Part 14: Education

2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

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Introduction

Cardiac arrest is a major public health issue, with more than 500 000 deaths of children and adults per year in the United States.[1–3] Despite significant scientific advances in the care of cardiac arrest victims, there remain striking disparities in survival rates for both out-of-hospital and in-hospital cardiac arrest. Survival can vary among geographic regions by as much as 6-fold for victims in the prehospital setting.[4,5] Significant variability in survival outcomes also exists for cardiac arrest victims in the hospital setting, particularly when the time of day or the location of the cardiac arrest is considered.[6] Inconsistencies in performance of both healthcare professionals and the systems in which they work likely contribute to these differences in outcome.[7]

For out-of-hospital cardiac arrest victims, the key determinants of survival are the timely performance of bystander cardiopulmonary resuscitation (CPR) and defibrillation for those in ventricular fibrillation or pulseless ventricular tachycardia. Only a minority of cardiac arrest victims receive potentially lifesaving bystander CPR, thus indicating room for improvement from a systems and educational point of view. For in-hospital cardiac arrest, the important provider-dependent determinants of survival are early defibrillation for shockable rhythms and high-quality CPR, along with recognition and response to deteriorating patients before an arrest.

Defining the optimal means of delivering resuscitation education to address these critical determinants of survival may help to improve outcomes from cardiac arrest.

Resuscitation education is primarily focused on ensuring widespread and uniform implementation of the science of resuscitation (eg, the Scientific Statements and Guidelines) into practice by lay and healthcare CPR providers. It aims to close the gap between actual and desired performance by providing lay providers with CPR skills and the self-efficacy to use them; supplementing training with in-the-moment support, such as dispatch-assisted CPR; improving healthcare professionals' ability to recognize and respond to patients at risk of cardiac arrest; improving resuscitation performance (including CPR); and ensuring continuous quality improvement activities to optimize future performance through targeted education. Simply ensuring that cardiac arrest victims receive care consistent with the current state of scientific knowledge has the potential to save thousands of lives every year in the United States.

Development of Evidence-Based Education Guidelines

The American Heart Association (AHA) Emergency Cardiovascular Care (ECC) Committee uses a rigorous process to review and analyze the peer-reviewed published scientific evidence supporting the AHA Guidelines for CPR and ECC, including this update. In 2000, the AHA began collaborating with other resuscitation councils throughout the world, via the International Liaison Committee on Resuscitation (ILCOR), in a formal international process to evaluate resuscitation science. This process resulted in the publication of the International Consensus on CPR and ECC Science With Treatment Recommendations in 2005 and in 2010.[8] These publications provided the scientific support for AHA Guidelines revisions in those years.[9,10]

In 2011, the AHA created an online evidence review process, the Scientific Evidence Evaluation and Review System (SEERS), to support ILCOR systematic reviews for 2015 and beyond. This new process includes the use of Grading of Recommendations Assessment, Development, and Evaluation (GRADE) software to create systematic reviews that will be available online and used by resuscitation councils to develop their guidelines for CPR and ECC. The drafts of the online reviews were posted for public comment, and ongoing reviews will be accessible to the public.[11] Throughout the online version of this publication, live links are provided so the reader can connect directly to the systematic reviews on the SEERS website. These links are indicated by a combination of letters and numbers (eg, EIT 647). We encourage readers to use the links and review the evidence and appendixes, such as the GRADE tables.

For this 2015 international evidence review, members of the ILCOR Education, Implementation, and Teams Task Force[12,13] identified topics through consensus, based on their perceived relevance, potential impact on saving lives, and

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the likelihood for new evidence since the 2010 Guidelines. They also sought recommendations about topics from ILCOR member resuscitation councils through their council chairs and individual task force members. The systematic reviews of these high-priority topics provided the evidence base for these 2015 education guidelines.

Each review seeks to determine the answer to a question regarding the effect in a population of an intervention (evaluated against a control or other comparison group) on an outcome. The Education, Implementation, and Teams Task Force identified patient-related outcomes and actual performance in the clinical setting as the critical outcomes, with learning-related outcomes (immediate and longer retention) considered to be important outcomes. This approach is consistent with other recognized program evaluation paradigms, such as Kirkpatrick's model,[14] where "results" (or patient outcome) are considered more important than "transfer" of learning to the clinical setting, which is in turn more important than evidence of "learning." McGaghie's model describing translational outcomes for medical education research follows a similar logic.[15] The implication is that treatment recommendations based strictly on studies demonstrating improved learning will be weaker than if differences in critical patient related outcomes are demonstrated.

Because this *2015 AHA Guidelines Update for CPR and ECC* represents the first update to the previous Guidelines, recommendations from both this 2015 Guidelines Update and the 2010 Guidelines are in the Appendix.

