to improve CPR quality irrespective of training content (instructor, or automated feedback or both) in Paediatric Basic Life Support providers during simulated cardiac arrest[61] and improved with further training.[62]

Peer-led resuscitation training has also been shown to be an effective means of delivering BLS training. Peer-tutors and assessors are competent, more available and less costly than clinical staff. Student instructors develop skills in teaching, assessment and appraisal, organisation and research. Sustainability is possible given succession-planning and consistent leadership. A 15 year review of peer led BLS teaching in a major University medical school demonstrated that such programmes can deliver greater participant satisfaction with learning outcomes equal to previous lecture-based sessions.[63]

As there is evidence that frequent training improves CPR skills, responder confidence and willingness to perform CPR, it is recommended that organisations and individuals review the need for more frequent retraining based on the likelihood of cardiac arrest in their area. Retraining should take place at least every 12–24 months for students who are taking BLS courses. Additional high frequency, low dose update or retraining in certain settings may be considered. It is recommended that individuals more likely to encounter cardiac arrest consider more frequent retraining, due to the evidence that skills decay within 3–12 months after BLS training[33,46,53,54,56,64] and evidence that frequent training improves CPR skills,[34,65–69] responder confidence,[65] and willingness to perform CPR.[34]

Use of CPR prompt/feedback devices during training

The use of CPR prompt/feedback devices may be considered during CPR training for lay people and healthcare professionals. Devices can be prompting (i.e. signal to perform an action e.g. metronome for compression rate or voice feedback), give feedback (i.e. after-event information based on effect of an action such as visual display of compression depth), or a combination of prompts and feedback. Training using a prompt/feedback device can improve CPR skill performance.[70] Instructors and rescuers should be made aware that a compressible support surface (e.g. mattress) may cause some prompt/feedback devices to overestimate depth of compression.[71,72]

A systematic appraisal of the literature determined in both manikin and human studies that audiovisual feedback devices during resuscitation resulted in rescuers providing chest compression parameters closer to recommendations but no evidence was found that this translates into improved patient outcomes.[73] Substantial variation in the ability of CPR feedback devices to improve performance was found.[74–76]

Advanced level training

Advanced level courses are mainly directed at healthcare personnel. In general, they cover the knowledge, skills and attitudes needed to function as part of (and ultimately lead) a resuscitation team.

Pre-course training and possible alternatives strategies to improve CPR training

A variety of methods can be used to prepare candidates before attending a life support course. These include the provision of pre-course reading, in the form of manuals and/or e-learning. Incorporating a pre-test into the preparatory work may further enhance these materials.[77–82] One such example was a CD-based pre-course e-learning program for ALS that was well received by the participants. It was rated as improving their understanding of the key learning domains of the ALS course but failed to show superiority for cognitive or psychomotor skills during a standard cardiac arrest simulation.[83]

Evidence has emerged regarding blended learning models (independent electronic learning coupled with a reduced duration instructor-led course). A pilot blended learning approach to ALS training including e-learning led to a 5.7% lower pass rate in cardiac arrest scenario testing, but similar scores on a knowledge and skills assessments, and reduced costs by more than half. There was no significant difference in overall pass rates.[84] This UK-based e-learning-ALS course was subsequently implemented and a further study of 27,170 candidates demonstrated equivalence to traditional instructor-led learning.[85] The online e-learning program of 6–8 h was to be completed by candidates prior to attending a one-day modified instructor-led ALS-course. e-ALS scores were significantly higher on the pre- and post-course MCQ and first attempt CAS-test pass rate was higher than compared to standard ALS courses (overall pass rate similar in both). Considering benefits such as increased candidate autonomy, improved cost-effectiveness, decreased instructor burden and improved standardisation of course material these reports encourage further dissemination of the e-learning courses for CPR training.

Principles of teaching skills

CPR skills can be taught in a stepwise process: dissecting the components of a skill into a real-time demonstration, explaining the facts, demonstration by the participants, and practicing to facilitate visualisation, understanding, cognitive processing and execution of a skill. No studies have showed any advantage for different stepwise approaches despite their theoretical framework.[86,87]

Basics of simulation to teach on advanced level courses

Simulation training is an integral part of resuscitation training. A systematic review and meta-analysis of 182 studies involving 16,636 participants on simulation-based training for resuscitation showed improvement in knowledge and skill performance compared to training without simulation.[88]

Simulation training can be used to train a range of roles from the first responder to the resuscitation team member and ultimately the resuscitation team leader. It can be utilised to train both individual and team behaviour. A critical adjunct to this learning is the debriefing that occurs at the conclusion of the scenario.

