Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality

Web-based Integrated 2010 & 2015 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Key Words: cardiac arrest cardiopulmonary resuscitation defibrillation emergency

1 Highlights & Introduction

1.1 Highlights: Lay Rescuer CPR

Summary of Key Issues and Major Changes

Key issues and major changes in the 2015 Guidelines Update recommendations for adult CPR by lay rescuers include the following:

- The crucial links in the out-of-hospital adult Chain of Survival are unchanged from 2010, with continued emphasis on the simplified universal Adult Basic Life Support (BLS) Algorithm.
- The Adult BLS Algorithm has been modified to reflect the fact that rescuers can activate an emergency response (ie, through use of a mobile telephone) without leaving the victim's side.
- It is recommended that communities with people at risk for cardiac arrest implement PAD programs.
- Recommendations have been strengthened to encourage immediate recognition of unresponsiveness, activation of the emergency response system, and initiation of CPR if the lay rescuer finds an unresponsive victim is not breathing or not breathing normally (eg, gasping).
- Emphasis has been increased about the rapid identification of potential cardiac arrest by dispatchers, with immediate provision of CPR instructions to the caller (ie, dispatch-guided CPR).
- The recommended sequence for a single rescuer has been confirmed: the single rescuer is to initiate chest compressions before giving rescue breaths (C-A-B rather than A-B-C) to reduce delay to first compression. The single rescuer should begin CPR with 30 chest compressions followed by 2 breaths.
- There is continued emphasis on the characteristics of high-quality CPR: compressing the chest at an adequate rate and depth, allowing complete chest recoil after each compression, minimizing interruptions in compressions, and avoiding excessive ventilation.
- The recommended chest compression rate is 100 to 120/min (updated from *at least* 100/min).
- The clarified recommendation for chest compression depth for adults is at least 2 inches (5 cm) but not greater than 2.4 inches (6 cm).
- Bystander-administered naloxone may be considered for suspected life-threatening opioid-associated emergencies.

These changes are designed to simplify lay rescuer training and to emphasize the need for early chest compressions for victims of sudden cardiac arrest. More information about these changes appears below.

In the following topics, changes or points of emphasis that are similar for lay rescuers and HCPs are noted with an asterisk (*).

Community Lay Rescuer AED Programs

2015 (Updated): It is recommended that PAD programs for patients with OHCA be implemented in public locations where there is a relatively high likelihood of witnessed cardiac arrest (eg, airports, casinos, sports facilities).

2010 (Old): CPR and the use of automated external defibrillators (AEDs) by public safety first responders were recommended to increase survival rates for out-of-hospital sudden cardiac arrest. The 2010 Guidelines recommended the establishment of AED programs in public locations where there is a relatively high likelihood of witnessed cardiac arrest (eg, airports, casinos, sports facilities).

Why: There is clear and consistent evidence of improved survival from cardiac arrest when a bystander performs CPR and rapidly uses an AED. Thus, immediate access to a defibrillator is a primary component of the system of care. The implementation of a PAD program requires 4 essential components: (1) a planned and practiced response, which ideally includes identification of locations and neighborhoods where there is high risk of cardiac arrest, placement of AEDs in those areas and ensuring that bystanders are aware of the location of the AEDs, and, typically, oversight by an HCP; (2) training of anticipated rescuers in CPR and use of the AED; (3) an integrated link with the local EMS system; and (4) a program of ongoing quality improvement.

A system-of-care approach for OHCA might include public policy that encourages reporting of public AED locations to public service access points (PSAPs; the term *public service access point* has replaced the less-precise *EMS dispatch center*). Such a policy would enable PSAPs to direct bystanders to retrieve nearby AEDs and assist in their use when OHCA occurs. Many municipalities as well as the US federal government have enacted legislation to place AEDs in municipal buildings, large public venues, airports, casinos, and schools. For the 20% of OHCAs that occur in public areas, these community programs represent an important link in the Chain of Survival between recognition and activation of the PSAPs. This information is expanded in "Part 4: Systems of Care and Continuous Quality Improvement" in the 2015 Guidelines Update.

There is insufficient evidence to recommend for or against the deployment of AEDs in homes. Victims of OHCAs that occur in private residences are much less likely to receive chest compressions than are patients who experience cardiac arrest in public settings. Real-time instructions provided by emergency dispatchers may help potential in-home rescuers to initiate action. Robust community CPR training programs for cardiac arrest, along with effective, prearrival dispatch protocols, can improve outcomes.