As with all AHA Guidelines, each 2015 recommendation is labeled with a Class of Recommendation (COR) and a Level of Evidence (LOE). This 2015 update uses the newest AHA COR and LOE classification system, which contains modifications of the Class III recommendation and introduces LOE B-R (randomized studies) and B-NR (nonrandomized studies) as well as LOE C-LD (limited data) and C-EO (expert opinion/consensus). For further information, please see "Part 2: Evidence Evaluation and Management of Conflicts of Interest."

These 2015 AHA education guidelines differ from the 2010 AHA Guidelines on education, implementation, and teams because the focus of this publication is strictly on training, with important related topics covered in other Parts (eg, dispatch-guided CPR in "Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality" and continuous quality improvement in "Part 4: Systems of Care and Continuous Quality Improvement").

Key recommendations in this 2015 update to the 2010 Guidelines include the following:

- Use of high-fidelity manikins is encouraged at training centers and organizations that have the infrastructure, trained personnel, and resources to maintain the program.
- Use of CPR feedback devices can help to learn the psychomotor skill of CPR.
- Two-year retraining cycles are not optimal. More frequent training in basic life support (BLS) and retraining in advanced life support (ALS) may be helpful for providers who are likely to encounter a cardiac arrest.

Educational Design

Evidence-based instructional design is essential to improve training of providers and ultimately improve resuscitation performance and patient outcomes. The quality of rescuer performance depends on learners integrating, retaining, and applying the cognitive, behavioral, and psychomotor skills required to perform resuscitation successfully. Learners need to develop the self-efficacy to use the skills they learned when faced with a resuscitation scenario.[16,17] Well-designed resuscitation education informed by adult learning theories and educational science increases the likelihood that this will occur. The appropriate application of learning theories combined with research into program effectiveness has resulted in substantial changes to AHA ECC courses over the past quarter century.[18] In 2013, the AHA established the ECC Educational Sciences and Programs Subcommittee to help inform the creation of courses by using the best available evidence in education science. The development of the AHA courses are guided by core educational principles (Table 1), including deliberate, hands-on practice, where feedback and debriefing should support participants' development toward mastery.[18–20]

An essential component of resuscitation education is the experiential learning that occurs through simulation and the associated debriefing. Kolb's experiential learning cycle provides a framework of 4 stages that are required to consolidate learning (Figure 1).[44] For most individuals participating in resuscitation courses, clinical resuscitations are rare events, emphasizing the importance of learning from simulated scenarios so that they are able to act when the real-life events occur.[45] By engaging learners in scenarios and guiding them through a constructive debriefing, instructors can maximize knowledge transfer to real-life events. Critical to this learning process is the notion that the experience is not enough to promote practice change. Experience needs to be coupled with a constructive debriefing, allowing for guided reflection that can promote change in performance.[9,20,46] AHA courses promote the use of structured and supported debriefing by using the GAS (gather-analyze-summarize) model of debriefing paired with evidence-based scripted debriefing tools.[18,47]

As a part of this educational process, attention to functional task alignment is necessary to ensure that learners take away the appropriate skills.[48] By aligning the nature and degree of realism with the predetermined learning objectives and/or tasks, the instructor is deliberately targeting realism to the learning need. Taking shortcuts within the educational design of these courses can result in significant unintended consequences. As an example, a study by Krogh et al demonstrated poor adherence to the recommended 2-minute CPR time cycles when learners practiced CPR with abbreviated cycles.[49] Greater attention to promoting realism of the simulation scenario with respect to timing, duration, and integration of tasks with accompanying feedback creates a learning environment best suited to improving learning outcomes.[50] To quote the legendary coach Vince Lombardi, "Practice doesn't make perfect. Only perfect practice makes perfect."

There is substantial evidence to suggest that mastery learning is the key to skill retention and the prevention of rapid decay in skills and knowledge after simulation-based learning.[45,51–53] The goal of mastery learning is to have learners

