1: Executive Summaries

1 Executive Summary - 2017 Update

2017 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

1.1 Introduction

The purpose of this Executive Summary is to provide an overview of the new, revised, or unchanged recommendations contained in these 2017 focused updates. This year marks the start of a continuous evidence evaluation (CEE) review of published relevant and new science related to the implementation of cardiopulmonary resuscitation (CPR) quality.

The updates align with the International Liaison Committee on Resuscitation's (ILCOR's) CEE review process. Updates are published when ILCOR completes a literature review based on new science. This year included a recent evidence-based review of the following adult basic life support (BLS) topics: emergency medical services (EMS)–delivered CPR, dispatch-assisted CPR, bystander CPR, chest compression–to–ventilation ratio, and CPR for cardiac arrest. A summary of the key findings and major changes highlights the use of continuous vs interrupted chest compressions by EMS providers, dispatch-assisted CPR, and the use of compression-only CPR vs CPR using chest compressions with ventilation for in-hospital and out-of-hospital settings. The adult BLS focused update also provides clarity about the descriptions of lay rescuers (eg, untrained, trained in chest compression–only CPR, trained in CPR using chest compressions and ventilation) in response to questions from the American Heart Association's Training Network. The pediatric BLS focused update provides an evidence-based review and treatment recommendations for compression-only CPR vs CPR using chest compressions with rescue breaths for children younger than 18 years of age.

1.2 Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality

1.2.1 Summary of Key Issues and Major Changes

The topics reviewed here include the following:

- Dispatch-assisted CPR
- Use of continuous vs interrupted chest compressions by emergency medical services (EMS) providers
- Use of chest compression–only (Hands-Only) CPR vs CPR using chest compressions with ventilation in both the in-hospital and out-of-hospital settings

At the request of the AHA Training Network, we have clarified the descriptions of lay rescuers as follows:

1. Untrained
2. Trained in chest compression–only CPR
3. Trained in CPR using chest compressions and ventilation (rescue breaths)

1.2.2 Dispatch-Assisted CPR

2017 (Updated): We recommend that when dispatchers' instructions are needed, dispatchers should provide chest compression–only CPR instructions to callers for adults with suspected out-of-hospital cardiac arrest (OHCA).

2015 (Old): Dispatchers should provide chest compression–only CPR instructions to callers for adults with suspected OHCA.

Why: The 2017 BLS International Consensus on CPR and ECC Science With Treatment Recommendations (CoSTR) summary and systematic review considered instructions for dispatch-assisted chest compression–only CPR for OHCA. No new studies were reviewed for this topic.

1.2.3 Bystander CPR

2017 (Updated):

1. For adults in OHCA, untrained lay rescuers should provide chest compression–only CPR with or without dispatcher assistance.
2. For lay rescuers trained in chest compression–only CPR, we recommend that they provide chest compression–only CPR for adults in OHCA.
3. For lay rescuers trained in CPR using chest compressions and ventilation (rescue breaths), it is reasonable to provide ventilation (rescue breaths) in addition to chest compressions for the adult in OHCA.

2015 (Old):

1. For lay rescuers, compression-only CPR is a reasonable alternative to conventional CPR in the adult cardiac arrest patient.
2. For trained lay rescuers, it is reasonable to provide ventilation in addition to chest compressions for the adult in cardiac arrest.
3. For trained lay rescuers, it is reasonable to provide ventilation in addition to chest compressions for the adult in cardiac arrest.

Why: The 2017 BLS CoSTR summary and systematic review compared bystander use of chest compression–only CPR with CPR using chest compressions and ventilation (rescue breaths).

1.2.4 EMS-Delivered CPR

2017 (Updated):

1. We recommend that before placement of an advanced airway (supraglottic airway or tracheal tube), EMS providers perform CPR with cycles of 30 compressions and 2 breaths. As an alternative, it is reasonable for EMS providers to perform CPR in cycles of 30 compressions and 2 breaths without interrupting chest compressions to give breaths. It may be reasonable for EMS providers to use a rate of 10 breaths per minute (1 breath every 6 seconds) to provide asynchronous ventilation during continuous chest compressions before placement of an advanced airway.
2. These updated recommendations do not preclude the 2015 recommendation that a reasonable alternative for EMS systems that have adopted bundles of care is the initial use of minimally interrupted chest compressions (ie, delayed ventilation) for witnessed, shockable OHCA.

2015 (Old):

1. As long as the patient does not have an advanced airway in place, the rescuers should deliver cycles of 30 compressions and 2 breaths during CPR. The rescuer delivers breaths during pauses in compressions and delivers each breath over approximately 1 second.
2. However, in EMS systems that use bundles of care involving continuous chest compressions, the use of passive ventilation techniques may be considered as part of that bundle.

Why: The 2017 BLS CoSTR summary and systematic review compared bystander use of chest compression–only CPR with CPR using chest compressions and ventilation (rescue breaths).

1.2.5 CPR for Cardiac Arrest

2017 (Updated): Whenever an advanced airway (tracheal tube or supraglottic device) is inserted during CPR, it may be reasonable for providers to perform continuous compressions with positive-pressure ventilation delivered without pausing chest compressions.

2017 (Unchanged): It may be reasonable for the provider to deliver 1 breath every 6 seconds (10 breaths per minute) while continuous chest compressions are being performed.

2015 (Old): When the victim has an advanced airway in place during CPR, rescuers no longer deliver cycles of 30 compressions and 2 breaths (ie, they no longer interrupt compressions to deliver 2 breaths). Instead, it may be reasonable for the provider to deliver 1 breath every 6 seconds (10 breaths per minute) while continuous chest compressions are being performed.

Why: The 2017 BLS CoSTR summary and systematic review considered the use of continuous vs interrupted chest compressions after placement of an advanced airway in the hospital setting. No new studies were reviewed for this topic.

1.2.6 Chest Compression-to-Ventilation Ratio

2017 (Updated): It is reasonable for rescuers trained in CPR using chest compressions and ventilation (rescue breaths) to provide a compression-to-ventilation ratio of 30:2 for adults in cardiac arrest.

2015 (Old): It is reasonable for rescuers to provide a compression-to-ventilation ratio of 30:2 for adults in cardiac arrest.

Why: The 2017 BLS CoSTR summary and systematic review considered the compression-to-ventilation ratio for adult BLS. No new studies were reviewed for this topic.

1.3 Part 11: Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality

1.3.1 Summary of Key Issues and Major Changes

The changes for pediatric BLS were a result of weighing the survival benefits of CPR using chest compressions with rescue breaths against chest compression–only CPR, with the conclusion that the incremental benefit of rescue breaths justified a distinct recommendation. The topics reviewed here include the following:

- Reaffirming that compressions and ventilation are needed for infants and children in cardiac arrest
- Strongly recommending that bystanders who are unwilling or unable to deliver rescue breaths should provide chest compressions for infants and children

1.3.2 Components of High-Quality CPR: Pediatric BLS

2017 (Updated): Chest compressions with rescue breaths should be provided for infants and children in cardiac arrest.

2015 (Old): Conventional CPR (chest compressions and rescue breaths) should be provided for pediatric cardiac arrests.

Why: Grounded in a growing evidence base since the 2015 Guidelines Update publication, the recommendation for providing CPR using chest compressions with rescue breaths to infants and children in cardiac arrest is reasonable.

1.3.3 Components of High-Quality CPR: Chest Compression-Only CPR

2017 (Updated): If bystanders are unwilling or unable to deliver rescue breaths, we recommend that rescuers provide chest compressions for infants and children in cardiac arrest.

2015 (Old): Because compression-only CPR is effective in patients with a primary cardiac event, if rescuers are unwilling or unable to deliver breaths, we recommend that rescuers perform compression-only CPR for infants and children in cardiac arrest.

Why: In comparing the survival benefits of CPR using chest compressions with rescue breaths against the convenience of adopting alignment with the adult recommendation for chest compression–only CPR, we concluded that the incremental benefit of rescue breaths justified a different recommendation.

2 Executive Summary - 2015 Update

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

2.1 Introduction

Publication of the *2015 American Heart Association* (AHA) *Guidelines Update for Cardiopulmonary Resuscitation* (CPR) *and Emergency Cardiovascular Care* (ECC) marks 49 years since the first CPR guidelines were published in 1966 by an Ad Hoc Committee on Cardiopulmonary Resuscitation established by the National Academy of Sciences of the National Research Council. Since that time, periodic revisions to the Guidelines have been published by the AHA in 1974,[1] 1980,[2] 1986,[3] 1992,[4] 2000,[5] 2005,[6] 2010,[7] and now 2015. The *2010 AHA Guidelines for CPR and ECC* provided a comprehensive review of evidence-based recommendations for resuscitation, ECC, and first aid. *The 2015 AHA Guidelines Update for CPR and ECC* focuses on topics with significant new science or ongoing controversy, and so serves as an update to the *2010 AHA Guidelines for CPR and ECC* rather than a complete revision of the Guidelines.

The purpose of this Executive Summary is to provide an overview of the new or revised recommendations contained in the 2015 Guidelines Update. This document does not contain extensive reference citations; the reader is referred to Parts 3 through 9 for more detailed review of the scientific evidence and the recommendations on which they are based.

There have been several changes to the organization of the 2015 Guidelines Update compared with 2010. "Part 4: Systems of Care and Continuous Quality Improvement" is an important new Part that focuses on the integrated structures and processes that are necessary to create systems of care for both in-hospital and out-of-hospital resuscitation capable of measuring and improving quality and patient outcomes. This Part replaces the "CPR Overview" Part of the 2010 Guidelines.

Another new Part of the 2015 Guidelines Update is "Part 14: Education," which focuses on evidence-based recommendations to facilitate widespread, consistent, efficient and effective implementation of the AHA Guidelines for CPR and ECC into practice. These recommendations will target resuscitation education of both lay rescuers and healthcare providers. This Part replaces the 2010 Part titled "Education, Implementation, and Teams." The 2015 Guidelines Update does not include a separate Part on adult stroke because the content would replicate that already offered in the most recent AHA/American Stroke Association guidelines for the management of acute stroke.[8,9] Finally, the 2015 Guidelines Update marks the beginning of a new era for the AHA Guidelines for CPR and ECC, because the Guidelines will transition from a 5-year cycle of periodic revisions and updates to a Web-based format that is continuously updated. The first release of the *Web-based Integrated Guidelines*, now available online at ECCguidelines.heart.org is based on the comprehensive 2010 Guidelines plus the 2015 Guidelines Update. Moving forward, these Guidelines will be updated by using a continuous evidence evaluation process to facilitate more rapid translation of new scientific discoveries into daily patient care.

Creation of practice guidelines is only one link in the chain of knowledge translation that starts with laboratory and clinical science and culminates in improved patient outcomes. The AHA ECC Committee has set an impact goal of doubling bystander CPR rates and doubling cardiac arrest survival by 2020. Much work will be needed across the entire spectrum of knowledge translation to reach this important goal.