Dispatcher Identification of Agonal Gasps

Cardiac arrest victims sometimes present with seizure-like activity or agonal gasps that can confuse potential rescuers. Dispatchers should be specifically trained to identify these presentations of cardiac arrest to enable prompt recognition and immediate dispatcher-guided CPR.

2015 (Updated): To help bystanders recognize cardiac arrest, dispatchers should inquire about a victim's absence of responsiveness and quality of breathing (normal versus not normal). If the victim is unresponsive with absent or abnormal breathing, the rescuer and the dispatcher should assume that the victim is in cardiac arrest. Dispatchers should be educated to identify unresponsiveness with abnormal and agonal gasps across a range of clinical presentations and descriptions.

2010 (Old): To help bystanders recognize cardiac arrest, dispatchers should ask about an adult victim's responsiveness, if the victim is breathing, and if the breathing is normal, in an attempt to distinguish victims with agonal gasps (ie, in those who need CPR) from victims who are breathing normally and do not need CPR.

Why: This change from the 2010 Guidelines emphasizes the role that emergency dispatchers can play in helping the lay rescuer recognize absent or abnormal breathing.

Dispatchers should be specifically educated to help bystanders recognize that agonal gasps are a sign of cardiac arrest. Dispatchers should also be aware that brief generalized seizures may be the first manifestation of cardiac arrest. In summary, in addition to activating professional emergency responders, the dispatcher should ask straightforward questions about whether the patient is unresponsive and if breathing is normal or abnormal in order to identify patients with possible cardiac arrest and enable dispatcher-guided CPR.

Emphasis on Chest Compressions* 2015

2015 (Updated): Untrained lay rescuers should provide compression-only (Hands-Only) CPR, with or without dispatcher guidance, for adult victims of cardiac arrest. The rescuer should continue compression-only CPR until the arrival of an AED or rescuers with additional training. All lay rescuers should, at a minimum, provide chest compressions for victims of cardiac arrest. In addition, if the trained lay rescuer is able to perform rescue breaths, he or she should add rescue breaths in a ratio of 30 compressions to 2 breaths. The rescuer should continue CPR until an AED arrives and is ready for use, EMS providers take over care of the victim, or the victim starts to move.

2010 (Old): If a bystander is not trained in CPR, the bystander should provide compression-only CPR for the adult victim who suddenly collapses, with an emphasis to "push hard and fast" on the center of the chest, or follow the directions of the EMS dispatcher. The rescuer should continue compression-only CPR until an AED arrives and is ready for use or EMS providers take over care of the victim. All trained lay rescuers should, at a minimum, provide chest compressions for victims of cardiac arrest. In addition, if the trained lay rescuer is able to perform rescue breaths, compressions and breaths should be provided in a ratio of 30 compressions to 2 breaths. The rescuer should continue CPR until an AED arrives and is ready for use or EMS providers take over care of the victim.

Why: Compression-only CPR is easy for an untrained rescuer to perform and can be more effectively guided by dispatchers over the telephone. Moreover, survival rates from adult cardiac arrests of cardiac etiology are similar with either compression only CPR or CPR with both compressions and rescue breaths when provided before EMS arrival. However, for the trained lay rescuer who is able, the recommendation remains for the rescuer to perform both compressions and breaths.

Chest Compression Rate*

2015 (Updated): In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100 to 120/min.

2010 (Old): It is reasonable for lay rescuers and HCPs to perform chest compressions at a rate of at least 100/min.

Why: The number of chest compressions delivered per minute during CPR is an important determinant of return of spontaneous circulation (ROSC) and survival with good neurologic function. The actual number of chest compressions delivered per minute is determined by the rate of chest compressions and the number and duration of interruptions in compressions (eg, to open the airway, deliver rescue breaths, allow AED analysis). In most studies, more compressions are associated with higher survival rates, and fewer compressions are associated with lower survival rates. Provision of adequate chest compressions requires an emphasis not only on an adequate compression rate but also on minimizing interruptions to this critical component of CPR. An inadequate compression rate or frequent interruptions (or both) will reduce the total number of compressions delivered per minute. New to the 2015 Guidelines Update are upper limits of recommended compression rate and compression depth, based on preliminary data suggesting that excessive compression rate and depth adversely affect outcomes. The addition of an upper limit of compression rate is based on 1 large registry study analysis associating extremely rapid compression rates (greater than 140/min) with inadequate compression depth. Box 1 uses the analogy of automobile travel to explain the effect of compression rate and interruptions on total number of compressions delivered during resuscitation.