Table 1. Core AHA Emergency Cardiovascular Care Educational Concepts

Simplification	Course content should be simplified in both the presentation of the content and the breadth of content to facilitate accomplishment of course objectives.[21,22]
Consistency	Course content and skill demonstrations should be presented in a consistent manner. Video-mediated, practice-while-watching instruction is the preferred method for basic psychomotor skill training because it reduces instructor variability that deviates from the intended course agenda.[22–25]
Contextual	Adult learning principles[26] should be applied to all ECC courses, with emphasis on creating relevant training scenarios that can be applied practically to the learners' real-world setting, such as having hospital-based learners practice CPR on a bed instead of the floor.
Hands-on practice	Substantial hands-on practice is needed to meet psychomotor and nontechnical/leadership skill performance objectives.[22,23,27–29]
Practice to mastery	Learners should have opportunities for repetitive performance of key skills coupled with rigorous assessment and informative feedback in a controlled setting.[30–33] This deliberate practice should be based on clearly defined objectives[34–36] and not time spent, to promote student development toward mastery.[37–41]
Debriefing	The provision of feedback and/or debriefing is a critical component of experiential learning.[20] Feedback and debriefing after skills practice and simulations allow learners (and groups of learners) the opportunity to reflect on their performance and to receive structured feedback on how to improve their performance in the future.[18]
Assessment	Assessment of learning in resuscitation courses serves to both ensure achievement of competence and provide the benchmarks that students will strive toward. Assessment also provides the basis for student feedback (assessment *for* learning). Assessment strategies should evaluate competence and promote learning. Learning objectives[42] must be clear and measurable and serve as the basis of evaluation.
Course/program evaluation	This is an integral component of resuscitation education, with the appraisal of resuscitation courses including learner, individual instructor, course, and program performance.[43] Training organizations should use this information to drive the continuous quality improvement process.

AHA indicates American Heart Association; CPR, cardiopulmonary resuscitation; and ECC, emergency cardiovascular care.

achieve the highest standards for all educational outcomes instead of simply meeting the minimum standard.[54] Although this is not a new educational concept, this represents a shift in the way resuscitation courses are taught. Flexibility is necessary for mastery learning to occur because the time required for learners to meet this mastery standard may vary.[53]

Assessment within AHA courses needs to play an important dual role. Summative assessment (ie, assessment conducted at the end of training that is compared with a standard or benchmark) is required to ensure that intended learning outcomes are met. Formative assessment (ie, low stakes assessment with little to no "point" value in the course) provides clarity to learners about what the important desired outcomes are and provides practical advice to learners on where they can improve and how to do it (so-called assessment *for* learning). Assessment is deliberately aligned to the learning objectives and instructional programs within the AHA courses. In recognizing that successful resuscitation requires the integration of cognitive, psychomotor, and behavioral skills, there is

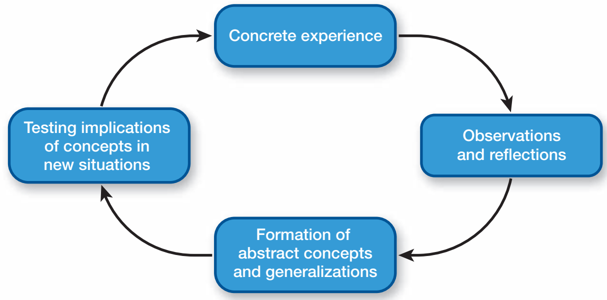

Figure 1. Experiential learning cycle. Kolb, David A., Experiential Learning: Experience as a Source of Learning & Development, 1st, ©1984, 21. Reprinted by permission of Pearson Education, Inc., New York, New York.[44]

an increasing emphasis on focusing learner evaluation on the higher levels of Miller's classic description of assessment (ie, above the level of knowledge). The simulated setting readily allows such an approach.[55] Optimal learning depends heavily on the assessment skills of the instructor; therefore, early and ongoing faculty development is a priority, as are the development and implementation of appropriate assessment tools with evidence of validity and reliability.

The degree to which a learner masters the material depends on the instructor's expertise and the debriefing process.[20,56] Helping learners understand *why* the course is important (ie, the relevance) and how it applies to their situation is critical in motivating adult learners. Respecting their prior experience and defining how their learning in the course can help them care for loved ones or their patients can be particularly useful. During debriefing, learners reflect on their performance during the simulation, performance gaps are identified and corrected, and "take-home" messages are generalized to maximize learning.[57] Without this step, learners are unlikely to improve nontechnical skills, decision-making abilities, situational awareness, and team coordination.[46] Future work should aim to establish competency and performance standards for resuscitation instructors that will help to standardize quality of instruction across training programs.[58]

Basic Life Support Training

CPR Instruction Methods[EIT 647]—Updated

Studies on CPR instruction methods (video- and/or computer-based with hands-on practice versus instructor-led courses) are heterogeneous with regard to instruction delivery and learner outcomes. Although instructor-led courses have been considered the gold-standard, multiple studies have demonstrated no difference in learning outcomes (cognitive performance, skill performance at course conclusion, and skill decay) when courses with self-instruction are compared with traditional instructor-led courses.[22–25,41,59–66] CPR self-instruction through video- and/or computer-based modules paired with hands-on practice may be a reasonable alternative to instructor-led courses (Class IIb, LOE C-LD). This recommendation is based on the absence of differences in learner outcomes, the benefits of increased standardization, plus the likely reduction of time and resources required for training.

Automated External Defibrillator Training Methods[EIT 651]—New

Allowing the use of automated external defibrillators (AEDs) by untrained bystanders can potentially be lifesaving and should be encouraged when trained individuals are not immediately available. Although AEDs can be used effectively without prior training, even brief training increases the willingness of a bystander to use an AED and improves individual performance,[67–69] although the most effective method of instruction is not known. None of the studies identified in the literature review addressed patient-related outcomes (ie, they were manikin-based with learning outcomes assessed within 6 months of training).