With the exception of simulation training using live actors, the majority of training involves the use of purpose built manikins. High-fidelity manikins can provide physical findings, display vital signs, physiologically respond to interventions (via computer interface) and enable procedures to be performed on them (e.g. bag mask ventilation, intubation, intravenous or intra-osseous vascular access).[89] Simulation training using high-fidelity versus low-fidelity manikins seems to deliver a slight improvement in training outcome on skill performance at the end of the course.[90]

When considering physical realism, these high-fidelity manikins are more popular with candidates and faculty but they are also much more expensive. Evidence that participants in ERC courses learn more or better CPR by using high-fidelity manikins is lacking. With this in mind, high-fidelity manikins can be used but if they are not available, the use of low-fidelity manikins is acceptable for standard advanced life support training.

Adherence to real-time 2-min cycles during advanced life support simulations is an important part of realistic fidelity. It is important that the duration of CPR cycles is not deliberately decreased in order to increase the number of scenarios.[91]

New teaching methods hold promise for the future but need more research before being adopted on a larger scale. Examples include specifically teaching “action-linked phrases” like “There’s no pulse, I will start chest compressions” which will generally prompt action (e.g. chest compressions) when taught on courses.[92] Another example is “Rapid cycle deliberate practice” (RPSD) training, which has been shown to increase resuscitation skills in paediatric residents.[93] After an initial uninterrupted scenario and debriefing, the next scenarios are short, and interrupted at predetermined points to give direct feedback on specific procedures or actions.

Training of non-technical skills (NTS) including leadership and team training to improve CPR outcome

Accomplishing successful resuscitation is a team performance in most instances and as with any other skill, effective teamwork and leadership skills need to be trained.[94,95] For example, the implementation of team training programmes resulted in an increase in hospital survival from paediatric cardiac arrest[96] and in surgical patients.[97]

Training in non-technical skills, such as effective communication, situational awareness, leadership and followership, using crisis resource management principles purposefully in simulations, has been shown to transfer learning from simulation into clinical practise.[98,99] Resuscitation team performance has been shown to improve in actual cardiac arrest or simulated in-hospital advanced life support scenarios, when specific team or leadership training is added to advanced level courses.[100–104] By delivering training in

an environment as close to real-life experience as possible, concepts regarding team working can be addressed at the level of the individual.[105,106]

Specific team training can increase team performance, leadership skills, and task management performance and the effect can last for up to one year.[94,95,100,101,107–111] On the other hand, leadership training in addition to CPR skills has been shown not to improve actual CPR skills.[112]

Assessment instruments (mainly checklists) have been developed, validated, and recommended for individual team members. Rating scales exist for the assessment of team performance, which can subsequently be used to deliver feedback on team performance.[113–116]

Training intervals and assessment of competences

Little evidence exists about the retention of knowledge after ALS courses.[117] It is believed that learners with increased clinical experience have improved long-term retention of knowledge and skills.[118,119] Written tests in ALS courses do not reliably predict practical skill performance and should not be used as a substitute for demonstration of clinical skill performance.[120,121] Assessment at the end of training seems to have a beneficial effect on subsequent performance and retention.[122,123]

There is emerging evidence that frequent manikin-based refresher training in the form of low-dose in-situ training may save costs, reduce the total time for retraining, and it seems to be preferred by the learners.[124,125] Refresher training is invariably required to maintain knowledge and skills; however, the optimal frequency for refresher training is unclear.[124,126–128]

A simulation-enhanced booster session nine months after a neonatal resuscitation training program demonstrated better procedural skill and teamwork behaviour at fifteen months.[129] Teamwork behaviours were further enhanced when residents were engaged in clinical resuscitation or by exposure to deliberate practice with simulation.

Use of checklists, feedback devices, and in-situ training

Cognitive aids such as checklists may improve adherence to guidelines as long as they do not cause delays in starting CPR and the correct checklist is used during simulation [130] and real patient cardiac arrest.[131] For example, the implementation of an Advanced Trauma Life Support check list improved adherence to protocol driven task performance, frequency and speed of task completion.[132]

Feedback devices that provide directive feedback in compression rate, depth, release, and hand position during training may be considered to improve the level of skill acquisition by the end of course.[61,74,76,133–137] In their absence, tonal guidance (e.g. music or metronome) during training may improve compression rates only. There is evidence that tonal guidance can reduce compression depth as the candidate focuses on the rate.[137–139] CPR prompt or feedback devices improve CPR skill acquisition and retention in BLS and might also be used to improve proper application of these basic CPR skills during advanced level training. However, the use of CPR feedback or prompt devices during CPR should only be considered as part of a broader system of care that should include comprehensive CPR quality improvement initiatives,[140] rather than as an isolated intervention.