Box 1

Number of Compressions Delivered Affected by Compression Rate and by Interruptions

The total number of compressions delivered during resuscitation is an important determinant of survival from cardiac arrest.

- The number of compressions delivered is affected by the compression *rate* (the frequency of chest compressions per minute) and by the compression *fraction* (the portion of total CPR time during which compressions are performed). Increases in compression rate and fraction increase the total number of compressions delivered. Compression fraction is improved by reducing the number and duration of any interruptions in compressions.
- An analogy can be found in automobile travel. When traveling in an automobile, the number of miles traveled in a day is affected not only by the speed (rate of travel) but also by the number and duration of any stops (interruptions in travel). Traveling 60 mph without interruptions translates to an actual travel distance of 60 miles in an hour. Traveling 60 mph except for a 10-minute stop translates to an actual travel of 50 miles in that hour. The more frequent and the more prolonged the stops, the lower the actual miles traveled.
- During CPR, rescuers should deliver effective compressions at an appropriate rate (100 to 120/min) and depth while minimizing the number and duration of interruptions in chest compressions. Additional components of high-quality CPR include allowing complete chest recoil after each compression and avoiding excessive ventilation.

Chest Compression Depth*

2015 (Updated): During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches (5 cm) for an average adult, while avoiding excessive chest compression depths (greater than 2.4 inches [6 cm]).

2010 (Old): The adult sternum should be depressed at least 2 inches (5 cm).

Why: Compressions create blood flow primarily by increasing intrathoracic pressure and directly compressing the heart, which in turn results in critical blood flow and oxygen delivery to the heart and brain. Rescuers often do not compress the chest deeply enough despite the recommendation to "push hard." While a compression depth of at least 2 inches (5 cm) is recommended, the 2015 Guidelines Update incorporates new evidence about the potential for an upper threshold of compression depth (greater than 2.4 inches [6 cm]), beyond which complications may occur. Compression depth may be difficult to judge without use of feedback devices, and identification of upper limits of compression depth may be challenging. It is important for rescuers to know that the recommendation about the upper limit of compression depth is based on 1 very small study that reported an association between excessive compression depth and injuries that were not life-threatening. Most monitoring via CPR feedback devices suggests that compressions are more often too shallow than they are too deep.

Bystander Naloxone in Opioid-Associated Life-Threatening Emergencies*

2015 (New): For patients with known or suspected opioid addiction who are unresponsive with no normal breathing but a pulse, it is reasonable for appropriately trained lay rescuers and BLS providers, in addition to providing standard BLS care, to administer intramuscular (IM) or intranasal (IN) naloxone. Opioid overdose response education with or without naloxone distribution to persons at risk for opioid overdose in any setting may be considered. This topic is also addressed in the Special Circumstances of Resuscitation section.

Why: There is substantial epidemiologic data demonstrating the large burden of disease from lethal opioid overdoses, as well as some documented success in targeted national strategies for bystander-administered naloxone for people at risk. In 2014, the naloxone autoinjector was approved by the US Food and Drug Administration for use by lay rescuers and HCPs. The resuscitation training network has requested information about the best way to incorporate such a device into the adult BLS guidelines and training. This recommendation incorporates the newly approved treatment.

1.2 Highlights: HCP BLS

Summary of Key Issues and Major Changes

Key issues and major changes in the 2015 Guidelines Update recommendations for HCPs include the following:

- These recommendations allow flexibility for activation of the emergency response system to better match the HCP's clinical setting.
- Trained rescuers are encouraged to simultaneously perform some steps (ie, checking for breathing and pulse at the same time), in an effort to reduce the time to first chest compression.
- Integrated teams of highly trained rescuers may use a choreographed approach that accomplishes multiple steps and assessments simultaneously rather than the sequential manner used by individual rescuers (eg, one rescuer activates the emergency response system while another begins chest compressions, a third either provides ventilation or retrieves the bag-mask device for rescue breaths, and a fourth retrieves and sets up a defibrillator).
- Increased emphasis has been placed on high-quality CPR using performance targets (compressions of adequate rate and depth, allowing complete chest recoil between compressions, minimizing interruptions in compressions, and avoiding excessive ventilation). See Table 1.
- Compression rate is modified to a range of 100 to 120/min.
- Compression depth for adults is modified to at least 2 inches (5 cm) but should not exceed 2.4 inches (6 cm).
- To allow full chest wall recoil after each compression, rescuers must avoid leaning on the chest between compressions.
- Criteria for minimizing interruptions is clarified with a goal of chest compression fraction as high as possible, with a target of at least 60%.
- Where EMS systems have adopted bundles of care involving continuous chest compressions, the use of passive ventilation techniques may be considered as part of that bundle for victims of OHCA.
- For patients with ongoing CPR and an advanced airway in place, a simplified ventilation rate of 1 breath every 6 seconds (10 breaths per minute) is recommended.

Table 1: BLS Dos and Don'ts of Adult High-Quality CPR

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BLS Dos and Don'ts of Adult High-Quality CPR

Rescuers Should	Rescuers Should *Not*
Perform chest compressions at a rate of 100-120/min	Compress at a rate slower than 100/min or faster than 120/min
Compress to a depth of at least 2 inches (5 cm)	Compress to a depth of less than 2 inches (5 cm) or greater than 2.4 inches (6 cm)
Allow full recoil after each compression	Lean on the chest between compressions

Rescuers Should	Rescuers Should *Not*
Minimize pauses in compressions	Interrupt compressions for greater than 10 seconds
Ventilate adequately (2 breaths after 30 compressions, each breath delivered over 1 second, each causing chest rise)	Provide excessive ventilation (ie, too many breaths or breaths with excessive force)

These changes are designed to simplify training for HCPs and to continue to emphasize the need to provide early and high-quality CPR for victims of cardiac arrest. More information about these changes follows.

In the following topics for HCPs, an asterisk (*) marks those that are similar for HCPs and lay rescuers.

Immediate Recognition and Activation of Emergency Response System

2015 (Updated): HCPs must call for nearby help upon finding the victim unresponsive, but it would be practical for an HCP to continue to assess the breathing and pulse simultaneously before fully activating the emergency response system (or calling for backup).

2010 (Old): The HCP should check for response while looking at the patient to determine if breathing is absent or not normal.

Why: The intent of the recommendation change is to minimize delay and to encourage fast, efficient simultaneous assessment and response, rather than a slow, methodical, step-by-step approach.

Emphasis on Chest Compressions*

2015 (Updated): It is reasonable for HCPs to provide chest compressions and ventilation for all adult patients in cardiac arrest, whether from a cardiac or noncardiac cause. Moreover, it is realistic for HCPs to tailor the sequence of rescue actions to the most likely cause of arrest.

2010 (Old): It is reasonable for both EMS and in-hospital professional rescuers to provide chest compressions and rescue breaths for cardiac arrest victims.

Why: Compression-only CPR is recommended for untrained rescuers because it is relatively easy for dispatchers to guide with telephone instructions. It is expected that HCPs are trained in CPR and can effectively perform both compressions and ventilation. However, the priority for the provider, especially if acting alone, should still be to activate the emergency response system and to provide chest compressions. There may be circumstances that warrant a change of sequence, such as the availability of an AED that the provider can quickly retrieve and use.

Shock First vs CPR First

2015 (Updated): For witnessed adult cardiac arrest when an AED is immediately available, it is reasonable that the defibrillator be used as soon as possible. For adults with unmonitored cardiac arrest or for whom an AED is not immediately available, it is reasonable that CPR be initiated while the defibrillator equipment is being retrieved and applied and that defibrillation, if indicated, be attempted as soon as the device is ready for use

2010 (Old): When any rescuer witnesses an out-of-hospital arrest and an AED is immediately available on-site, the rescuer should start CPR with chest compressions and use the AED as soon as possible. HCPs who treat cardiac arrest in hospitals and other facilities with on-site AEDs or defibrillators should provide immediate CPR and should use the AED/defibrillator as soon as it is available. These recommendations are designed to support early CPR and early defibrillation, particularly when an AED or defibrillator is available within moments of the onset of sudden cardiac arrest. When an OHCA is not witnessed by EMS personnel, EMS may initiate CPR while checking the rhythm with the AED or on the electrocardiogram (ECG) and preparing for defibrillation. In such instances, 1½ to 3 minutes of CPR may be considered before attempted defibrillation. Whenever 2 or more rescuers are present, CPR should be provided while the defibrillator is retrieved.