In lay providers, 4 studies examined self-instruction without instructor involvement versus a traditional instructor-led course.[27,41,70,71] There was no significant difference between these methods.[27,41,70,71] Two studies evaluated self-instruction combined with instructor-led training versus traditional courses; one study showed equivalent results,[70] whereas the other demonstrated that self-instruction combined with instructor-led AED training was inferior to traditional methods.[27]

A combination of self-instruction and instructor-led teaching with hands-on training can be considered as an alternative to traditional instructor-led courses for lay providers. If instructor-led training is not available, self-directed training may be considered for lay providers learning AED skills (Class IIb, LOE C-EO). Potential to increase the numbers of lay providers trained and cost implications were important considerations in the development of this recommendation.

In healthcare providers, 3 studies compared self-instruction without instructor involvement[25,72,73] versus an instructor-led course and demonstrated either no difference in performance[25,72] or inferior performance in the self-instruction group.[73] When compared with instructor-led training alone, self-instruction combined with instructor-led AED training led to slight reductions in performance but significant reductions in training time.[25,72] Self-directed methods can be considered for healthcare professionals learning AED skills (Class IIb, LOE C-EO).

CPR Feedback/Prompt Devices in Training[EIT 648]—New and Updated

Mastery learning requires accurate assessment of CPR skills and feedback to help learners improve subsequent performance. Unfortunately, inadequate performance of CPR is common yet challenging for providers and instructors to detect,[74,75] thereby making it difficult to appropriately focus feedback and improve future performance. Technology could theoretically help address this problem by assessing CPR performance and providing feedback. In conducting this analysis, we separated CPR feedback devices that provide corrective feedback to the learner from prompt devices that provide only a tone or rate for the rescuer to follow (with no feedback on how the learner is actually performing).

Learners who used devices that provided corrective feedback during CPR training had improved compression rate, depth, and recoil compared with learners performing CPR without feedback devices.[50,76–96] Evidence on the effect of feedback devices on CPR skill retention is limited, with 1 of 3 studies demonstrating improved retention.[82,85,86] Use of feedback devices can be effective in improving CPR performance during training (Class IIa, LOE A).

Three randomized trials examined the use of auditory guidance (ie, use of a metronome or music) to guide CPR performance. All 3 studies found that compression rate was more appropriate when auditory guidance was used, although there was a negative impact on compression depth in 1 study.[94–96] If feedback devices are not available, auditory guidance (eg, metronome, music) may be considered to improve adherence to recommendations for chest compression rate only (Class IIb, LOE B-R). These recommendations are made, balancing the potential benefit of improved CPR performance with the cost of the use of such devices during training.

Retraining Intervals for BLS[EIT 628]—Updated

The standard retraining period for BLS is every 2 years, despite growing evidence that BLS knowledge and skills decay rapidly after initial training. Studies have demonstrated the deterioration of BLS skills in as little as 3 months after initial training.[9,97,98]

Three studies evaluated the impact of 1 additional episode of BLS retraining 6 to 9 months after BLS certification and found no difference in chest compression performance or time to defibrillation.[99–101] Two studies examined the effect of brief, more frequent training sessions; both studies demonstrated slight improvement in chest compression performance, and 1 study found a shorter time to defibrillation.[86,102] These same studies also found that students reported improved confidence and willingness to perform CPR after additional or high-frequency training.

There is insufficient evidence to determine the optimal method and timing of BLS recertification. Given the rapidity with which BLS skills decay after training, coupled with the observed improvement in skill and confidence among students who train more frequently, it may be reasonable for BLS retraining to be completed more often by individuals who are likely to encounter cardiac arrest (Class IIb, LOE C-LD). It should be emphasized that BLS skill maintenance needs to be appropriately tailored for potential provider groups on the basis of their setting and the feasibility of more frequent training.

Advanced Life Support Training

Precourse Preparation[EIT 637]—Updated

To maximize learning from an ALS training program, an adult learner should be well prepared before attending such a program. Similarly, instructors have the responsibility of providing an optimal learning environment that will facilitate the acquisition and refinement of skills in motivated trainees. In view of the resources (time, equipment, supplies, money, etc) required and the potential impact (life or death) on patients, this duty is paramount. During the past decade, many life support programs have mandated independent review of content knowledge, via study of the pertinent provider manual, and successful completion of an online examination before attendance at the program. Unfortunately, trainee preparation has not been extensively studied. A single multicenter randomized controlled trial[103] compared extensive precourse preparation using an interactive compact disc and additional course materials (intervention group) with the use of course materials alone (control group). Subjects exhibited no differences in performance during a simulated cardiac arrest, and no differences were noted in knowledge acquisition or performance of the technical skills required during resuscitation. Although this study revealed no benefit of trainee preparation, it is important to acknowledge that the type of skill(s) practiced during preprogram preparation and the skill(s) assessed during the program may not have been directly aligned and thus may have confounded the results. Therefore, any conclusions from this study must be tempered by its limitations. Precourse preparation is consistent with theories of learning and current practices in other professional education. It has the potential to improve learning and improve the care delivered to patients.