In-situ simulations can offer opportunities to train the full team [141] as well as provide insight into the work flow on the organisational level.[142] Furthermore it might be easier to include training of a full team of care providers across disciplines in-situ and this can improve advanced life support provider knowledge,[143] skill performance,[144] confidence and preparedness,[141] familiarity with the environment[145] and identify common system and user errors.[142,146,147]

Briefing and debriefing after cardiac arrest simulation

Debriefing after cardiac arrest simulation is an essential part of the learning process. If the simulated scenario training is followed by debriefing then learning will occur, as opposed to scenario training without debriefing.[148] The ideal format of debriefing has yet to be determined. Studies have failed to show a difference with and without the use of video clips for debriefing.[149,150]

Implementation and change management

The formula for survival concludes with 'Local Implementation'.[2] The combination of medical science and educational efficiency is not sufficient to improve survival if there is poor or absent implementation. Frequently, this implementation will also require some form of change management to embed new visions into a local culture. Quite often, the 'easy fix' will not be the sustainable solution and prolonged negotiation and diplomacy may be needed. A prime example of this is the implementation of CPR training on the school curriculum–countries that have achieved this goal have sometimes spent years campaigning and persuading governments for this change to be adopted. Change can be driven from below, but to be sustainable it usually needs top down buy-in as well.

This section was not present in the 2010 ERC Guidelines and has been added in recognition of its importance in the quest to improve survival.

Impact of guidelines

In each country, implementation is largely based on the internationally agreed guidelines for cardiac resuscitation. National strategies for education are dependent upon evidence-based solutions to the management of cardiac arrest. The most important question, therefore, should be whether these guidelines actually result in any meaningful and improved outcomes. The authors freely acknowledge a conflict of interest here—if we prove that our guidelines have no tangible benefit then we call into question the resources that have been invested to generate them. The evidence suggests a positive benefit when considering survival to hospital discharge,[8,151–156] return of spontaneous circulation,[8,151–155] and CPR performance.[8,153] Irrespective, the likelihood of benefit is high relative to possible harm.

Cardiac arrest centres

In the last few years, regional healthcare systems have emerged for the management of conditions like stroke, major trauma, and myocardial infarction. These have mainly been driven by centralisation of limited resources as opposed to evidence of benefit from randomised trials. There is emerging evidence that the transport of patients with out-of-hospital cardiac arrest to a specialised cardiac arrest centre may be associated with improved neurologically intact survival.[157–170] The studies currently available had inconsistencies in terms of the specific factors that allegedly contributed to better outcomes. More research needs to be performed to identify the specific aspects of a cardiac arrest centre that improve outcome, as well as the influence of journey times and whether secondary transfers to such centres could also obtain the same benefit.

Scenario-based simulation training and re-training, regular practice and a team approach to device placement are necessary for coronary catheterisation laboratory personnel. When introducing

mechanical chest compression devices into clinical practice a significant learning curve was observed.[171] During prolonged resuscitation efforts in the coronary catheterisation laboratory, the implementation of a structured resuscitation approach improved teamwork.[172]

Use of technology and social media

The prevalence of smartphones and tablet devices has led to the generation of numerous approaches to implementation through the use of 'apps' and also social media. These fall into several categories:

(1) Simple delivery of information–apps that display resuscitation algorithms.
(2) Interactive delivery of information–apps that use the geolocation of the user to display the location of the nearest AED.
(3) Interactive delivery of education–apps that engage with the user and create an immersive and interactive means of educating the user (e.g. Lifesaver) [www.life-saver.org.uk].
(4) Blended learning packages for life support courses–an e-learning programme with abbreviated instructor-led training has been shown to be equivalent to standard training for advanced life support courses.[85]
(5) Feedback devices—real time use of the accelerometer to improve rate, depth of compressions as well as recording data for debriefing.[173]
(6) Notification and activation of bystander schemes—if individuals are willing and able to provide basic life support in a community, the use of these systems may lead to faster response times when compared with emergency service attendance.[174,175]
(7) Use of social media to disseminate information to a wider audience and assist with campaigns to effect change.