2.2 Evidence Review and Guidelines Development Process

The process used to generate the *2015 AHA Guidelines Update for CPR and ECC* was significantly different from the process used in prior releases of the Guidelines, and marks the planned transition from a 5-year cycle of evidence review to a continuous evidence evaluation process. The AHA continues to partner with the International Liaison Committee on Resuscitation (ILCOR) in the evidence review process. However, for 2015, ILCOR prioritized topics for systematic review based on clinical significance and availability of new evidence. Each priority topic was defined as a question in PICO (population, intervention, comparator, outcome) format. Many of the topics reviewed in 2010 did not have new published evidence or controversial aspects, so they were not rereviewed in 2015. In 2015, 165 PICO questions were addressed by systematic reviews, whereas in 2010, 274 PICO questions were addressed by evidence evaluation. In addition, ILCOR adopted the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) process for evidence evaluation and expanded the opportunity for public comment. The output of the GRADE process was used to generate the *2015 International Consensus on CPR and ECC Science With Treatment Recommendations* (CoSTR).[10,11]

The recommendations of the ILCOR 2015 CoSTR were used to inform the recommendations in the 2015 *AHA Guidelines Update for CPR and ECC*. The wording of these recommendations is based on the AHA classification system for evidentiary review (see "Part 2: Evidence Evaluation and Management of Conflicts of Interest").

The *2015 AHA Guidelines Update for CPR and ECC* contains 315 classified recommendations. There are 78 Class I recommendations (25%), 217 Class II recommendations (68%), and 20 Class III recommendations (7%). Overall, 3 (1%) are based on Level of Evidence (LOE) A, 50 (15%) are based on LOE B-R (randomized studies), 46 (15%) are based on LOE B-NR (nonrandomized studies), 145 (46%) are based on LOE C-LD (limited data), and 73 (23%) are based on LOE C-EO (consensus of expert opinion). These results highlight the persistent knowledge gap in resuscitation science that needs to be addressed through expanded research initiatives and funding opportunities.

As noted above, the transition from a 5-year cycle to a continuous evidence evaluation and Guidelines update process will be initiated by the 2015 online publication of the *AHA Integrated Guidelines for CPR and ECC* at ECCguidelines.heart.org. The initial content will be a compilation of the 2010 Guidelines and the 2015 Guidelines Update. In the future, the Scientific Evidence Evaluation and Review System (SEERS) Web-based resource will also be periodically updated with results of the ILCOR continuous evidence evaluation process at www.ilcor.org/seers.

2.3 Part 3: Ethical Issues

As resuscitation practice evolves, ethical considerations must also evolve. Managing the multiple decisions associated with resuscitation is challenging from many perspectives, especially when healthcare providers are dealing with the ethics surrounding decisions to provide or withhold emergency cardiovascular interventions.

Ethical issues surrounding resuscitation are complex and vary across settings (in or out of hospital), providers (basic or advanced), patient population (neonatal, pediatric, or adult), and whether to start or when to terminate CPR. Although the ethical principles involved have not changed dramatically since the 2010 Guidelines were published, the data that inform many ethical discussions have been updated through the evidence review process. The 2015 ILCOR evidence review process and resultant 2015 Guidelines Update include several recommendations that have implications for ethical decision making in these challenging areas.

2.3.1 Significant New and Updated Recommendations That May Inform Ethical Decisions

- The use of extracorporeal CPR (ECPR) for cardiac arrest
- Intra-arrest prognostic factors for infants, children, and adults
- Prognostication for newborns, infants, children, and adults after cardiac arrest
- Function of transplanted organs recovered after cardiac arrest

New resuscitation strategies, such as ECPR, have made the decision to discontinue cardiac arrest measures more complicated (see “Part 6: Alternative Techniques and Ancillary Devices for Cardiopulmonary Resuscitation” and “Part 7: Adult Advanced Cardiovascular Life Support”). Understanding the appropriate use, implications, and likely benefits related to such new treatments will have an impact on decision making. There is new information regarding prognostication for newborns, infants, children, and adults with cardiac arrest and/or after cardiac arrest (see “Part 13: Neonatal Resuscitation,” “Part 12: Pediatric Advanced Life Support,” and “Part 8: Post-Cardiac Arrest Care”). The increased use of targeted temperature management has led to new challenges for predicting neurologic outcomes in comatose post-cardiac arrest patients, and the latest data about the accuracy of particular tests and studies should be used to guide decisions about goals of care and limiting interventions.

With new information about the success rate for transplanted organs obtained from victims of cardiac arrest, there is ongoing discussion about the ethical implications around organ donation in an emergency setting. Some of the different view-points on important ethical concerns are summarized in “Part 3: Ethical Issues.” There is also an enhanced awareness that although children and adolescents cannot make legally binding decisions, information should be shared with them to the extent possible, using appropriate language and information for their level of development. Finally, the phrase “limitations of care” has been changed to “limitations of interventions,” and there is increasing availability of the Physician Orders for Life-Sustaining Treatment (POLST) form, a new method of legally identifying people who wish to have specific limits on interventions at the end of life, both in and out of healthcare facilities.

2.4 Part 4: Systems of Care and Continuous Quality Improvement

Almost all aspects of resuscitation, from recognition of cardio-pulmonary compromise, through cardiac arrest and resuscitation and post-ardiac arrest care, to the return to productive life, can be discussed in terms of a system or systems of care. Systems of care consist of multiple working parts that are interdependent, each having an effect on every other aspect of the care within that system. To bring about any improvement, providers must recognize the interdependency of the various parts of the system. There is also increasing recognition that out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA) systems of care must function differently. “ Part 4: Systems of Care and Continuous Quality Improvement” in this 2015 Guidelines Update makes a clear distinction between the two systems, noting that OHCA frequently is the result of an unexpected event with a reactive element, whereas the focus on IHCA is shifting from reactive resuscitation to prevention. New Chains of

Survival are suggested for in-hospital and out-of-hospital systems of care, with relatively recent in-hospital focus on prevention of arrests. Additional emphasis should be on continuous quality improvement by identifying the problem that is limiting survival, and then by setting goals, measuring progress toward those goals, creating accountability, and having a method to effect change in order to improve outcomes.

This new Part of the AHA Guidelines for CPR and ECC summarizes the evidence reviewed in 2015 with a focus on the systems of care for both IHCA and OHCA, and it lays the framework for future efforts to improve these systems of care. A universal taxonomy of systems of care is proposed for stakeholders. There are evidence-based recommendations on how to improve these systems.

2.4.1 Significant New and Updated Recommendations

In a randomized trial, social media was used by dispatchers to notify nearby potential rescuers of a possible cardiac arrest. Although few patients ultimately received CPR from volunteers dispatched by the notification system, there was a higher rate of bystander-initiated CPR (62% versus 48% in the control group).[12]

Given the low risk of harm and the potential benefit of such notifications, it may be reasonable for communities to incorporate, where available, social media technologies that summon rescuers who are willing and able to perform CPR and are in close proximity to a suspected victim of OHCA.
(Class IIb, LOE B-R)

Specialized cardiac arrest centers can provide comprehensive care to patients after resuscitation from cardiac arrest. These specialized centers have been proposed, and new evidence suggests that a regionalized approach to OHCA resuscitation may be considered that includes the use of cardiac resuscitation centers.

A variety of early warning scores are available to help identify adult and pediatric patients at risk for deterioration. Medical emergency teams or rapid response teams have been developed to help respond to patients who are deteriorating. Use of scoring systems to identify these patients and creation of teams to respond to those scores or other indicators of deterioration may be considered, particularly on general care wards for adults and for children with high-risk illnesses, and may help reduce the incidence of cardiac arrest.

Evidence regarding the use of public access defibrillation was reviewed, and the use of automated external defibrillators (AEDs) by laypersons continues to improve survival from OHCA. We continue to recommend implementation of public access defibrillation programs for treatment of patients with OHCA in communities who have persons at risk for cardiac arrest.

2.4.2 Knowledge Gaps

- What is the optimal model for rapid response teams in the prevention of IHCA, and is there evidence that rapid response teams improve outcomes?
- What are the most effective methods for increasing bystander CPR for OHCA?
- What is the best composition for a team that responds to IHCA, and what is the most appropriate training for that team?

2.5 Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality

2.5.1 New Developments in Basic Life Support Science Since 2010

The 2010 Guidelines were most notable for the reorientation of the universal sequence from A-B-C (Airway, Breathing, Compressions) to C-A-B (Compressions, Airway, Breathing) to minimize time to initiation of chest compressions. Since 2010, the importance of high-quality chest compressions has been reemphasized, and targets for compression rate and depth have been further refined by relevant evidence. For the untrained lay rescuer, dispatchers play a key role in the recognition of abnormal breathing or agonal gasps as signs of cardiac arrest, with recommendations for chest compression-only CPR.

This section presents the updated recommendations for the 2015 adult basic life support (BLS) guidelines for lay rescuers and healthcare providers. Key changes and continued points of emphasis in this 2015 Guidelines Update include the following: The crucial links in the adult Chain of Survival for OHCA are unchanged from 2010; however, there is increased emphasis on the rapid identification of potential cardiac arrest by dispatchers, with immediate provision of CPR instructions to the caller. These Guidelines take into consideration the ubiquitous presence of mobile phones that can allow the rescuer to activate the emergency response system without leaving the victim's side. For healthcare providers, these recommendations allow flexibility for activation of the emergency response to better match the provider's clinical setting. More data are available indicating that high-quality CPR improves survival from cardiac arrest. Components of high-quality CPR include

- Ensuring chest compressions of adequate rate
- Ensuring chest compressions of adequate depth
- Allowing full chest recoil between compressions
- Minimizing interruptions in chest compressions
- Avoiding excessive ventilation

Recommendations are made for a simultaneous, choreographed approach to performance of chest compressions, airway management, rescue breathing, rhythm detection, and shock delivery (if indicated) by an integrated team of highly trained rescuers in applicable settings.

2.5.2 Significant New and Updated Recommendations

Many studies have documented that the most common errors of resuscitation are inadequate compression rate and depth; both errors may reduce survival. New to this 2015 Guidelines Update are upper limits of recommended compression rate based on preliminary data suggesting that excessive rate may be associated with lower rate of return of spontaneous circulation (ROSC). In addition, an upper limit of compression depth is introduced based on a report associating increased non-life-threatening injuries with excessive compression depth.

- ***In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100/min to 120/min. (Class IIa, LOE C-LD)***

  The addition of an upper limit of compression rate is the result of 1 large registry study associating extremely rapid compression rates with inadequate compression depth.

- ***During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches or 5 cm for an average adult, while avoiding excessive chest compression depths (greater than 2.4 inches or 6 cm). (Class I, LOE C-LD)***

  The addition of an upper limit of compression depth followed review of 1 publication suggesting potential harm from excessive chest compression depth (greater than 6 cm, or 2.4 inches). Compression depth may be difficult to judge without use of feedback devices, and identification of upper limits of compression depth may be challenging.

- ***In adult cardiac arrest, total preshock and postshock pauses in chest compressions should be as short as possible. (Class I, LOE C-LD)***

  Shorter pauses can be associated with greater shock success, ROSC, and, in some studies, higher survival to hospital discharge. The need to reduce such pauses has received greater emphasis in this 2015 Guidelines Update.