Precourse preparation, including review of appropriate content information, online/precourse testing, and practice of pertinent technical skills is reasonable before attending ALS training programs (Class IIa, LOE C-EO).

Team and Leadership Training[EIT 631]—Updated

Effective management of a cardiac arrest patient requires a team-based approach with providers who have the knowledge, clinical skills, interpersonal communication skills, and leadership skills to perform effectively in a high-stakes environment. This also requires a team leader who has the ability to provide oversight of the team, provide guidance for specific tasks, and maintain a heightened level of situational awareness to avoid fixation on certain aspects of care. Given that team-based skills are different from clinical care skills, specific team and leadership training may have a role in the effective performance of resuscitation teams and patient outcomes after cardiac arrest.

A systematic review of the resuscitation education literature identified several studies assessing the impact of team training for healthcare professionals in a cardiac arrest setting. In 1 observational study, the implementation of a hospital-wide mock code program with team training resulted in a survival increase for pediatric cardiac arrest during the study period.[104]

In another observational study, the implementation of surgical team training resulted in a decrease in surgical patient mortality in hospitals that implemented the program when compared with those that did not.[105]

A number of additional studies demonstrated better performance of patient tasks, teamwork, and/or leadership behaviors in the immediate postcourse time period up to 1 year after training.[95–106]

Given very small risk for harm and the potential benefit of team and leadership training, the inclusion of team and leadership training as part of ALS training is reasonable (Class IIa, LOE C-LD).

Manikin Fidelity[EIT 623]—Updated

Many training programs use high-fidelity manikins for adult and pediatric ALS training.[106–108] The use of high-fidelity manikins can encourage learners to engage physically and emotionally with the manikin and the environment, thus helping to promote teamwork, clinical decision making, and full participant immersion within the experiential learning environment. High-fidelity manikins have a wide range of functionality depending on make and model type, but generally they are defined as manikins that provide physical findings (such as heart and breath sounds, pulses, chest rise and fall, and blinking eyes), display vital signs that correlate with physical findings, and "physiologically" respond to medical intervention through an operator-controlled computer interface.[107] Many of these manikins also allow participants to actually perform some critical care procedures, including bag-mask ventilation, intubation, intraosseous needle insertion, and/or chest tube insertion.

A meta-analysis of 12 randomized controlled trials showed improvement of skills at course conclusion with the use of high-fidelity manikins.[47,109–119] A meta-analysis of 8 randomized controlled trials assessing knowledge at course conclusion demonstrated no significant benefit of training with high-fidelity manikins compared with low-fidelity manikins.[47,110,111,116–118,120,121] This is supported by 1 additional nonrandomized trial demonstrating no substantial benefit of high-fidelity training on knowledge acquisition.[122] With regard to skill retention, 1 study showed no benefit of high-fidelity training on skills performance (in the simulated environment) at 1 year after training,[109] and another demonstrated similar results for skills performance between course conclusion and 1 year.[118]

The use of high-fidelity manikins for ALS training can be beneficial for improving skills performance at course conclusion (Class IIa, LOE B-R). The usefulness of high-fidelity manikins for improving knowledge at course conclusion and skills performance beyond course conclusion is uncertain. Given the increased cost associated with high-fidelity training, the use of high-fidelity manikins is particularly appropriate in programs where existing resources (ie, human and financial resources) are already in place.

Training Intervals[EIT 633]—Updated

Retraining intervals for AHA basic and advanced life support programs have traditionally been time-specific, with a maximum 2-year interval recommended, despite evidence that core skills and knowledge decay within 3 to 12 months after initial training.[9,97] Unfortunately, the literature directly assessing the question of the retraining intervals is limited. In 1 pediatric ALS study,[123] frequent refreshers with manikin-based simulation showed better clinical performance scores and equivalent behavioral performance scores, using less total time of retraining, when compared with standard retraining intervals.

Recent literature in resuscitation education also demonstrates improved learning from "frequent, low-dose" versus "comprehensive, all-at-once" instruction and a learner preference for this format.[124]

Given the potential educational benefits of short, frequent retraining sessions coupled with the potential for cost savings from reduced training time and removal of staff from the clinical environment for standard refresher training, it is reasonable that individuals who are likely to encounter a cardiac arrest victim perform more frequent manikin-based retraining (Class IIa, LOE C-LD). There is insufficient evidence to recommend the optimum time interval.