Ultimately, technology and social media are powerful vectors for implementation and change management. Their development and use should be encouraged and analysed to assess the actual impact on survival.

Measuring performance of resuscitation systems

As systems evolve to improve the outcomes from cardiac arrest, we need to accurately assess their impact. This is particularly important for larger systems with multi-factorial components any of which may be beneficial either in isolation or combination. For example, it has already been shown that further work needs to be done to evaluate the impact of cardiac arrest centres.

Measuring performance and implementing quality improvement initiatives will further enhance systems to deliver optimal results.[102,176–181]

Debriefing after resuscitation in the clinical setting

Feedback to members of an in-hospital cardiac arrest team about their performance in an actual cardiac arrest (as opposed to the training environment) can lead to improved outcomes. This can either be real-time and data-driven (e.g. use of feedback devices on cardiac compression metrics) or in a structured post event performance focused debrief.[102,182] The ideal approach to debriefing is yet to be determined, including the interval between actual performance and the debriefing event. Although it seems intuitive to provide this level of debriefing for out-of-hospital cardiac arrest performance, no evidence exists to support or refute its benefit.

Medical emergency teams for adults

When considering the chain of survival for cardiac arrest,[1] the first link is the early recognition of the deteriorating patient and prevention of cardiac arrest. A considerable amount of work has been done to evaluate the role of the Medical Emergency Team (MET) in this respect. We recommend their use and, in particular, the use of higher intensity systems (e.g. higher MET calling rates, senior medical staff on the team) as their use has been associated with a reduced incidence of cardiac/respiratory arrest[183–189] and improved survival rates.[184,186–189,183,190]

It is recommended that these systems include:

(1) staff education about the signs of patient deterioration
(2) appropriate and regular vital signs monitoring of patients
(3) clear guidance (e.g. via calling criteria or early warning scores) to assist staff in the early detection of patient deterioration
(4) a clear uniform system of calling for assistance
(5) a clinical response to calls for assistance.

Training in resource limited settings

There are many different techniques for teaching ALS and BLS in resource limited settings. These include simulation, multimedia learning, self-directed learning, limited instruction, and self-directed computer-based learning. Some of these techniques are less expensive and require less instructor resources than a traditional teaching format. Some techniques also enable wider dissemination of ALS and BLS training. It is reasonable to suggest the use of these strategies in resource limited settings, although the optimal strategy is yet to be determined and will differ from one country to another.[191–197]

Training in ethics and first aid

Insights into training health care professionals about DNAR issues and approaches to practicing procedures on the newly deceased are provided in the Ethics chapter of the ERC guidelines 2015.[198] The First Aid chapter of the 2015 ERC Guidelines provides guidelines about first aid education and training programs as well as public health campaigns.[199]

The ERC resuscitation course program

The ERC has developed a wide range of courses targeting all levels of providers, from basic life support for lay rescuers to advanced life support for health care providers. ERC courses teach the competences to undertake resuscitation in the clinical setting at the level that they would be expected to perform. Besides resuscitation skills, emphasis is given to non-technical skills and leadership training, application of ethical principles and advanced educational strategies as well as organisational improvements on a system level to improve survival after cardiac arrest. Specific courses teach these competences whilst others train how competences are to be taught.

ERC courses focus on teaching in small groups with a high instructor to candidate ratio using blended learning strategies, including interactive discussion, workshops and hands-on practice for skills and simulations using resuscitation manikins.[200,201]

Up-to-date information about ERC courses is available in the "ERC course rules" on the ERC website [https://www.erc.edu/index.php/doclibrary/en/]. The course rules describe in detail the ERC terminology and definitions; specifics of the organisation and management of different ERC course formats and quality control; the instructor development up to course director, instructor trainer and ERC educator; the ERC assessment and certification/recertification

process; and the ERC professional behavioural guides including complaints procedures.

Ethos

Instructors on ERC courses are trained in teaching and assessment. The ethos is to create a supportive, learner-centred environment that promotes learning, enhancing understanding of knowledge and retention of skills. First names are encouraged among both faculty and candidates to reduce apprehension. Interactions between faculty and candidates are driven to learn from each other's experiences. Aimed changes in behaviour are elaborated by encouragement with constructive and corrective feedback as well as debriefing on performance. A mentor/mentee system is used to enhance feedback and support for the candidate. Some stress is inevitable,[202] particularly during assessment, but instructors aim to enable the candidates to do their best. ERC courses are driven by the ultimate goal to improve resuscitation performance to increase survival of cardiac arrest victims.