- ***In adult cardiac arrest with an unprotected airway, it may be reasonable to perform CPR with the goal of a chest compression fraction as high as possible, with a target of at least 60%. (Class IIb, LOE C-LD)***

  The addition of this target compression fraction to the 2015 Guidelines Update is intended to limit interruptions in compressions and to maximize coronary perfusion and blood flow during CPR.

- ***For patients with known or suspected opioid overdose who have a definite pulse but no normal***

breathing or only gasping (ie, a respiratory arrest), in addition to providing standard BLS care, it is reasonable for appropriately trained BLS healthcare providers to administer IM or IN naloxone. (Class IIa, LOE C-LD)

- ***It is reasonable to provide opioid overdose response education with or without naloxone distribution to persons at risk for opioid overdose (or those living with or in frequent contact with such persons). (Class IIa, LOE C-LD)***

For more information, see "Part 10: Special Circumstances of Resuscitation".

- ***For witnessed OHCA with a shockable rhythm, it may be reasonable for EMS systems with priority-based, multitiered response to delay positive-pressure ventilation by using a strategy of up to 3 cycles of 200 continuous compressions with passive oxygen insufflation and airway adjuncts. (Class IIb, LOE C-LD)***

- ***We do not recommend the routine use of passive ventilation techniques during conventional CPR for adults. (Class IIb, LOE C-LD)***

- ***However, in EMS systems that use bundles of care involving continuous chest compressions, the use of passive ventilation techniques may be considered as part of that bundle. (Class IIb, LOE C-LD)***

- ***It is recommended that emergency dispatchers determine if a patient is unresponsive with abnormal breathing after acquiring the requisite information to determine the location of the event. (Class I, LOE C-LD)***

- ***If the patient is unresponsive with abnormal or absent breathing, it is reasonable for the emergency dispatcher to assume that the patient is in cardiac arrest. (Class IIa, LOE C-LD)***

- ***Dispatchers should be educated to identify unresponsiveness with abnormal breathing and agonal gasps across a range of clinical presentations and descriptions. (Class I, LOE C-LD)***

- ***We recommend that dispatchers should provide chest compression-only CPR instructions to callers for adults with suspected OHCA. (Class I, LOE C-LD)***

- ***It is reasonable for healthcare providers to provide chest compressions and ventilation for all adult patients in cardiac arrest, from either a cardiac or noncardiac cause. (Class IIa, LOE C-LD)***

-

When the victim has an advanced airway in place during CPR, rescuers no longer deliver cycles of 30 compressions and 2 breaths (ie, they no longer interrupt compressions to deliver 2 breaths). Instead, it may be reasonable for the provider to deliver 1 breath every 6 seconds (10 breaths per minute) while continuous chest compressions are being performed. (Class IIb, LOE C-LD)

This simple rate, rather than a range of breaths per minute, should be easier to learn, remember, and perform.

- ***There is insufficient evidence to recommend the use of artifact-filtering algorithms for analysis of ECG rhythm during CPR. Their use may be considered as part of a research protocol or if an EMS system, hospital, or other entity has already incorporated ECG artifact-filtering algorithms in its resuscitation protocols. (Class IIb, LOE C-EO)***
- ***It may be reasonable to use audiovisual feedback devices during CPR for real-time optimization of CPR performance. (Class IIb, LOE B-R)***
- ***For victims with suspected spinal injury, rescuers should initially use manual spinal motion restriction (eg, placing 1 hand on either side of the patient's head to hold it still) rather than immobilization devices, because use of immobilization devices by lay rescuers may be harmful. (Class III: Harm, LOE C-LD)***

2.5.3 Knowledge Gaps

- The optimal method for ensuring adequate depth of chest compressions during manual CPR
- The duration of chest compressions after which ventilation should be incorporated when using Hands-only CPR
- The optimal chest compression fraction
- Optimal use of CPR feedback devices to increase patient survival

2.6 Part 6: Alternative Techniques and Ancillary Devices for Cardiopulmonary Resuscitation

High-quality conventional CPR (manual chest compressions with rescue breaths) generates about 25% to 33% of normal cardiac output and oxygen delivery. A variety of alternatives and adjuncts to conventional CPR have been developed with the aim of enhancing coronary and cerebral perfusion during resuscitation from cardiac arrest. Since the 2010 AHA Guidelines for CPR and ECC were published, a number of clinical trials have provided new data regarding the effectiveness of these alternatives. Compared with conventional CPR, many of these techniques and devices require specialized equipment and training. Some have been tested in only highly selected subgroups of cardiac arrest patients; this selection must be noted when rescuers or healthcare systems consider implementation of the devices.

2.6.1 Significant New and Updated Recommendations

- The Resuscitation Outcomes Consortium (ROC) Prehospital Resuscitation Impedance Valve and Early Versus Delayed Analysis (PRIMED) study (n=8718)[13] failed to demonstrate improved outcomes with the use of an impedance threshold device (ITD) as an adjunct to conventional CPR when compared with use of a sham device. This negative high-quality study prompted a Class III: No Benefit recommendation regarding routine use of the ITD.

- One large randomized controlled trial evaluated the use of active compression-decompression CPR plus an ITD.[14] The writing group found interpretation of the true clinical effect of active compression-decompression CPR plus an ITD challenging because of wide confidence intervals around the effect estimate and also because of methodological concerns. The finding of improved neurologically intact survival in the study, however, supported a recommendation that this combination may be a reasonable alternative with available equipment and properly trained providers.

- Three randomized clinical trials comparing the use of mechanical chest compression devices with conventional CPR have been published since the 2010 Guidelines. None of these studies demonstrated superiority of mechanical chest compressions over conventional CPR. Manual chest compressions remain the standard of care for the treatment of cardiac arrest, but mechanical chest compression devices may be a reasonable alternative for use by properly trained personnel.

  The use of mechanical piston devices may be considered in specific settings where the delivery of high-quality manual compressions may be challenging or dangerous for the provider (eg, limited rescuers available, prolonged CPR, during hypothermic cardiac arrest, in a moving ambulance, in the angiography suite, during preparation for extracorporeal CPR [ECPR]), provided that rescuers strictly limit interruptions in CPR during deployment and removal of the devices.
  (Class IIb, LOE C-EO)

- Although several observational studies have been published documenting the use of ECPR, no randomized controlled trials have evaluated the effect of this therapy on survival.

2.6.2 Knowledge Gaps

- Are mechanical chest compression devices superior to manual chest compressions in special situations such as a moving ambulance, prolonged CPR, or procedures such as coronary angiography?
- What is the impact of implementing ECPR as part of the system of care for OHCA?

2.7 Part 7: Adult Advanced Cardiovascular Life Support

The major changes in the 2015 advanced cardiovascular life support (ACLS) guidelines include recommendations regarding prognostication during CPR based on end-tidal carbon dioxide measurements, use of vasopressin during resuscitation, timing of epinephrine administration stratified by shockable or nonshockable rhythms, and the possibility of bundling steroids, vasopressin, and epinephrine administration for treatment of IHCA. In addition, vasopressin has been removed from the pulseless arrest algorithm. Recommendations regarding physiologic monitoring of CPR were reviewed, although there is little new evidence.

2.7.1 Significant New and Updated Recommendations

- Based on new data, the recommendation for use of the maximal feasible inspired oxygen during CPR was strengthened. This recommendation applies only while CPR is ongoing and does not apply to care after ROSC.

- The new 2015 Guidelines Update continues to state that physiologic monitoring during CPR may be useful, but there has yet to be a clinical trial demonstrating that goal-directed CPR based on physiologic parameters improves outcomes.

- Recommendations for ultrasound use during cardiac arrest are largely unchanged, except for the explicit proviso that the use of ultrasound should not interfere with provision of high-quality CPR and conventional ACLS therapy.

- Continuous waveform capnography remained a Class I recommendation for confirming placement of an endotracheal tube. Ultrasound was added as an additional method for confirmation of endotracheal tube placement.

- The defibrillation strategies addressed by the 2015 ILCOR review resulted in minimal changes in defibrillation recommendations.

- The Class of Recommendation for use of standard dose epinephrine (1 mg every 3 to 5 minutes) was unchanged but reinforced by a single new prospective randomized clinical trial demonstrating improved ROSC and survival to hospital admission that was inadequately powered to measure impact on long-term outcomes.

- Vasopressin was removed from the ACLS Cardiac Arrest Algorithm as a vasopressor therapy in recognition of equivalence of effect with other available interventions (ig, epinephrine). This modification valued the simplicity of approach toward cardiac arrest when 2 therapies were found to be equivalent.

- The recommendations for timing of epinephrine administration were updated and stratified based on the initial presenting rhythm, recognizing the potential difference in pathophysiologic disease. For those with a nonshockable rhythm, it may be reasonable to administer epinephrine as soon as feasible. For those with a shockable rhythm, there is insufficient evidence to make a recommendation about the optimal timing of epinephrine administration, because defibrillation is a major focus of resuscitation.

- The use of steroids in cardiac arrest is controversial. In OHCA, administration of steroids did not improve survival to hospital discharge in 2 studies, and routine use is of uncertain benefit. The data regarding the use of steroids for IHCA were more vexing. In 2 randomized controlled trials led by the same investigators, a pharmacologic bundle that included methylprednisolone, vasopressin, and epinephrine administered during cardiac arrest followed by hydrocortisone given after ROSC improved survival. Whether the improved survival was a result of the bundle or of the steroid therapy alone could not be assessed

In IHCA, the combination of intra-arrest vasopressin, epinephrine, and methylprednisolone and post-arrest hydrocortisone as described by Mentzelopoulos et al [15] may be considered; however, further studies are needed before recommending the routine use of this therapeutic strategy.

(Class IIb, LOE C-LD)

- Prognostication during CPR was also a very active topic. There were reasonably good data indicating that low partial pressure of end-tidal carbon dioxide (Petco2) in intubated patients after 20 minutes of CPR is strongly associated with failure of resuscitation. Importantly, this parameter should not be used in isolation and should not be used in nonintubated patients.

- ECPR, also known as venoarterial extracorporeal membrane oxygenation, may be considered as an alternative to conventional CPR for select patients with refractory cardiac arrest when the suspected etiology of the cardiac arrest is potentially reversible during a limited period of mechanical cardiorespiratory support.

2.7.2 Knowledge Gaps

- More knowledge is needed about the impact on survival and neurologic outcome when physiologic targets and ultrasound are used to guide resuscitation during cardiac arrest.
- The dose-response curve for defibrillation of shockable rhythms is unknown, and the initial shock energy, subsequent shock energies, and maximum shock energies for each waveform are unknown.
- More information is needed to identify the ideal current delivery to the myocardium that will result in defibrillation, and the optimal way to deliver it. The selected energy is a poor comparator for assessing different waveforms, because impedance compensation and subtleties in waveform shape result in a different transmyocardial current among devices at any given selected energy.
- Is a hands-on defibrillation strategy with ongoing chest compressions superior to current hands-off strategies with pauses for defibrillation?
- What is the dose-response effect of epinephrine during cardiac arrest?
- The efficacy of bundled treatments, such as epinephrine, vasopressin, and steroids, should be evaluated, and further studies are warranted as to whether the bundle with synergistic effects or a single agent is related to any observed treatment effect.
- There are no randomized trials for any antiarrhythmic drug as a second-line agent for refractory ventricular fibrillation/pulseless ventricular tachycardia, and there are no trials evaluating the initiation or continuation of antiarrhythmics in the post-cardiac arrest period.
- Controlled clinical trials are needed to assess the clinical benefits of ECPR versus traditional CPR for patients with refractory cardiac arrest and to determine which populations would most benefit.