With in-hospital sudden cardiac arrest, there is insufficient evidence to support or refute CPR before defibrillation. However, in monitored patients, the time from ventricular fibrillation (VF) to shock delivery should be under 3 minutes, and CPR should be performed while the defibrillator is readied.

Why: While numerous studies have addressed the question of whether a benefit is conferred by providing a specified period (typically 1½ to 3 minutes) of chest compressions before shock delivery, as compared with delivering a shock as soon as the AED can be readied, no difference in outcome has been shown. CPR should be provided while the AED pads are applied and until the AED is ready to analyze the rhythm.

Chest Compression Rate: 100 to 120/min*

2015 (Updated): In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100 to 120/min.

2010 (Old): It is reasonable for lay rescuers and HCPs to perform chest compressions at a rate of at least 100/min.

Why: The minimum recommended compression rate remains 100/min. The upper limit rate of 120/min has been added because 1 large registry series suggested that as the compression rate increases to more than 120/min, compression depth decreases in a dose-dependent manner. For example, the proportion of compressions of inadequate depth was about 35% for a compression rate of 100 to 119/min but increased to inadequate depth in 50% of compressions when the compression rate was 120 to 139/min and to inadequate depth in 70% of compressions when compression rate was more than 140/min.

Chest Compression Depth*

2015 (Updated): During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches (5 cm) for an average adult while avoiding excessive chest compression depths (greater than 2.4 inches [6 cm]).

2010 (Old): The adult sternum should be depressed at least 2 inches (5 cm).

Why: A compression depth of approximately 5 cm is associated with greater likelihood of favorable outcomes compared with shallower compressions. While there is less evidence about whether there is an upper threshold beyond which compressions may be too deep, a recent very small study suggests potential injuries (none life-threatening) from excessive chest compression depth (greater than 2.4 inches [6 cm]). Compression depth may be difficult to judge without use of feedback devices, and identification of upper limits of compression depth may be challenging. It is important for rescuers to know that chest compression depth is more often too shallow than too deep.

Chest Recoil*

2015 (Updated): It is reasonable for rescuers to avoid leaning on the chest between compressions, to allow full chest wall recoil for adults in cardiac arrest.

2010 (Old): Rescuers should allow complete recoil of the chest after each compression, to allow the heart to fill completely before the next compression.

Why: Full chest wall recoil occurs when the sternum returns to its natural or neutral position during the decompression phase of CPR. Chest wall recoil creates a relative negative intrathoracic pressure that promotes venous return and cardiopulmonary blood flow. Leaning on the chest wall between compressions precludes full chest wall recoil. Incomplete recoil raises intrathoracic pressure and reduces venous return, coronary perfusion pressure, and myocardial blood flow and can influence resuscitation outcomes.

Minimizing Interruptions in Chest Compressions*

2015 (Reaffirmation of 2010): Rescuers should attempt to minimize the frequency and duration of interruptions in compressions to maximize the number of compressions delivered per minute.

2015 (New): For adults in cardiac arrest who receive CPR without an advanced 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%.

Why: Interruptions in chest compressions can be intended as part of required care (ie, rhythm analysis and ventilation) or unintended (ie, rescuer distraction). Chest compression fraction is a measurement of the proportion of total resuscitation time that compressions are performed. An increase in chest compression fraction can be achieved by minimizing pauses in chest compressions. The optimal goal for chest compression fraction has not been defined. The addition of a target compression fraction is intended to limit interruptions in compressions and to maximize coronary perfusion and blood flow during CPR.

Comparison of Key Elements of Adult, Child, and Infant BLS

Table 2 lists the 2015 key elements of adult, child, and infant BLS (excluding CPR for newly born infants).

Table 2: Summary of High-Quality CPR Components for BLS Providers

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Summary of High-Quality CPR Components for BLS Providers

*Compression depth should be no more than 2.4 inches (6 cm).
Abbreviations: AED, automated external defibrillator; AP, anteroposterior; CPR, cardiopulmonary resuscitation.