Course management

ERC courses are overseen by the Joint International Course Committee (JICC) consisting of the chairpersons of the International Course Committees (ICC) for all ERC-course types (BLS/AED, Immediate Life Support (ILS), ALS, Neonatal Life Support (NLS), European Paediatric Immediate Life Support/European Paediatric Advanced Live Support (EPILS/EPALS), Generic Instructor Course (GIC)) and is led by the Board Director for Training and Education (DTE). On the national level, each National Resuscitation Council (NRC) assigns National Course Directors (NCD) for each course type.

The ERC has developed a web-based course management system [http://courses.erc.edu] for the administration of these courses. Candidates may sign up online to a course, or may contact the course organiser to register their interest in a specific course. At the end of the course the system will generate unique numbered course certificates for successful candidates and also each faculty member. For quality control an evaluation tool is available for each course and results are accessible for NRCs, NCDs and ICC members. Participants who successfully complete provider courses are referred to as 'providers'.

Language

Initially, the ERC courses were taught in English by an international faculty. As local instructors have been trained, and manuals and course materials have been translated into different languages, many NRCs are now able to deliver their courses locally in their native language. It is important that this does not compromise the quality control of courses and instructor development and the process of translation of new guidelines and course materials should not delay the implementation of new guidelines.[5]

Instructor development

Individuals who have passed and demonstrated a high level of performance during a provider course and, importantly, have shown qualities of leadership and team working, shown clinical credibility, with skills that include being articulate, supportive, and motivated may be identified by the course faculty as Instructor Potential (IP). Individuals with IP in any advanced course will be invited to take the ERC Generic Instructor Course (GIC). IPs after BLS/AED courses will be invited to take the BLS/AED instructor Course.

At the GIC, an ERC educator who has undertaken specific training in medical education and in the principles of adult learning (ERC Educator Master Class), is responsible for delivering the educational principles of ERC courses.

From the instructor candidate (IC) stage to full instructor (FI)

Following successful completion of a GIC, IPs are granted IC status and normally will teach on two provider courses, under supervision of the course faculty, receiving constructive and corrective feedback on his or her performance with the aim of being promoted to FI status. This feedback enhances teaching practice during the GIC and as an IC in the first provider courses by formulating learning goals for subsequent courses.

Course director (CD) status

An approved Course Director leads each ERC course. CDs are proposed by NCDs and approved by their NRC or the respective ICC. CDs are senior instructors who are clinically credible, have demonstrated excellent qualities as a teacher, mentor, and assessor, and possess the skills to lead a faculty of instructors.

General ERC course principles [ERC course rules on www.erc.edu]

Content of ERC courses

All ERC courses follow contemporary ERC guidelines. Each course has its specific course manual or teaching booklet providing the required pre-course knowledge. Candidates receive the manual in advance to prepare for each course with a mandatory pre-course MCQ (except for BLS/AED, ILS and EPILS) that aims to ensure that candidates read the materials before attending the course.

All ERC courses comprise interactive lecture and group discussions, small group workshops, hands-on skills teaching and, for advanced level training, clinically orientated Cardiac Arrest Simulation (CAS) and emergency case scenarios. Most course formats include options enabling instructors to tailor their teaching to the candidates' local needs.

Immediate and advanced life support courses

Immediate and advanced life support courses target the training of healthcare providers. Curricula have core content and can be tailored to match individual learning needs, patient case mix and the individual's role within the healthcare systems response to cardiac arrest. Core modules for these courses include:

- Cardiac arrest prevention.[203,204]
- High quality chest compressions (adherence to rate, depth, full recoil and minimizing hands-off time) and ventilation using basic skills (e.g. pocket mask, bag mask).
- Defibrillation, with charging during compressions for hands-free defibrillation.
- Advanced life support algorithms and cardiac arrest drugs.
- Non-technical skills (e.g. leadership and team training, communication).

Immediate life support courses. ILS courses for adults and EPILS courses for children are one-day courses focusing on the causes and prevention of cardiac arrest, the ABCDE approach to the critically ill patient, starting effective BLS/AED, initiating the chain of survival, and basic CPR skills (e.g. effective chest compression and safe delivery of a defibrillation shock, basic airway management, choking, intravenous or intra-osseous access, and drugs during cardiac arrest).[205] These courses are designed to be simple to run with small groups of candidates. The aim is to train candidates in the use of the equipment (e.g. defibrillator type) that is available in their clinical setting and the management of the first minutes of cardiac arrest until professional rescuers arrive.