When ROSC is not rapidly achieved after cardiac arrest, several options exist to provide prolonged circulatory support. These options include mechanical CPR devices, and use of endovascular ventricular assist devices, intra-aortic balloon counterpulsation, and ECPR have all been described. The role of these modalities, alone or in combination, is not well understood. (For additional information, see, "Part 6: Alternative Techniques and Ancillary Devices for Cardiopulmonary Resuscitation")

2.8 Part 8: Post–Cardiac Arrest Care

Post–cardiac arrest care research has advanced significantly over the past decade. Multiple studies and trials detail the heterogeneity of patients and the spectrum of pathophysiology after cardiac arrest. Post–cardiac arrest care should be titrated based on arrest etiology, comorbid disease, and illness severity. Thus, the 2015 Guidelines Update integrates available data to help experienced clinicians make the complex set of therapeutic decisions required for these patients. The central principles of postarrest care are (1) to identify and treat the underlying etiology of the cardiac arrest, (2) to mitigate ischemia-reperfusion injury and prevent secondary organ injury, and (3) to make accurate estimates of prognosis to guide the clinical team and to inform the family when selecting goals of continued care.

2.8.1 New Developments

Early coronary angiography and coronary intervention are recommended for patients with ST elevation as well as for patients without ST elevation, when an acute coronary event is suspected. The decision to perform coronary angiography should not include consideration of neurologic status, because of the unreliability of early prognostic signs. Targeted temperature management is still recommended for at least 24 hours in comatose patients after cardiac arrest, but clinicians may choose a target temperature from the wider range of 32°C to 36°C. Estimating the prognosis of patients after cardiac arrest is best accomplished by using multiple modalities of testing: clinical examination, neurophysiological testing, and imaging.

2.8.2 Significant New and Updated Recommendations

One of the most common causes of cardiac arrest outside of the hospital is acute coronary occlusion. Quickly identifying and treating this cause is associated with better survival and better functional recovery. Therefore, coronary angiography should be performed emergently (rather than later in the hospital stay or not at all) for OHCA patients with suspected cardiac etiology of arrest and ST elevation on ECG. Emergency coronary angiography is reasonable for select (eg, electrically or hemodynamically unstable) adults who are without ST elevation on ECG but are comatose after OHCA of suspected cardiac origin. Emergency coronary angiography is also reasonable for post–cardiac arrest patients for whom coronary angiography is indicated, regardless of whether the patient is comatose or awake.

A high-quality randomized controlled trial did not identify any superiority of targeted temperature management at 36°C compared with management at 33°C. Excellent outcomes are possible when patients are actively managed at either temperature. All comatose (ie, lack of meaningful response to verbal commands) adult patients with ROSC after cardiac arrest should have targeted temperature management, with providers selecting and maintaining a constant temperature between 32°C and 36°C for at least 24 hours after achieving target temperature. It is also reasonable to actively prevent fever in comatose patients after targeted temperature management.

- Multiple randomized controlled trials tested prehospital infusion of cold intravenous fluids to initiate hypothermia after OHCA. The absence of any benefit and the presence of some complications in these trials led to a recommendation against the routine prehospital cooling of patients after ROSC by using rapid infusion of cold saline. However, this recommendation does not preclude the use of cold intravenous fluids in more controlled or more selected settings and did not address other methods of inducing hypothermia.

- Specific management of patients during postresuscitation intensive care includes avoiding and immediately correcting hypotension and hypoxemia. It is reasonable to use the highest available oxygen concentration until the arterial oxyhemoglobin saturation or the partial pressure of arterial oxygen can be measured. However, the benefits of any specific target ranges for blood pressure, ventilator management, or glucose management are uncertain.

- Multiple studies examined methods to determine prognosis in patients after cardiac arrest, and the use of multiple modalities of testing is recommended. The earliest time to prognosticate a poor neurologic outcome by using clinical examination in patients not treated with targeted temperature management is 72 hours after ROSC, but this time can be even longer after cardiac arrest if the residual effect of sedation or paralysis is suspected to confound the clinical examination. In patients treated with targeted temperature management, where sedation or paralysis could confound clinical examination, it is reasonable to wait until 72 hours after return to normothermia.

- Useful clinical findings that are associated with poor neurologic outcome include
    - The absence of pupillary reflex to light at ?72 hours after cardiac arrest
    - The presence of status myoclonus during the first 72 hours after cardiac arrest
    - The absence of the N20 somatosensory evoked potential cortical wave 24 to 72 hours after cardiac arrest or after rewarming
    - The presence of a marked reduction of the gray-white ratio on brain computed tomography obtained within 2 hours after cardiac arrest
    - Extensive restriction of diffusion on brain magnetic resonance imaging at 2 to 6 days after cardiac arrest
    - Persistent absence of electroencephalographic reactivity to external stimuli at 72 hours after cardiac arrest
    - Persistent burst suppression or intractable status epilepticus on electroencephalogram after rewarming
    - *Note*: Absent motor movements, extensor posturing or myoclonus should not be used alone for predicting outcome.

- All patients who are resuscitated from cardiac arrest but who subsequently progress to death or brain death should be evaluated as potential organ donors. Patients who do not have ROSC after resuscitation efforts also may be considered candidates as kidney or liver donors in settings where programs exist.

2.8.3 Knowledge Gaps

- Which post-cardiac arrest patients without ST elevation are most likely to benefit from early coronary angiography?
- What are the optimal goals for blood pressure, ventilation, and oxygenation in specific groups of post-cardiac arrest patients?
- What are the optimal duration, timing, and methods for targeted temperature management?
- Will particular subgroups of patients benefit from management at specific temperatures?
- What strategies can be used to prevent or treat post–cardiac arrest cerebral edema and malignant electroencephalographic patterns (seizures, status myoclonus)?
- What is the most reliable strategy for prognostication of futility in comatose post–cardiac arrest survivors?

2.9 Part 9: Acute Coronary Syndromes

The 2015 Guidelines Update newly limits recommendations for the evaluation and management of acute coronary syndromes (ACS) to the care rendered during the prehospital and emergency department phases of care only, and specifically does not address management of patients after emergency department disposition. Within this scope, several important components of care can be classified as diagnostic interventions in ACS, therapeutic interventions in ACS, reperfusion decisions in ST-segment elevation myocardial infarction (STEMI), and hospital reperfusion decisions after ROSC. Diagnosis is focused on ECG acquisition and interpretation and the rapid identification of patients with chest pain who are safe for discharge from the emergency department. Therapeutic interventions focus on prehospital adenosine diphosphate receptor antagonists in STEMI, prehospital anticoagulation, and the use of supplementary oxygen. Reperfusion decisions include when and where to use fibrinolysis versus percutaneous coronary intervention (PCI) and when post-ROSC patients may benefit from having access to PCI.

2.9.1 Significant New and Updated Recommendations

A well-organized approach to STEMI care still requires integration of community, EMS, physician, and hospital resources in a bundled STEMI system of care. Two studies published since the 2010 evidence review confirm the importance of acquiring a 12-lead ECG for patients with possible ACS as early as possible in the prehospital setting. These studies reaffirmed previous recommendations that when STEMI is diagnosed in the prehospital setting, prearrival notification of the hospital and/or prehospital activation of the catheterization laboratory should occur without delay. These updated recommendations place new emphasis on obtaining a prehospital ECG and on both the necessity for and the timing of receiving hospital notification.

- ***Prehospital 12-lead ECG should be acquired early for patients with possible ACS. (Class I, LOE B-NR)***

- ***Prehospital notification of the receiving hospital (if fibrinolysis is the likely reperfusion strategy) and/or prehospital activation of the catheterization laboratory should occur for all patients with a recognized STEMI on prehospital ECG. (Class I, LOE B-NR)***

Because the rate of false-negative results of 12-lead ECGs may be unacceptably high, a computer reading of the ECG should not be a sole means to diagnose STEMI, but may be used in conjunction with physician or trained provider interpretation. New studies examining the accuracy of ECG interpretation by trained nonphysicians have prompted a revision of the recommendation to explicitly permit trained nonphysicians to interpret ECGs for the presence of STEMI.

- ***We recommend that computer-assisted ECG interpretation may be used in conjunction with physician or trained provider interpretation to recognize STEMI . (Class IIb, LOE C-LD)***

- ***While transmission of the prehospital ECG to the ED physician may improve positive predictive value (PPV) and therapeutic decision-making regarding adult patients with suspected STEMI, if transmission is not performed, it may be reasonable for trained nonphysician ECG interpretation to be used as the basis for decision-making, including activation of the catheterization laboratory, administration of fibrinolysis, and selection of destination hospital. (Class IIa, LOE B-NR)***

High-sensitivity cardiac troponin is now widely available. The 2015 CoSTR review examined whether a negative troponin test could reliably exclude a diagnosis of ACS in patients who did not have signs of STEMI on ECG. For emergency department patients with a presenting complaint consistent with ACS, high-sensitivity cardiac troponin T (hs-cTnT) and cardiac troponin I (cTnI) measured at 0 and 2 hours should not be interpreted in isolation (without performing clinical risk stratification) to exclude the diagnosis of ACS. In contrast, high-sensitivity cardiac troponin I (hs-cTnI), cTnI, or cardiac troponin T (cTnT) may be used in conjunction with a number of clinical scoring systems to identify patients at low risk for 30-day major adverse cardiac events (MACE) who may be safely discharged from the emergency department.

- ***We recommend that hs-cTnI measurements that are less than the 99th percentile, measured at 0 and 2 hours, may be used together with low-risk stratification (TIMI score of 0 or 1 or low risk per Vancouver rule) to predict a less than 1% chance of 30-day MACE. (Class IIa, LOE B-NR)***

- ***We recommend that negative cTnI or cTnT measurements at 0 and between 3 and 6 hours may be used together with very low-risk stratification (TIMI score of 0, low-risk score per Vancouver rule, North American Chest Pain score of 0 and age less than 50 years, or low-risk HEART score) to predict a less than 1% chance of 30-day MACE. (Class IIa, LOE B-NR)***

New recommendations have been made regarding several therapeutic interventions in ACS. New data from a case-control study that compared heparin and aspirin administered in the prehospital to the hospital setting found blood flow rates to be higher in infarct-related arteries when heparin and aspirin are administered in the prehospital setting. Because of the logistical difficulties in introducing heparin to EMS systems that do not currently use this drug and the limitations in interpreting data from a single study, initiation of adenosine diphosphate (ADP) inhibition may be reasonable in either the prehospital or the hospital setting in patients with suspected STEMI who intend to undergo primary PCI.