Special Considerations

Compression-Only CPR Training in Communities[EIT 881]—New

Compression-only (Hands-Only™) CPR has been advocated as a method of training laypeople that is simpler to learn and may increase bystander willingness to provide CPR. Most published studies on bystander compression-only CPR have involved dispatcher-guided CPR by lay rescuers. Life support course students, when surveyed, have reported a greater willingness to provide compression-only CPR than conventional CPR with assisted ventilations.[125–129] Two studies published after a state-wide educational campaign for bystander compression-only CPR showed that the prevalence of both overall bystander CPR and compression-only CPR by bystanders increased over time, but no effect on patient survival was demonstrated.[130,131]

Communities may consider training bystanders in compression-only CPR for adult out-of-hospital cardiac arrest as an alternative to training in conventional CPR (Class IIb, LOE C-LD). Communities should consider existing bystander CPR rates and other factors, such as local epidemiology of out-of-hospital cardiac arrest and cultural preferences, when deciding on the optimal community CPR training strategy.

CPR Training in Resource-Limited Environments[EIT 634]—New

Studies examining CPR training in resource-limited environments are heterogeneous in design and training outcomes. Studies comparing traditional course format with training using computer-based instruction, self-directed learning, video-based instruction, and varied instructor-to-student ratios showed mixed results with regard to knowledge and skill at course completion and at reassessment up to 6 months after course completion.[132–138] These studies varied in course composition (paramedic students, medical students at various levels, nursing students, and credentialed healthcare providers), type of course (BLS or ALS), and instructional methods.

It may be reasonable to use alternative instructional modalities for BLS and/or ALS teaching in resource-limited environments (Class IIb, LOE C-LD). In making this recommendation, we considered the cost of and access to training as major impediments to training BLS and ALS for healthcare workers in resource-limited areas. Additionally, the intent is to promote research and initiatives around creative teaching strategies that lower both cost and human resources needed to achieve more widespread BLS and ALS training that meets the desired learning objectives in resource-limited environments.

CPR for High-Risk Populations[EIT 649]—New

There are many studies evaluating the effectiveness of BLS training in family members and/or caregivers of high-risk cardiac patients, including some that measure the frequency at which CPR is performed by family members[125,139–147]; their retention of knowledge, skills, and adequacy of performance[125,139,140,142,148,149]; and the survival rates of cardiac arrest victims receiving CPR from family members.[66,139,140,142,150–153] Despite the heterogeneity and generally low quality, these studies consistently showed high scores for CPR performance in those who were trained compared with those who were untrained. Most studies examining retention of skills showed a decline in CPR performance over time without retraining. Training primary caregivers and/or family members of high-risk patients may be reasonable (Class IIb, LOE C-LD), although further work needs to help define which groups to preferentially target. This recommendation is predicated on the significant potential benefit and low potential for harm in patients receiving bystander CPR by a trained family member or caregiver.

Knowledge Gaps

Implementing resuscitation science into clinical practice requires educational practice based on high-quality educational research. To date, the resuscitation education literature has been limited by outcomes that focus on short-term learning rather than patient outcome or transfer of provider performance into the clinical environment (or even long-term retention of critical skills), variable quality of research design, and the use of assessment tools that lack validity and reliability evidence. With that in mind, the writing group for the AHA education guidelines suggests the following general concepts to advance educational research and educational practice, along with a series of specific themes of research that warrant further exploration (Table 2).

General Concepts

Research on resuscitation education needs higher-quality studies that are adequately powered and that address important educational questions. Multicenter collaborative studies may be of benefit to support both quality in study design and enrolling adequate numbers of participants. Ideally, the outcomes from educational studies should focus on patient outcomes (where feasible), transfer of learning into performance in the clinical environment, or at least long-term retention of psychomotor and behavioral skills in the simulated resuscitation environment. Too much of the current focus of educational research is exclusively on the immediate end-of-course performance, which may not be representative of participants' performance when they are faced with a resuscitation event months to years later. Because much of the training for resuscitation events uses manikin-based simulation, research is needed to reflect important patient characteristics in training devices, such as chest compliance and clinical signs of distress. Assessment tools that have been empirically studied for