Advanced life support courses. ALS courses for adults, EPALS for neonates and children, and NLS courses for newborns build upon the knowledge and skills from the respective Basic and/or Immediate Life Support courses. This provides the foundation for these 2-day advanced courses placing emphasis on safe defibrillation and ECG interpretation, the management of the airway, ventilation and vascular access, the management of peri-arrest rhythms, and special circumstances relating to severe illness, injury, and cardiac arrest. Post-resuscitation care, ethical aspects related to resuscitation and care of the bereaved are also included. These courses should enable providers to cover the first hour of critical illness or injury and cardiac arrest. They are not designed to provide instruction in advanced intensive care or cardiology.

The faculty meeting

The faculty meeting usually takes place at the start and at the end of each course day and is led by the course director. The aim is to brief the teaching faculty and to assess the performance and progress of each candidate. During the final faculty meeting each candidate's performance is reviewed to make a decision about successful course participation and whether candidates who have met the required criteria are offered instructor potential status. Instructor candidates on the courses are also assessed on their performance. Faculty meetings also provide an opportunity to debrief the faculty at the end of the course.

Assessment and feedback

Throughout the course, the faculty assesses each candidate formatively and individually. Candidates' performances and attitudes are discussed at the daily faculty meetings, with mentoring and feedback given as required. Instructors are taught to use a framework aimed at providing timely, constructive, goal orientated, student centred and action planned feedback to enable the learner to achieve the desired outcome.

The standard ERC feedback format is the Learning Conversation. The learning conversation starts with an invitation to reflect and it is primarily centred on any issue that the candidate wishes to discuss. This is followed by a discussion of any key areas that the instructor wishes to discuss, along with contributions from the group and other instructors. Any important performance issues are then summarised with specific action points for the candidate to improve their further performance.

Candidates' performances are continuously assessed throughout BLS, ILS, and GIC courses, measuring their competences against pre-determined criteria; no summative tests are required to be certified.

Towards the end of NLS and ALS courses a Cardiac Arrest Simulation Test (CAST) assesses the candidates' applied knowledge and skills during a simulated cardiac arrest including leading a cardiac arrest team. The reliability and measurement properties of CAST have been established.[121,206,207] Their core knowledge is assessed with an MCQ.

Mentoring

Mentoring is an essential part of all ERC courses and enables candidates to have a nominated role model. Group or 1:1 mentoring happens during ERC courses on a regular basis.

Specific formats of ERC resuscitation courses

Basic life support and automated external defibrillation (BLS/AED) provider courses and BLS/AED instructor course. BLS/AED courses are appropriate for all citizens including lay persons and trained first responders (first-aid workers, lifeguards), those with a duty of care for others (e.g. school teachers, care workers, security personnel) and ultimately all clinical and non-clinical healthcare professionals (including EMS systems dispatchers, general practitioners, dentists, medical and nursing students, and those who are less likely to manage a cardiac arrest). Combined BLS/AED courses are encouraged.

BLS/AED courses aim to enable each candidate to gain competency in recognising a cardiac arrest, immediate instigation of effective chest compression, calling appropriate help to the scene and safe use of an AED. These courses teach children and adults in CPR competences for children and adults in cardiac arrest.

The ERC BLS/AED instructor course offers candidates who hold a valid BLS/AED certificate and who are identified as instructor potential the opportunity to train to be BLS/AED instructors.

Immediate life support (ILS) course. The ILS course teaches the majority of healthcare professionals from all disciplines and professions who face adult cardiac arrests rarely but are potential first responders or resuscitation team members.[208] Applied ILS competences should result in successful resuscitation whilst awaiting the arrival of the resuscitation team covering the first minutes of CPR.[209] In a cohort study after implementation of an ILS-programme the number of cardiac arrest calls and true arrests decreased while pre-arrest calls increased as well as initial survival and survival to discharge.[210]

Advanced life support (ALS) course. The target candidates for the ALS course are physicians, nurses, EMS personnel, and selected hospital technicians who may be resuscitation team leaders and members for adult CPR.[211,212]

Beyond the expected BLS and ILS competences to be mastered by the candidates, this course format teaches the management of cardiac arrest from a diversity of causes and the management of peri-arrest problems and concentrates on the application of non-technical skills with emphasis on team-cooperation under clear team leadership.