- ***We recommend that EMS systems that do not currently administer heparin to suspected STEMI patients do not add this treatment, whereas those that do administer it may continue their current practice. (Class IIb, LOE B-NR)***

- ***In suspected STEMI patients for whom there is a planned PCI reperfusion strategy, administration of unfractionated heparin (UFH) can occur either in the prehospital or in-hospital setting. (Class IIb, LOE B-NR)***

Supplementary oxygen has been routinely administered to patients with suspected ACS for years. Despite this tradition, the usefulness of supplementary oxygen therapy has not been established in normoxemic patients.

- ***The usefulness of supplementary oxygen therapy has not been established in normoxic patients. In the prehospital, ED, and hospital settings, the withholding of supplementary oxygen therapy in normoxic patients with suspected or confirmed acute coronary syndrome may be considered. (Class IIb, LOE C-LD)***

Timely restoration of blood flow to ischemic myocardium in acute STEMI remains the highest treatment priority. While the Class of Recommendation regarding reperfusion strategies remains unchanged from 2010, the choice between fibrinolysis and PCI has been reexamined to focus on clinical circumstances, system capabilities, and timing, and the recommendations have been updated accordingly. The anticipated time to PCI has been newly examined in 2015, and new time-dependent recommendations regarding the most effective reperfusion strategy are made. In STEMI patients, when long delays to primary PCI are anticipated (more than 120 minutes), a strategy of immediate fibrinolysis followed by routine early angiography (within 3 to 24 hours) and PCI, if indicated, is reasonable. It is acknowledged that fibrinolysis becomes significantly less effective at more than 6 hours after symptom onset, and thus a longer delay to primary PCI is acceptable in patients at more than 6 hours after symptom onset. To facilitate ideal treatment, systems of care must factor information about hospital capabilities into EMS destination decisions and interfaculty transfers.

- ***In adult patients presenting with STEMI in the ED of a non-PCI-capable hospital, we recommend immediate transfer without fibrinolysis from the initial facility to a PCI center instead of immediate fibrinolysis at the initial hospital with transfer only for ischemia-driven PCI. (Class I, LOE B-R)***

- ***When STEMI patients cannot be transferred to a PCI-capable hospital in a timely manner, fibrinolytic therapy with routine transfer for angiography may be an acceptable alternative to immediate transfer to PPCI. (Class IIb, LOE C-LD)***

- ***When fibrinolytic therapy is administered to a STEMI patient in a non–PCI-capable hospital, it may be reasonable to transport all postfibrinolysis patients for early routine angiography in the first 3 to 6 hours and up to 24 hours rather than transport postfibrinolysis patients only when they require ischemia-guided angiography. (Class IIb, LOE B-R)***

2.9.2 Knowledge Gaps

- More knowledge is needed about the optimal diagnostic approach for patients with serial troponin levels lower than the 99th percentile who are identified as being at moderate or high risk based on clinical scoring rules.
- The role of a single troponin measurement in identifying patients who are safe for discharge from the emergency department is currently evolving.
- The time from symptom onset to first medical contact is highly variable. An ideal reperfusion strategy considering the contribution of this variability in time to presentation has yet to be determined.

2.10 Part 10: Special Circumstances of Resuscitation

"Part 10: Special Circumstances of Resuscitation" presents new guidelines for the prevention and management of resuscitation emergencies related to opioid toxicity, and for the role of intravenous lipid emulsion (ILE) therapy for treatment of cardiac arrest due to drug overdose. Updated guidelines for the management of cardiac arrest occurring during the second half of pregnancy, cardiac arrest caused by pulmonary embolism, and cardiac arrest occurring during PCI are included.

2.10.1 Significant New and Updated Recommendations

- The 2010 Guidelines included a Class I recommendation to perform bag-mask–assisted ventilation and administer naloxone for patients with known or suspected opioid overdose who have respiratory depression but are not in cardiac arrest. Since that time, significant experience has accumulated to show that naloxone can be administered with apparent safety and effectiveness in the first aid and BLS settings. Accordingly, the 2015 Guidelines Update contains new recommendations for naloxone administration by non–healthcare providers, with recommendations for simplified training. A new algorithm for management of unresponsive victims with suspected opioid overdose is provided.

- Administration of ILE for the treatment of local anesthetic systemic toxicity (LAST), particularly from bupivacaine, is supported by extensive animal research and human case reports. In the 2015 Guidelines Update, this science was reviewed and a weak recommendation supporting use of ILE for treatment of LAST was reaffirmed. Since 2010, animal studies and human case reports have been published that examined the use of ILE for patients with other forms of drug toxicity, with mixed results. The 2015 Guidelines Update contains a new recommendation that ILE may be considered in patients with cardiac arrest due to drug toxicity other than LAST who are failing standard resuscitative measures.

- Relief of aortocaval compression has long been recognized as an essential component of resuscitation for women who develop cardiac arrest in the latter half of pregnancy, and this remains an important area of emphasis in the Guidelines. In the 2010 Guidelines, relief of aortocaval compression with manual left uterine displacement was a Class IIb recommendation. Although no cardiac arrest outcome studies have been published that compared left uterine displacement to other strategies to relieve aortocaval compression during CPR, the critical importance of high-quality CPR has been further supported. Because alternative strategies to relieve aortocaval compression (eg, lateral tilt) do not seem to be compatible with delivery of high-quality CPR, the recommendation to perform left uterine displacement during CPR was strengthened.

  If the fundus height is at or above the level of the umbilicus, manual LUD can be beneficial in relieving aortocaval compression during chest compressions. (Class IIa, LOE C-LD)

- In addition to providing the opportunity for separate resuscitation of a potentially viable fetus, perimortem cesarean delivery (PMCD) provides the ultimate relief of aortocaval compression and may improve maternal resuscitation outcomes. The 2010 Guidelines included a Class IIb recommendation to consider performing PMCD at 4 to 5 minutes after the onset of maternal cardiac arrest without ROSC. The 2015 Guidelines Update expands on these recommendations.

  In situations such as nonsurvivable maternal trauma or prolonged pulselessness, in which maternal resuscitative efforts are obviously futile, there is no reason to delay performing PMCD. (Class I, LOE C-LD)

PMCD should be considered at 4 minutes after onset of maternal cardiac arrest or resuscitative efforts (for the unwitnessed arrest) if there is no ROSC. (Class IIa, LOE C-EO)

The complexity and need for clinical judgment in this decision making is explicitly acknowledged.

2.10.2 Knowledge Gaps

- Although the recommendation to consider PMCD after 4 minutes of unsuccessful maternal resuscitation attempts has been promulgated since 1986, it is based on scientific rationale rather than experimental evidence or critical analysis of prospectively collected data. A recent systematic review found that early time to PMCD (less than 10 minutes) was associated with improved survival of the mother but not of the child, and PMCD within 4 to 5 minutes may not be achievable in most settings. Although clinical trials are not feasible, large registry studies may be able to support evidence-based decision making in timing of PMCD to improve both maternal and neonatal outcomes.
- Since the first animal studies were published in 1998, a large body of literature has developed that describes the use of ILE in resuscitation from poisoning and drug toxicity. Although the experimental studies and human anecdotal reports are consistently positive for treatment of LAST from bupivacaine, more variable results are reported for treatment of LAST from other agents, and results achieved after ILE administration for other toxicants are mixed. Administration of ILE alters the effectiveness of epinephrine and vasopressin in animal resuscitation studies, may increase the absorption of lipophilic medications from the gastrointestinal tract, and sometimes interferes with the operation of venoarterial extracorporeal membrane oxygenation circuits. Further research is needed to determine the role of ILE in the management of cardiac arrest and refractory shock due to poisoning.

2.11 Part 11: Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality

The 2015 Guidelines Update for pediatric BLS concentrated on modifications in the algorithms for lone- and 2-rescuer CPR, initial actions of rescuers, and CPR quality process measures. Algorithms for 1- and 2-person healthcare provider CPR have been separated to better guide rescuers through the initial stages of resuscitation. In an era where handheld cellular telephones with speakers are common, this technology can allow a single rescuer to activate the emergency response system while beginning CPR. Healthcare providers should perform an assessment of breathing and pulse check simultaneously, to minimize delays in starting CPR if the child is unresponsive with no breathing or only gasping.

2.11.1 Significant New and Updated Recommendations

The 3 major CPR process characteristics that were evaluated included C-A-B (Compressions, Airway, Breathing) versus A-B-C (Airway, Breathing, Compressions), compression-only CPR, and compression depth and rate. No major changes were made for the 2015 Guidelines Update; however, new concepts in CPR delivery were examined for children.

- ***Because of the limited amount and quality of the data, it may be reasonable to maintain the sequence from the 2010 Guidelines by initiating CPR with C-A-B over A-B-C sequence. (Class IIb, LOE C-EO)***

  There are no pediatric human studies to evaluate C-A-B versus A-B-C, but manikin studies do demonstrate a shorter time to fist chest compression. This recommendation was made to simplify training, provide consistency for teaching rescuers of adults and children, and hopefully increase the number of victims who receive bystander CPR.
- Compression depth of at least one third of the anterior-posterior diameter, approximately 1.5 inches (4 cm) for infants and approximately 2 inches (5 cm) for children, was affirmed (Updated). The Class of Recommendation was downgraded from Class I to Class IIa, primarily based on the rigor of the evidence evaluation. There are limited clinical data on the effect of compression depth on resuscitation outcomes, but 2 clinical studies suggest that compression depth is also associated with survival.
- Compression rate was not reviewed because of insufficient evidence, and we recommend that rescuers use the adult rate of 100 to 120/min (Updated).

- The asphyxial nature of the majority of pediatric cardiac arrests necessitates ventilation as part of effective CPR, and two large database studies documented worse 30-day outcomes with compression-only CPR compared with conventional CPR.

Conventional CPR (chest compressions and rescue breaths) should be provided for pediatric cardiac arrests. (Class I, LOE B-NR)

However, because compression-only CPR is effective in patients with a primary cardiac event, if rescuers are unwilling or unable to deliver breaths, we recommend rescuers perform compression-only CPR for infants and children in cardiac arrest. (Class I, LOE B-NR)

Conventional CPR (chest compressions and rescue breaths) is a Class I recommendation. (LOE B-NR)

2.11.2 Knowledge Gaps

- Much of the data supporting pediatric BLS is primarily extrapolated from studies in adults. Multicenter pediatric studies from both in-hospital and out-of hospital arrest are needed to optimize outcomes for children.
- More knowledge is needed about the optimal sequence, feedback techniques and devices, and effect of different surfaces on CPR delivery in children.

2.12 Part 12: Pediatric Advanced Life Support

2.12.1 Significant New and Updated Recommendations

The following are the most important changes and reinforcements to recommendations made in the 2010 Guidelines:

There is new evidence that when treating pediatric septic shock in specific settings, the use of restricted volume of isotonic crystalloid leads to improved survival, contrasting with the long-standing belief that all patients benefit from aggressive volume resuscitation. New guidelines suggest a cautious approach to fluid resuscitation, with frequent patient reassessment, to better tailor fluid therapy and supportive care to children with febrile illness.