Table 2. Specific Themes for Future Resuscitation Education Research

Topic	Research Needs/Questions
Basic Life Support Training	
CPR instruction methods	• Determine the impact of short, video-based practice on long-term CPR performance as well as patient outcomes • Determine the optimal design of these short courses
AED training methods	• Define the optimal instructional strategies and retraining intervals, including the methods of retraining, to improve performance and self-efficacy
CPR feedback/prompt devices in training	• Determine the impact of CPR feedback devices on future (long-term) performance of CPR • Explore the additional or reduced costs of training with feedback devices
Retraining intervals for basic life support	• Determine the ideal frequency of retraining required to enhance retention of skills and performance in simulated and real resuscitations • Assess if real resuscitation events, coupled with appropriate feedback and/or assessment, can serve as an adjunct or replacement for more frequent retraining
Compression-only CPR training in communities	• Define the optimal community bystander CPR training strategy based on cultural and local variables
CPR training in resource-limited environments	• Determine the optimal method of low-cost instruction while enhancing learning and patient outcomes
CPR for high-risk populations	• Determine which populations are best suited for targeted training, including the cost-effectiveness of this intervention
Advanced Life Support Training	
Precourse preparation	• Determine the content, timing, and importance of precourse preparation for various life support courses on learning outcomes
Team and leadership training	• Determine the optimal methodology (ie, instructional design), frequency, and context of team and leadership training for acquisition and retention of key resuscitation skills • Define how individual leadership and team skills influence and/or relate to specific clinical performance metrics during resuscitation
Manikin fidelity	• Determine the relative impact of different types of manikin fidelity (physical, emotional, conceptual) on learning, performance, and real clinical outcomes • Determine which aspects of manikin fidelity are important for achieving improved learning outcomes for specific objectives (eg, technical versus cognitive versus behavioral)
Training intervals	• Determine the ideal methodology (ie, instructional design) and frequency of retraining required to enhance retention of skills and performance in simulated and real resuscitations • Assess if real resuscitation events, coupled with appropriate feedback and/or assessment, can serve as an adjunct or replacement for more frequent retraining
Other Topics	
Repetitive practice/mastery learning	• Determine how repetitive practice and mastery learning can be applied to enhance the acquisition and retention of the various critical resuscitation competencies
Briefing/debriefing	• Determine how the various aspects of briefing (eg, content, duration) influence learning outcomes from simulation-based resuscitation education • Determine how various aspects of debriefing (eg, duration, method, framework, facilitator, use of video) can be tailored to improve the quality of simulation-based resuscitation education
Data-informed feedback	• Determine the value of data-informed feedback (eg, quantitative CPR data, video review) during advanced life support courses
Blended learning	• Determine how different learning methods and models (eg, screen-based learning, mastery learning, high-fidelity simulation) can be blended to enhance learning and patient outcomes
Instructor training and competencies	• Determine the key instructor competencies that influence positive learning outcomes • Determine the optimal means of coaching, training, and assessing instructors

AED indicates automated external defibrillator; and CPR, cardiopulmonary resuscitation.

evidence of validity and reliability are foundational to high-quality research. Standardizing the use of such tools across studies could potentially allow for meaningful comparisons when evidence is synthesized in systematic reviews to more precisely determine the impact of certain interventions. Finally, there is a clear need for cost-effectiveness research because many of the AHA education guidelines are developed in the absence of this information.

Disclosures

Part 14: Education: 2015 Guidelines Update Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Farhan Bhanji	McGill University	None	None	None	None	None	None	None
Jeffrey M. Berman	UNC Hospitals	None	None	None	None	None	None	None
Adam Cheng	Alberta Children's Hospital	Heart and Stroke Foundation of Canada*	None	None	None	None	None	None
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Gustavo E. Flores	Emergency & Critical Care Trainings, LLC	None	None	None	None	None	None	None
Louis P. Halamek	Stanford University School of Medicine	None	None	None	None	None	None	None
Margaret S. Wolff	University of Michigan	None	None	None	None	None	None	None
Consultant								
Elizabeth H. Sinz	Pennsylvania State University College of Medicine	AHRQ*	None	None	None	None	American Heart Association†	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

Appendix

2015 Guidelines Update: Part 14 Recommendations

Year Last Reviewed	Topic	Correct Recommendation	Comments
2015	Basic Life Support Training	CPR self-instruction through video- and/or computer-based modules paired with hands-on practice may be a reasonable alternative to instructor-led courses (Class IIb, LOE C-LD).	updated for 2015
2015	Basic Life Support Training	A combination of self-instruction and instructor-led teaching with hands-on training can be considered as an alternative to traditional instructor-led courses for lay providers. If instructor-led training is not available, self-directed training may be considered for lay providers learning AED skills (Class IIb, LOE C-EO).	new for 2015
2015	Basic Life Support Training	Self-directed methods can be considered for healthcare professionals learning AED skills (Class IIb, LOE C-EO).	new for 2015
2015	Basic Life Support Training	Use of feedback devices can be effective in improving CPR performance during training (Class IIa, LOE A).	updated for 2015
2015	Basic Life Support Training	If feedback devices are not available, auditory guidance (eg, metronome, music) may be considered to improve adherence to recommendations for chest compression rate only (Class IIb, LOE B-R).	updated for 2015
2015	Basic Life Support Training	Given the rapidity with which BLS skills decay after training, coupled with the observed improvement in skill and confidence among students who train more frequently, it may be reasonable for BLS retraining to be completed more often by individuals who are likely to encounter cardiac arrest (Class IIb, LOE C-LD).	updated for 2015