Newborn life support (NLS) course. This one-day inter-professional course aims to give healthcare workers likely to be present at the birth of babies (e.g. midwives,[213] nurses, EMS personnel, physicians) the background knowledge and skills to approach the management and resuscitation of the newly born during the first 10-20 min. NLS places appropriate emphasis on airway management, chest compression, umbilical venous access and drugs for newborn CPR.[214]

European paediatric immediate life support (EPILS) course. EPILS is a one-day course (5 to 8 h) that trains nurses, EMS personnel, and doctors who are not part of a paediatric resuscitation team to recognise and treat critically-ill infants and children, to prevent cardiorespiratory arrest and to treat children in cardiorespiratory arrest during the first few minutes whilst awaiting the arrival of a resuscitation team. Short practical simulations adapted to the workplace and to the actual clinical role of candidates are used to teach the core competencies.

European paediatric advanced life support (EPALS) course. EPALS is designed for healthcare workers who are involved in the resuscitation of newborns, infants or children providing sufficient competences to manage critically ill or injured children during the first hour of illness.[215–218] Refresher training in paediatric basic life support and relief of foreign body airway obstruction is included.

EPALS puts great emphasis on the recognition and continuous assessment and timely treatment of the sick child (e.g. cardiac and respiratory failure, arrest and trauma simulations). Aspects of team working and team leadership are integrated in the training, including problem anticipation and situational awareness. Depending on local needs and circumstances EPALS may further include modules on newborn resuscitation, post-arrest care and handover, and/or

modules on more advanced knowledge or technical skills. These latter modules are being continuously developed.

Generic instructor course (GIC). The GIC is for candidates who have been recommended as instructor potential (IP) emanating from any ERC provider courses (except the BLS/AED course that has a separate instructor course) or with IP status from certain other provider courses (e.g. European Trauma Course). The GIC puts emphasis on developing teaching and constructive and corrective feedback and mentoring. Core knowledge of the original provider course is assumed.

An ERC educator leads the educational process, the discussions and provides critical feedback. The Educator delivers interactive sessions covering the theory of adult learning, effective teaching of skills and simulated scenarios, assessment and effective feedback, and leadership and non-technical skills through a series of interactive sessions. The faculty demonstrates each of these competencies, followed by opportunities for the candidates to practise.

Abbreviated material from the original provider course is used for the simulated teaching sessions. The GIC emphasises the concept of constructive and corrective feedback to develop future learning strategies thus providing an opportunity for each candidate to adopt the instructor role.

Educator master class (EMC). ERC educators are an essential mandatory component of the GIC faculty. A two-day educator master class teaches experienced provider course instructors with a demonstrable interest in education to become ERC educators. NRCs propose suitable candidates who are then shortlisted by the ERC Working Group on Education based on specific criteria (including motivation, qualification in medical education or documentation of demonstrated special commitment to educational practice over a number of years within the ERC).

EMC instructors are experienced educators assigned by the Working Group on Education and the Director of Training and Education. The EMC covers the theoretical framework for ERC educators, assessment and quality control, teaching methodologies, critical appraisal, the mentor role, multi-professional education strategies and continuous development of the ERC teaching faculty. The format of the EMC is a series of closed discussions, small breakout groups and problem solving sessions. Candidates are formatively assessed throughout the EMC.

European resuscitation academy (ERA)—"It takes a system to save a life"

The ERA aims to improve survival from cardiac arrest through a focus on healthcare system improvements that bring the individual links in the Chain of Survival and the Formula for Survival together. Entire EMS staff (managers, administrative and medical directors, physicians, EMTs and dispatchers) from different health care systems and countries are invited to learn from the ERA Program (derived from the Seattle (US) based Resuscitation Academy [http://www.resuscitationacademy.com/] ten steps for improving cardiac arrest survival) together with the local host health institutions. The ERA puts emphasis on defining the local cardiac arrest survival rate by understanding the importance of reporting data in a standardised Utstein template. Participating EMS systems are encouraged to develop concrete measures to improve cardiac arrest survival followed by appropriate measurements of these action plans.

Future direction for research and course development

The production of international guidelines for resuscitation is a constantly evolving exercise. High quality research continues to be published with evidence that may or may not suggest that the guidelines of today are acceptable.

In parallel with this, the science of education also continues to evolve. Our methods for teaching these guidelines have changed substantially over the years from the early days of didactic theoretical delivery of teaching to contemporary interactive, hands-on methods that also utilise technology and social media.