- New literature suggests limited survival benefit to the routine use of atropine as a premedication for emergent tracheal intubation of non-neonates, and that any benefit in preventing arrhythmias is controversial. Recent literature also provides new evidence suggesting there is no minimum dose required for atropine use.

- Children in cardiac arrest may benefit from the titration of CPR to blood pressure targets, but this strategy is suggested only if they already have invasive blood pressure monitoring in place.

- New evidence suggests that either amiodarone or lidocaine is acceptable for treatment of shock-refractory pediatric ventricular fibrillation and pulseless ventricular tachycardia.

- Recent literature supports the need to avoid fever when caring for children remaining unconscious after OHCA.

- The writing group reviewed a newly published multicenter clinical trial of targeted temperature management that demonstrated that a period of either 2 days of moderate therapeutic hypothermia (32? to 34? C) or the strict maintenance of normothermia (36? to 37.5? C) were equally beneficial. As a result, the writing group feels either of these approaches are appropriate for infants and children remaining comatose after OHCA.

- Hemodynamic instability after cardiac arrest should be treated actively with fluids and/or inotropes/vasopressors to maintain systolic blood pressure greater than the fifth percentile for age. Continuous arterial pressure monitoring should be used when the appropriate resources are available.

2.12.2 Knowledge Gaps

- What clinical or physiologic parameters reflect high-quality pediatric CPR and improve outcome in children? Do devices to monitor these parameters improve survival?
- What is the role of targeted temperature management in the care of children who remain unconscious after in-hospital cardiac arrest?
- Does a postarrest bundle of care with specific targets for temperature, oxygenation and ventilation, and hemodynamic parameters improve outcomes after pediatric cardiac arrest?
- Does a combination of intra-arrest factors reliability predict successful resuscitation in children with either OHCA or IHCA?

2.13 Part 13: Neonatal Resuscitation

"Part 13: Neonatal Resuscitation" presents new guidelines for resuscitation of primarily newly born infants transitioning from intrauterine to extrauterine life. The recommendations are also applicable to neonates who have completed newborn transition and require resuscitation during the first weeks after birth.

Much of the neonatal resuscitation guidelines remains unchanged from 2010, but there is increasing focus on umbilical cord management, maintaining a normal temperature after birth, accurate determination of heart rate, optimizing oxygen use during resuscitation, and de-emphasis of routine suctioning for meconium in nonvigorous newborns. The etiology of neonatal arrest is almost always asphyxia, and therefore, establishing effective ventilation remains the most critical step.

2.13.1 Significant New and Updated Recommendations

Umbilical cord management: The 2015 Guidelines Update includes for the first time recommendations regarding umbilical cord management. Until recently, it was common practice to clamp the umbilical cord immediately after birth to facilitate rapid transfer of the baby to the pediatric provider for stabilization. A significant issue with the available evidence is that the published studies enrolled very few babies who were considered to need resuscitation.

- There is evidence, primarily in babies who do not require resuscitation, that delayed cord clamping is associated with less intraventricular hemorrhage, higher blood pressure and blood volume, less need for transfusion after birth, and less necrotizing enterocolitis. Delayed cord clamping conferred no benefit on mortality or severe intraventricular hemorrhage. The only negative consequence seems to be a slightly increased level of bilirubin, associated with more need for phototherapy.[16,17]

- ***Delayed cord clamping for longer than 30 seconds is reasonable for both term and preterm infants who do not require resuscitation at birth. (Class IIa, LOE C-LD)***

  There is still insufficient evidence to recommend an approach to cord clamping or cord "milking" for babies who require resuscitation at birth.

Assessment of heart rate: Immediately after birth, assessment of the newborn's heart rate is used to evaluate the effectiveness of spontaneous respiratory effort and determine the need for subsequent interventions. An increase in the newborn's heart rate is considered the most sensitive indicator of a successful response to resuscitation interventions. Therefore, identifying a rapid, reliable, and accurate method to measure the newborn's heart rate is critically important.

- Available evidence comparing clinical assessment with ECG in the delivery room and simultaneous pulse oximetry and ECG heart rate determination found that clinical assessment was both unreliable and inaccurate.

- ECG (3-lead) displayed a reliable heart rate faster than pulse oximetry. Pulse oximetry tended to underestimate the newborn's heart rate and would have led to potentially unnecessary interventions.[16,17]

-

During resuscitation of term and preterm newborns, the use of 3-lead ECG for the rapid and accurate measurement of the newborn's heart rate may be reasonable. (Class IIb, LOE C-LD)

Maintaining normal temperature of the newborn after birth:

- ***It is recommended that the temperature of newly born nonasphyxiated infants be maintained between 36.5°C and 37.5°C after birth through admission and stabilization.[14] (Class I, LOE C-LD)***

  There is new evidence supporting a variety of interventions that may be used alone or in combination to reduce hypothermia. Temperature must be monitored to avoid hyperthermia as well.

Management of the meconium stained infant: For more than a decade, vigorous infants born through meconium stained amniotic fluid have been treated no differently than if they had been born through clear fluid. However, there remained a long standing practice to intubate and suction infants born through meconium stained amniotic fluid who have poor muscle tone and inadequate breathing efforts at birth.

- ***Routine intubation for tracheal suction in this setting is not suggested because there is insufficient evidence to continue recommending this practice.[16,17] (Class IIb, LOE C-LD)***

- In making this suggested change, greater value has been placed on harm avoidance (delays in providing positive-pressure ventilation, potential harm of the procedure) over the unknown benefit of the intervention of routine trachea intubation and suctioning.

Oxygen use for preterm infants in the delivery room: Since the release of the 2010 AHA Guidelines for CPR and ECC, additional randomized trials have been published that examine the use of oxygen during resuscitation and stabilization of preterm newborns. These additional publications have allowed an increase from Class IIb to a Class I recommendation.

- Meta-analysis of the randomized trials that compared initiating resuscitation of preterm newborns (less than 35 weeks of gestation) with high oxygen (65% or greater) versus low oxygen (21%–30%) showed no improvement in survival or morbidity to hospital discharge with the use of high oxygen.[16,17]

- ***Resuscitation of preterm newborns of less than 35 weeks of gestation should be initiated with low oxygen (21% to 30%), and the oxygen concentration should be titrated to achieve preductal oxygen saturation approximating the interquartile range measured in healthy term infants after vaginal birth at sea level.[18] (Class I, LOE B-R)***

  This recommendation reflects a preference for not exposing preterm newborns to additional oxygen without data demonstrating a proven benefit for important outcomes.

Oxygen use during neonatal cardiac compressions: The evidence for optimal oxygen use during neonatal cardiac compressions was not reviewed for the 2010 Guidelines. Unfortunately, there are no clinical studies to inform the neonatal guidelines, but the available animal evidence demonstrated no obvious advantage of 100% oxygen over air. However, by the time resuscitation of a newborn includes cardiac compressions, the steps of trying to improve the heart rate via effective ventilation with low concentrations of oxygen should have already been tried. Thus, the 2015 Guidelines Task Force thought it was reasonable to increase the supplementary oxygen concentration during cardiac compressions and then subsequently wean the oxygen as soon as the heart rate recovers (see "Part 13: Neonatal Resuscitation" in the 2015 Web-based Integrated Guidelines).

Structure of educational programs to teach neonatal resuscitation: Currently, neonatal resuscitation training that includes simulation and debriefing is recommended at 2-year intervals.

- Studies that examined how frequently healthcare providers or healthcare students should train showed no differences in patient outcomes, but demonstrated some advantages in psychomotor performance, knowledge, and confidence when focused task training occurred every 6 months or more frequently.[16,17]

- ***It is therefore suggested that neonatal resuscitation task training occur more frequently than the current 2-year interval.***[14] ***(Class IIb, LOE B-R)***

2.13.2 Knowledge Gaps

Umbilical cord management for newborns needing resuscitation: As noted previously, the risks and benefits of delayed cord clamping for newborns who need resuscitation after birth remains unknown because such infants have thus far been excluded from the majority of trials. Concern remains that delay in establishing ventilation may be harmful. Further study is strongly endorsed.

- Some studies have suggested that cord milking might accomplish goals similar to delayed cord clamping.[17,19] Cord milking is rapid and can be accomplished within 15 seconds, before resuscitation might ordinarily be initiated. However, there is insufficient evidence of either the safety or utility of cord milking in babies requiring resuscitation.
- The effect of delayed cord clamping or cord milking on initial heart rate and oxygen saturations is also unknown. New normal ranges may need to be determined.
- The risks and benefits of inflating the lungs to establish breathing before clamping of the umbilical cord needs to be explored.

*Uti**lity of a sustained inflation during the initial breaths after birth***: Several recent animal studies suggested that a longer sustained inflation may be beneficial for establishing functional residual capacity during transition from a fluid-filled to an air-filled lung after birth. Some clinicians have suggested applying this technique for transition of human newborns.

- It was the consensus of the 2015 CoSTR and the 2015 Guidelines Task Force that there was inadequate study of the benefits and risks to recommend sustained inflation at this time. Further study using carefully designed protocols was endorsed (see "Part 13: Neonatal Resuscitation" in this 2015 Guidelines Update and Perlman et al[17,19]).

Determination of heart rate: Neonatal resuscitation success has classically been determined by detecting an increase in heart rate through auscultation. Heart rate also determines the need for changing interventions and escalating care. However, recent evidence demonstrates that auscultation of heart rate is inaccurate, and pulse oximetry takes several minutes to achieve a signal and also may be inaccurate during the early minutes after birth. Use of ECG in the delivery room has been suggested as a possible alternative.

- Although data suggest that the ECG provides a more accurate heart rate in the first 3 minutes of life, there are no available data to determine how outcomes would change by acting (or not acting) on the information.
- Some transient bradycardia may be normal and be reflective of timing of cord clamping. More studies are needed.
- The human factors issues associated with introducing ECG leads in the delivery room are unknown.
- In addition, improved technologies for rapid application of ECG are needed.

2.14 Part 14: Education

There remains strikingly low survival rates for both OHCA and IHCA despite scientific advances in the care of cardiac arrest victims. The Formula for Survival suggests that cardiac arrest survival is influenced by high-quality science, education of lay providers and healthcare professionals, and a well-functioning Chain of Survival.[19] Considerable opportunities exist for education to close the gap between actual and desired performance of lay providers and healthcare teams. For lay providers, this includes proficient CPR and AED skills and the self-efficacy to use them, along with immediate support such as dispatch-guided CPR. For healthcare providers, the goals remain to recognize and respond to patients at risk of cardiac arrest, deliver high-quality CPR whenever CPR is required, and improve the entire resuscitation process through improved teamwork. Additionally, there needs to be a feedback loop focused on continuous quality improvement that can help the system improve as well as identify needs for targeted learning/performance improvement. Optimizing the knowledge translation of what is known from the science of resuscitation to the victim's bedside is a key step to potentially saving many more lives.