(Continued)

2015 Guidelines Update: Part 14 Recommendations, *Continued*

Year Last Reviewed	Topic	Correct Recommendation	Comments
2015	Advanced Life Support Training	Precourse preparation, including review of appropriate content information, online/precourse testing, and practice of pertinent technical skills are reasonable before attending ALS training programs (Class IIa, LOE C-EO).	updated for 2015
2015	Advanced Life Support Training	Given very small risk for harm and the potential benefit of team and leadership training, the inclusion of team and leadership training as part of ALS training is reasonable (Class IIa, LOE C-LD).	updated for 2015
2015	Advanced Life Support Training	The use of high-fidelity manikins for ALS training can be beneficial for improving skills performance at course conclusion (Class IIa, LOE B-R).	updated for 2015
2015	Advanced Life Support Training	Given the potential educational benefits of short, frequent retraining sessions coupled with the potential for cost savings from reduced training time and removal of staff from the clinical environment for standard refresher training, it is reasonable that individuals who are likely to encounter a cardiac arrest victim perform more frequent manikin-based retraining (Class IIa, LOE C-LD).	updated for 2015
2015	Special Considerations	Communities may consider training bystanders in compression-only CPR for adult out-of-hospital cardiac arrest as an alternative to training in conventional CPR (Class IIb, LOE C-LD).	new for 2015
2015	Special Considerations	It may be reasonable to use alternative instructional modalities for BLS and/or ALS teaching in resource-limited environments (Class IIb, LOE C-LD).	new for 2015
2015	Special Considerations	Training primary caregivers and/or family members of high-risk patients may be reasonable (Class IIb, LOE C-LD), although further work needs to help define which groups to preferentially target.	new for 2015
The following recommendations were not reviewed in 2015. For more information, see the *2010 AHA Guidelines for CPR and ECC*, "Part 16: Education, Implementation, and Teams."			
2010	Barriers to Recognition of Cardiac Arrest	Rescuers should be taught to initiate CPR if the adult victim is unresponsive and is not breathing or not breathing normally (eg, only gasping) (Class I, LOE B).	not reviewed in 2015
2010	Physical and Psychological Concerns for Rescuers	It is reasonable that participants undertaking CPR training be advised of the vigorous physical activity required during the skills portion of the training program (Class IIa, LOE B).	not reviewed in 2015
2010	Barriers to AED Use	To maximize willingness to use an AED, public access defibrillation training should continue to be encouraged for the lay public (Class I, LOE B).	not reviewed in 2015
2010	Course Design	Consistent with established methodologies for program evaluation, the effectiveness of resuscitation courses should be evaluated (Class I, LOE C).	not reviewed in 2015
2010	AED Training Requirement	Allowing the use of AEDs by untrained bystanders can be beneficial and may be lifesaving (Class IIa, LOE B).	not reviewed in 2015
2010	AED Training Requirement	Because even minimal training has been shown to improve performance in simulated cardiac arrests, training opportunities should be made available and promoted for the lay rescuer (Class I, LOE B).	not reviewed in 2015
2010	Course Delivery Formats	It is reasonable to consider alternative course scheduling formats for advanced life support courses (eg, ACLS or PALS), provided acceptable programmatic evaluation is conducted and learners meet course objectives (Class IIa, LOE B).	not reviewed in 2015
2010	Checklists/Cognitive Aids	Checklists or cognitive aids, such as the AHA algorithms, may be considered for use during actual resuscitation (Class IIb, LOE C).	not reviewed in 2015
2010	Debriefing	Debriefing as a technique to facilitate learning should be included in all advanced life support courses (Class I, LOE B).	not reviewed in 2015
2010	Regional Systems of (Emergency) Cardiovascular Care	It is reasonable that regional systems of care be considered as part of an overall approach to improve survival from cardiac arrest (Class IIa, LOE C).	not reviewed in 2015
2010	Barriers to Bystander CPR	Because panic can significantly impair a bystander's ability to perform in an emergency, it may be reasonable for CPR training to address the possibility of panic and encourage learners to consider how they will overcome it (Class IIb LOE C).	not reviewed in 2015
2010	Barriers to Bystander CPR	Despite the low risk of infections, it is reasonable to teach rescuers about the use of barrier devices emphasizing that CPR should not be delayed for their use (Class IIa, LOE C).	not reviewed in 2015
2010	Post-Course Assessment	A written test should not be used exclusively to assess learner competence following an advanced life support course (Class I, LOE B).	not reviewed in 2015
2010	Post-Course Assessment	End-of-course assessment may be useful in helping learners retain skills (Class IIb, LOE C).	not reviewed in 2015

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