There is still a paucity of high quality evidence about the best methods of teaching, primarily because the numbers of candidates needed to produce statistical significance for meaningful outcomes (e.g. increase in patient survival) would need to be massive. There is a role therefore for international collaboration to achieve such numbers in a similar style to the collaborations used to assess some of the clinical content to the guidelines. Until the time that statistical significance is achieved, it is essential that we continue to evaluate our educational methods and assess the *educational* importance or relevance of the findings.

New insights about educational process, neuro-science impact on training and rapid developments in social media and online applications mean that our approach to education is constantly changing. This chapter highlights current changes and what may change in the near future.

Recommendations for educational research in resuscitation

Every educational intervention should be evaluated to ensure that it reliably achieves the learning objectives and at its best improves patient outcome in a cardiac arrest situation. The aim is to ensure that learners not only acquire skills and knowledge but also retain them to be able to provide adequate actions depending on the level of training. Evaluation at the level of patient outcome is difficult to achieve, as several other parameters influence patient outcome, such as changes in guidelines, changes in case-mix, and organisational changes. The level of outcome studied, should be determined during the planning phase of the educational event.[219] It is difficult to assess behaviour in the clinical setting so this attribute is more commonly assessed with simulation using manikins. Generalisability from manikin studies is questionable, though, and that is the reason why so little high-level evidence is found in the literature.

Education in resuscitation is still a relatively new field lacking high quality research. Studies are heterogenous in design and prone to risk of bias and therefore difficult to compare. A research compass to guide future studies in education has been devised at a research summit.[220]

Future course development

The educational strategy of the ERC is based on uniform instructor courses and standardised provider course curricula. This will evolve as more blended learning methods become available. Flexibility is needed in teaching CPR on all levels as different media like DVD, Internet and on-line training increase the learning benefit.

New curricula should allow this flexibility. Some core-content modules will be the 'heart' of any ERC-course which will allow the customisation of each course format with additional optional content (medical as well as non-technical aspects) to support and train learners according to local needs. Some institutions will, for some learners, have very specialised modules (e.g. cardiac arrest after cardiac surgery, advanced neonatal support at an ICU, obstetric resuscitation, resuscitation during surgery in the operation room) that can be added to the standard core-content of the course.

New teaching technology (IT-based learning like webinars, e-learning modules on the ERC virtual learning environment) will be adopted and this needs to be addressed in the GIC as well as in the supervision and mentoring of all instructors, course directors and educators.

Learners using video- or online training may no longer need a printed manual, as they will have immediate access to the content on the Internet. This will provide substantially more opportunity to integrate pictures, demonstration videos of skills and team performance, self-assessment tests with guidance of how to improve, and linked literature to deepen interests. A virtual learning environment (VLE) will furthermore monitor and support the ongoing learning trajectory of each individual in terms of knowledge, skills, attitudes and global performance from providers to instructors as well as course organisers.

Reading and learning knowledge-based facts, thinking through procedures and action strategies, and discussing open questions can all be done before candidates come to the course venue. Highly motivated course participants will come to the course centre with a high level of knowledge, a clear vision when to apply which procedures and how to interact with a team to perform quality CPR. Due to increasing constraints on study and teaching leave, the time spent at the course centre needs to be focused on the translation of the learned concepts in the simulated scenarios. This will enable candidates to try out, rehearse and execute life-saving techniques, using best medical practice and team leadership and management. This should ultimately enable providers to increase survival after cardiac arrest in the clinical setting.

High frequency training will be very short and might not necessarily need personal coaching by an instructor or mentor. The training environment should be brought to the learners, so that they can experience it during daily activities to reach the high frequency objective. A brief annual CPR competence test may be used to filter out those who do not achieve institutionally defined levels of competence. Some might need brief training under supervision to reach competence, whereas others may need a longer formal refresher process. Course organisers have to plan their courses in a flexible way, allowing a shorter duration for target groups with extra background, and more hands-on time for lay rescuers.

The use of high fidelity manikins and advanced feedback devices will be available for countries and organisations with the financial capacity, but not for all countries and organisations. When using low fidelity manikins, instructors need to be trained to deliver timely and valid feedback to the learner to increase their learning.

Ultimately, the goal of the ERC is to strengthen each component of the Chain of Survival through effective education and implementation. The aim should be to develop teaching strategies for lay people and healthcare professionals to deliver high quality BLS, swift defibrillation, effective advanced resuscitation, and high quality post resuscitation care. These strategies should be easy, accessible, well validated, and appealing. This will ensure that the scientific guidelines can effectively translate into improved survival rates.

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