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 successfully perform resuscitation. "Part 14: Education" provides an overview of the educational principles that the AHA has implemented to maximize learning from its educational programs. It is important to note that the systematic reviews from which the Guidelines were derived assigned a hierarchy of outcomes for educational studies that considered patient-related outcomes as critical and outcomes in educational settings as important.

2.14.1 Significant New and Updated Recommendations

The key recommendations based on the systematic reviews include the following:

- The use of high-fidelity manikins for ALS training can be beneficial in programs that have the infrastructure, trained personnel, and resources to maintain the program. Standard manikins continue to be an appropriate choice for organizations that do not have this capacity.

Use of a CPR feedback device is recommended to learn the psychomotor skill of CPR. Devices that provide feedback on performance are preferred to devices that provide only prompts (such as a metronome). Instructors are not accurate at assessment of CPR quality by visual inspection, so an adjunctive tool is necessary to provide accurate guidance to learners developing these critical psychomotor skills. Improved manikins that better reflect patient characteristics may prove important for future training. Use of CPR quality feedback devices during CPR is reviewed in the Adult BLS and CPR Quality Part, "Part 5: Adult Basic Life Support and CPR Quality."

- Two-year retraining cycles are not optimal. More frequent training of BLS and advanced life support skills may be helpful for providers likely to encounter a cardiac arrest.
- Although prior CPR training is not required for potential rescuers to initiate CPR, training helps people learn the skills and develop the self-efficacy to provide CPR when necessary. BLS skills seem to be learned as well through self-instruction (video or computer based) with hands-on practice as with traditional instructor-led courses. The opportunity to train many more individuals to provide CPR while reducing the cost and resources required for training is important when considering the vast population of potential rescuers that should be trained.
- To reduce the time to defibrillation for cardiac arrest victims, the use of an AED should not be limited to trained individuals only (although training is still recommended). 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.
- Precourse preparation, including review of appropriate content information, online/precourse testing, and/or practice of pertinent technical skills, may optimize learning from advanced life support courses.
- 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.
- Communities may consider training bystanders in compression-only CPR for adult OHCA as an alternative to training in conventional CPR.

2.14.2 Knowledge Gaps

- Research on resuscitation education needs higher-quality studies that address important educational questions. Outcomes from educational studies should focus on patient outcomes (where feasible), 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 on the immediate end-of-course performance, which may not be representative of participants' performance when they are faced with a resuscitation event months or years later. Assessment tools that have been empirically studied for 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 analyzing evidence in systematic reviews to more precisely determine the impact of certain interventions. Cost-effectiveness research is needed because many of the AHA education guidelines are developed in the absence of this information.

- The ideal methodology (ie, instructional design) and frequency of training required to enhance retention of skills and performance in simulated and real resuscitations needs to be determined.

2.15 Part 15: First Aid

"Part 15: First Aid" reaffirms the definition of first aid as the helping behaviors and initial care provided for an acute illness or injury. The provision of first aid has been expanded to include any person, from layperson to professional healthcare provider, in a setting where first aid is needed. Goals and competencies are now provided to give guidance and perspective beyond specific skills. While a basic tenet of first aid is the delivery of care using minimal or no equipment, it is increasingly recognized that in some cases first aid providers may have access to various adjuncts, such as commercial tourniquets, glucometers, epinephrine autoinjectors, or oxygen. The use of any such equipment mandates training, practice, and, in some cases, medical or regulatory oversight related to use and maintenance of that equipment.

Although there is a growing body of observational studies performed in the first aid setting, most recommendations set forth in "Part 15: First Aid" continue to be extrapolated from prehospital- and hospital-based studies. One important new development relates to the ability of a first aid provider to recognize the signs and symptoms of acute stroke. "Part 15: First Aid" describes the various stroke assessment systems that are available to first aid providers, and lists their sensitivities and specificities in identifying stroke based on included components. This new recommendation for use of a stroke assessment system complements previous recommendations for early stroke management by improving the recognition of stroke signs and symptoms at the first step of emergency care—first aid—thus potentially reducing the interval from symptom onset to definitive care.

2.15.1 Significant New and Updated Recommendations

- Evidence shows that the early recognition of stroke by using a stroke assessment system decreases the interval between the time of stroke onset and arrival at a hospital and definitive treatment. More than 94% of lay providers trained in a stroke assessment system are able to recognize signs and symptoms of a stroke, and this ability persists at 3 months after training.

  The use of a stroke assessment system by first aid providers is recommended. (Class I, LOE B-NR)

  Compared to stroke assessment systems without glucose measurement, assessment systems that include glucose measurement have similar sensitivity but higher specificity for recognition of stroke.

- Hypoglycemia is a condition that is commonly encountered by first aid providers. Severe hypoglycemia, which may present with loss of consciousness or seizures, typically requires management by EMS providers. If a person with diabetes reports low blood sugar or exhibits signs or symptoms of mild hypoglycemia and is able to follow simple commands and swallow, oral glucose should be given to attempt to resolve the hypoglycemia.

  Glucose tablets, if available, should be used to reverse hypoglycemia in a patient who is able to take these orally. (Class I, LOE B-R)

  If glucose tablets are not available, other forms of specifically evaluated forms of sucrose- and fructose-containing foods, liquids, and candy can be effective as an alternative to glucose tablets for reversal of mild symptomatic hypoglycemia.

- The first aid management of an open chest wound was evaluated for the 2015 ILCOR Consensus Conference. The improper use of an occlusive dressing or device with potential subsequent development of unrecognized tension pneumothorax is of great concern. There are no human studies comparing the application of an occlusive dressing to a nonocclusive dressing, and only a single animal study showed benefit to use of a nonocclusive dressing. As a result of the lack of evidence for use of an occlusive dressing and the risk of unrecognized tension pneumothorax, we recommend against the application of an occlusive dressing or device by first aid providers for an individual with an open chest wound.

- First aid providers often encounter individuals with a concussion (minor traumatic brain injury). The myriad of signs and symptoms of concussion can make recognition of this injury a challenge. Although a simple validated single-stage concussion scoring system could possibly help first aid providers in the recognition of concussion, there is no evidence to support the use of such a scoring system. There are sport concussion assessment tools for use by healthcare professionals that require a 2-stage assessment, before competition and after concussion, but these are not appropriate as a single assessment tool for first aid providers. Therefore, it is recommended that a healthcare provider evaluate as soon as possible any person with a head injury that has resulted in a change in level of consciousness, who has progressive development of signs or symptoms of a concussion or traumatic brain injury, or who is otherwise a cause for concern to the first aid provider.

- Dental avulsion can result in permanent loss of a tooth. Immediate reimplantation of the avulsed tooth is thought by the dental community to afford the greatest chance of tooth survival. First aid providers may not be able to reimplant an avulsed tooth because of lack of training, skill, or personal protective equipment, or they may be reluctant to perform a painful procedure. The storage of an avulsed tooth in a variety of solutions (compared with saliva or milk) has been shown to prolong viability of dental cells by 30 to 120 minutes. In situations that do not allow for immediate reimplantation, the temporary storage of an avulsed tooth in one of these solutions may afford time until the tooth can be reimplanted.

- Evidence shows that education in first aid can increase survival rates, improve recognition of acute illness, and resolve symptomatology.

  We recommend that first aid education be universally available. ***(Class I, LOE C-EO)***

- Past Guidelines recommended that first aid providers assist the person with symptoms of anaphylaxis to administer that person's epinephrine. Evidence supports the need for a second dose of epinephrine for acute anaphylaxis in persons not responding to a first dose.

  When a person with anaphylaxis does not respond to the initial dose, and arrival of advanced care will exceed 5 to 10 minutes, a repeat dose may be considered. ***(Class IIb, LOE C-LD)***

- There is no evidence of any benefit from routine administration of supplementary oxygen by first aid providers. Limited evidence shows benefit from use of oxygen for decompression sickness in the first aid setting. The use of supplementary oxygen by first aid providers with specific training (eg, a diving first aid oxygen course) is reasonable for cases of decompression sickness. Limited evidence suggests that supplementary oxygen may be effective for relief of dyspnea in advanced lung cancer patients with dyspnea and associated hypoxia, but not for similar patients without hypoxia.

- Newer-generation hemostatic agent–impregnated dressings have been shown to cause fewer complications and adverse effects and are effective in providing hemostasis in up to 90% of subjects in case series. First aid providers may consider use of hemostatic dressings when standard bleeding control (with direct pressure) is not effective.

- The use of cervical collars as a component of spinal motion restriction for blunt trauma was reviewed for the 2015 ILCOR consensus. No evidence was identified that showed a decrease in neurologic injury with use of a cervical collar. Evidence demonstrates adverse effects from use of a cervical collar, such as increased intracranial pressure and potential airway compromise. The ILCOR First Aid Task Force also expressed concern that proper technique for application of a cervical collar in high-risk individuals requires significant training and practice to be performed correctly and is not considered a standard first aid skill. Because of these concerns, and with a growing body of evidence demonstrating harmful effects and no good evidence showing clear benefit, we recommend against routine application of cervical collars by first aid providers.

2.15.2 Knowledge Gaps

- Control of severe bleeding is a topic that has gained public interest and importance with recent domestic terrorist attacks. The ideal order for the technique of bleeding control by first aid providers for severe bleeding of an extremity is not clear—ie, direct pressure ? tourniquet ? additional (double) tourniquet; direct pressure ? hemostatic dressing ? tourniquet. It is also unclear how tourniquets compare with hemostatic dressings (or double tourniquet) for control of bleeding in extremity wounds.
- First aid providers may have difficulty recognizing potentially life-threatening conditions. The development

and validation of highly sensitive assessment systems or scales (such as for stroke) and other educational techniques may help first aid providers recognize these entities so that they can provide rapid, appropriate care. Conditions that may benefit from development of such assessment educational systems include anaphylaxis, hypoglycemia, chest pain of cardiac origin, high-risk cervical spine injury, concussion, poisoning or overdose, abnormal versus normal breathing, and shock.
- How should a first aid provider care for a person with a potential spinal injury while awaiting arrival of EMS? Is there a benefit to manual cervical spinal stabilization by a first aid provider, and, if so, which technique is best? If verbal instructions to not move are given to a conscious/responsive person with trauma and possible spine injury, are they effective or useful?

2.16 Summary

The 2015 AHA Guidelines Update for CPR and ECC incorporated the evidence from the systematic reviews completed as part of the 2015 International Consensus on CPR and ECC Science With Treatment Recommendations. This 2015 AHA Guidelines Update marks the transition from periodic review and publication of new science-based recommendation to a more continuous process of evidence evaluation and guideline optimization designed to more rapidly translate new science into resuscitation practice that will save more lives. The Appendix to this Part contains a list of all recommendations published in the 2015 Update and, in addition, lists the recommendations from the 2010 AHA Guidelines for CPR and ECC. The 2015 recommendations were made consistent with the new AHA Classification System for describing the risk:benefit ratio for each Class and the Levels of Evidence supporting them. (Please see Table 1, in "Part 2: Evidence Evaluation and Management of Conflicts of Interest.")

Survival from both IHCA and OHCA has increased over the past decade, but there is still tremendous potential for improvement. It is clear that successful resuscitation depends on coordinated systems of care that start with prompt rescuer actions, require delivery of high-quality CPR, and continue through optimized ACLS and post–cardiac arrest care. Systems that monitor and report quality-of-care metrics and patient-centered outcomes will have the greatest opportunity through quality improvement to save the most lives.

2.17 Authorship and Disclosures

2.17.1 2015 Writing Team

Robert W. Neumar; Michael Shuster; Clifton W. Callaway; Lana M. Gent; Dianne L. Atkins; Farhan Bhanji; Steven C. Brooks; Allan R. de Caen; Michael W. Donnino; Jose Maria Ferrer; Russell E. Griffin; Monica E. Kleinman; Steven L. Kronick; Eric J. Lavonas; Mark S. Link; Mary E. Mancini; Laurie J. Morrison; Robert E. O'Connor; Ricardo A. Samson; Steven M. Schexnayder; Eunice "Nici" M. Singletary; Andrew H. Travers; Myra H. Wyckoff; Mary Fran Hazinski

Table 1: 2015 - Part 1: Executive Summary: 2015 Guidelines Update Writing Group Disclosures

Open table in a new window

Part 1: Executive Summary: 2015 Guidelines Update Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honora	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Robert W. Neumar	University of Michigan	NIH†	None	None	None	None	None	None
Dianne L. Atkins	University of Iowa	None	None	None	None	None	None	None
Farhan Bhanji	McGill University	None	None	None	None	None	None	None

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Steven C. Brooks	Queen's University	Heart and Stroke Foundation of Canada†; CIHR†; NIH†	None	None	None	None	None	South Eastern Ontario Academic Medical Association†
Clifton W. Callaway	University of Pittsburgh	None	None	None	None	None	None	None
Allan R. de Caen	University of Alberta; Stollery Children's Hospital	None	None	None	None	None	None	None
Monica E. Kleinman	Children's Hospital Boston	None	None	None	None	None	None	None
Steven L. Kronick	University of Michigan	None	None	None	None	None	None	None
Eric J. Lavonas	Rocky Mountain Poison & Drug Center	None	None	None	None	None	None	None
Mark S. Link	Tufts Medical Center	None	None	None	None	None	None	None
Mary E. Mancini	University of Texas at Arlington	None	None	None	None	None	None	None
Laurie J. Morrison	University of Toronto	NIH†; CIHR†; HSFC†	None	None	None	None	None	None
Robert E. O'Connor	University of Virginia	None	None	None	None	None	None	None
Eunice M. Singletary	University of Virginia	None	None	None	None	None	American Red Cross Scientific Advisory Board*	None
Myra H. Wyckoff	UT Southwestern	None	None	None	None	None	None	None
Staff								
Jose Maria E. Ferrer	American Heart Association	None	None	None	None	None	None	None
Lana M. Gent	American Heart Association	None	None	None	None	None	None	None
Consultants								
Michael W. Donnino	Beth Israel Deaconess Med Center	None	None	None	None	None	American Heart Association†	None
Mary Fran Hazinski	Vanderbilt University	None	None	None	None	None	American Heart Association†	None
Ricardo A. Samson	University of Arizona	None	None	None	None	None	American Heart Association†	None

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Steven M. Schexnayder	University of Arkansas; Arkansas Children's Hospital	None	None	None	None	None	American Heart Association†	None
Michael Shuster	Mineral Springs Hospital Emergency Medicine	None	None	None	None	None	American Heart Association†	None
Elizabeth H. Sinz	Pennsylvania State University College of Medicine	None	None	None	None	None	American Heart Association†	None
Andrew H. Travers	Emergency Health Services, Nova Scotia	None	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.

3 Footnotes

The American Heart Association requests that this document be cited as follows:

American Heart Association. Web-based Integrated Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care – Part 1: Executive Summary. ECCguidelines.heart.org.

References

1. Cardiopulmonary resuscitation. JAMA. 1966;198:372–379.
2. Standards for cardiopulmonary resuscitation (CPR) and emergency cardiac care (ECC). 3. Advanced life support. JAMA. 1974;227:suppl:852–860.
3. Standards and guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiac care (ECC). JAMA. 1980;244:453–509.
4. Standards and guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). National Academy of Sciences - National Research Council. JAMA. 1986;255:2905–2989.
5. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. JAMA. 1992;268:2135–2302.
6. American Heart Association in collaboration with International Liaison Committee on Resuscitation. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: International Consensus on Science. Circulation. 2000;102(suppl):I1–I384.
7. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2005; 112:IV1–203.
8.

FieldJM,HazinskiMF,SayreMR,ChameidesL,SchexnayderSM,Hemphill R, Samson RA, Kattwinkel J, Berg RA, Bhanji F, Cave DM, Jauch EC, Kudenchuk PJ, Neumar RW, Peberdy MA, Perlman JM, Sinz E, Travers AH, Berg MD, Billi JE, Eigel B, Hickey RW, Kleinman ME, Link MS, Morrison LJ, O'Connor RE, Shuster M, Callaway CW, Cucchiara B, Ferguson JD, Rea TD, Vanden Hoek TL. Part 1: executive summary: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2010;122(suppl 3):S640–S656. doi: 10.1161/CIRCULATIONAHA.110.970889.

9. Jauch EC, Saver JL, Adams HP Jr, Bruno A, Connors JJ, Demaerschalk BM, Khatri P, McMullan PW Jr, Qureshi AI, Rosenfield K, Scott PA, Summers DR, Wang DZ, Wintermark M, Yonas H; American Heart Association Stroke Council; Council on Cardiovascular Nursing; Council on Peripheral Vascular Disease; Council on Clinical Cardiology. Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013;44:870–947. doi: 10.1161/STR.0b013e318284056a.

10. Powers WJ, Derdeyn CP, Biller J, Coffey CS, Hoh BL, Jauch EC, Johnston KC, Johnston SC, Khalessi AA, Kidwell CS, Meschia JF, Ovbiagele B, Yavagal DR; on behalf of the American Heart Association Stroke Council. 2015 American Heart Association/American Stroke Association focused update of the 2013 guidelines for the early management of patients with acute ischemic stroke regarding endovascular treatment: a guideline for healthcare professionals from the American Heart Association/ American Stroke Association. Stroke. 2015;46:XXX–XXX. doi: 10.1161/ STR.0000000000000074.

11. HazinskiMF,NolanJP,AickinR,BhanjiF,BilliJE,CallawayCW,Castren M, de Caen AR, Ferrer JME, Finn JC, Gent LM, Griffin RE, Iverson S, Lang E, Lim SH, Maconochie IK, Montgomery WH, Morley PT, Nadkarni VM, Neumar RW, Nikolaou NI, Perkins GD, Perlman JM, Singletary EM, Soar J, Travers AH, Welsford M, Wylie J, Zideman DA. Part 1: executive summary: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2015;132(suppl 1):S2–S39. doi: 10.1161/ CIR.0000000000000270.

12. Nolan JP, Hazinski MF, Aickin R, Bhanji F, Billi JE, Callaway CW, Castren M, de Caen AR, Ferrer JME, Finn JC, Gent LM, Griffin RE, Iverson S, Lang E, Lim SH, Maconochie IK, Montgomery WH, Morley PT, Nadkarni VM, Neumar RW, Nikolaou NI, Perkins GD, Perlman JM, Singletary EM, Soar J, Travers AH, Welsford M, Wyllie J, Zideman DA. Part 1: executive summary: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation. 2015. In press.

13. Ringh M, Rosenqvist M, Hollenberg J, Jonsson M, Fredman D, Nordberg P, Järnbert-Pettersson H, Hasselqvist-Ax I, Riva G, Svensson L. Mobile- phone dispatch of laypersons for CPR in out-of-hospital cardiac arrest. N Engl J Med. 2015;372:2325–806. doi: 10.1056/NEJMoa1406038.

14. Aufderheide TP, Nichol G, Rea TD, Brown SP, Leroux BG, Pepe PE, Kudenchuk PJ, Christenson J, Daya MR, Dorian P, Callaway CW, Idris AH, Andrusiek D, Stephens SW, Hostler D, Davis DP, Dunford JV, Pirrallo RG, Stiell IG, Clement CM, Craig A, Van Ottingham L, Schmidt TA, Wang HE, Weisfeldt ML, Ornato JP, Sopko G; Resuscitation Outcomes Consortium (ROC) Investigators. A trial of an impedance threshold device in out-of-hospital cardiac arrest. N Engl J Med. 2011;365:798–806. doi: 10.1056/NEJMoa1010821.

15. Frascone RJ, Wayne MA, Swor RA, Mahoney BD, Domeier RM, Olinger ML, Tupper DE, Setum CM, Burkhart N, Klann L, Salzman JG, Wewerka SS, Yannopoulos D, Lurie KG, O'Neil BJ, Holcomb RG, Aufderheide TP. Treatment of non-traumatic out-of-hospital cardiac arrest with active compression decompression cardiopulmonary resuscitation plus an impedance threshold device. Resuscitation. 2013;84:1214–1222. doi: 10.1016/j. resuscitation.2013.05.002.

16. Mentzelopoulos SD, Malachias S, Chamos C, Konstantopoulos D, Ntaidou T, Papastylianou A, Kolliantzaki I, Theodoridi M, Ischaki H, Makris D, Zakynthinos E, Zintzaras E, Sourlas S, Aloizos S, Zakynthinos SG. Vasopressin, steroids, and epinephrine and neurologically favor- able survival after in-hospital cardiac arrest: a randomized clinical trial. JAMA. 2013;310:270–279. doi: 10.1001/jama.2013.7832.

17. Perlman JM, Wyllie J, Kattwinkel J, Wyckoff MH, Aziz K, Guinsburg R, Kim HS, Liley HG, Mildenhall L, Simon WM, Szyld E, Tamura M, Velaphi S; on behalf of the Neonatal Resuscitation Chapter Collaborators. Part 7: neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2015;132(suppl 1):S204–S241. doi: 10.1161/ CIR.0000000000000276.

18. Wyllie J, Perlman JM, Kattwinkel J, Wyckoff MH, Aziz K, Guinsburg R, Kim HS, Liley HG, Mildenhall L, Simon WM, Szyld E, Tamura M, Velaphi S; on behalf of the Neonatal Resuscitation Chapter Collaborators. Part 7: neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation. 2015. In press.

19. Mariani G, Dik PB, Ezquer A, Aguirre A, Esteban ML, Perez C, Fernandez Jonusas S, Fustiñana C. Pre-ductal and post-ductal O2 satura- tion in healthy term neonates after birth. J Pediatr. 2007;150:418–421. doi: 10.1016/j.jpeds.2006.12.015.

20. Søreide E, Morrison L, Hillman K, Monsieurs K, Sunde K, Zideman D, Eisenberg M, Sterz F, Nadkarni VM, Soar J, Nolan JP; Utstein Formula for Survival Collaborators. The formula for survival in resuscitation. Resuscitation. 2013;84:1487–1493. doi: 10.1016/j.resuscitation. 2013.07.020.