Component	Adults and Adolescents	Children (Age 1 Year to Puberty)	Infants (Age Less Than 1 Year, Excluding Newborns)
Scene safety	Make sure the environment is safe for rescuers and victim		
Recognition of cardiac arrest	Check for responsiveness No breathing or only gasping (ie, no normal breathing) No definite pulse felt within 10 seconds (Breathing and pulse check can be performed simultaneously in less than 10 seconds)		
Activation of emergency response system	If you are alone with no mobile phone, leave the victim to activate the emergency response system and get the AED before beginning CPR Otherwise, send someone and begin CPR immediately; use the AED as soon as it is available	***Witnessed collapse*** Follow steps for adults and adolescents on the left ***Unwitnessed collapse*** Give 2 minutes of CPR Leave the victim to activate the emergency response system and get the AED Return to the child or infant and resume CPR; use the AED as soon as it is available	
Compression-ventilation ratio *without advanced airway*	***1 or 2 rescuers*** 30:2	***1 rescuer*** 30:2 ***2 or more rescuers*** 15:2	
Compression-ventilation ratio *with advanced airway*	Continuous compressions at a rate of 100-120/min Give 1 breath every 6 seconds (10 breaths/min)		

Component	Adults and Adolescents	Children (Age 1 Year to Puberty)	Infants (Age Less Than 1 Year, Excluding Newborns)
Compression rate	100-120/min		
Compression depth	At least 2 inches (5 cm)*	At least one-third AP diameter of chest About 2 inches (5 cm)	At least one-third AP diameter of chest About 1 1?2 inches (4 cm)
Hand placement	2 hands on the lower half of the breastbone (sternum)	2 hands or 1 hand (optional for very small child) on the lower half of the breastbone (sternum)	***1 rescuer*** 2 fingers in the center of the chest, just below the nipple line ***2 or more rescuers*** 2 thumb–encircling hands in the center of the chest, just below the nipple line
Chest recoil	Allow full recoil of chest after each compression; do not lean on the chest after each compression		
Minimizing interruptions	Limit interruptions in chest compressions to less than 10 seconds		

Chest Compression Feedback

2015 (Updated): It may be reasonable to use audiovisual feedback devices during CPR for real-time optimization of CPR performance.

2010 (Old): New CPR prompt and feedback devices may be useful for training rescuers and as part of an overall strategy to improve the quality of CPR in actual resuscitations. Training for the complex combination of skills required to perform adequate chest compressions should focus on demonstrating mastery.

Why: Technology allows for real-time monitoring, recording, and feedback about CPR quality, including both physiologic patient parameters and rescuer performance metrics. These important data can be used in real time during resuscitation, for debriefing after resuscitation, and for system-wide quality improvement programs. Maintaining focus during CPR on the characteristics of compression rate and depth and chest recoil while minimizing interruptions is a complex challenge even for highly trained professionals. There is some evidence that the use of CPR feedback may be effective in modifying chest compression rates that are too fast, and there is separate evidence that CPR feedback decreases the leaning force during chest compressions. However, studies to date have not demonstrated a significant improvement in favorable neurologic outcome or survival to hospital discharge with the use of CPR feedback devices during actual cardiac arrest events.

Delayed Ventilation

2015 (New): For witnessed OHCA with a shockable rhythm, it may be reasonable for EMS systems with priority-based, multitiered response to delay positive-pressure ventilation (PPV) by using a strategy of up to 3 cycles of 200 continuous compressions with passive oxygen insufflation and airway adjuncts.

Why: Several EMS systems have tested a strategy of providing initial continuous chest compressions with delayed PPV for adult victims of OHCA. In all of these EMS systems, the providers received additional training with emphasis on provision of high-quality chest compressions. Three studies in systems that use priority-based, multitiered response in both urban and rural communities, and provide a bundled package of care that includes up to 3 cycles of passive oxygen insufflation, airway adjunct insertion, and 200 continuous chest compressions with interposed shocks, showed improved survival with favorable neurologic status for victims with witnessed arrest or shockable rhythm.

Ventilation During CPR With an Advanced Airway

2015 (Updated): 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 (ie, during CPR with an advanced airway).

2010 (Old): When an advanced airway (ie, endotracheal tube, Combitube, or laryngeal mask airway) is in place during 2-person CPR, give 1 breath every 6 to 8 seconds without attempting to synchronize breaths between compressions (this will result in delivery of 8 to 10 breaths per minute).

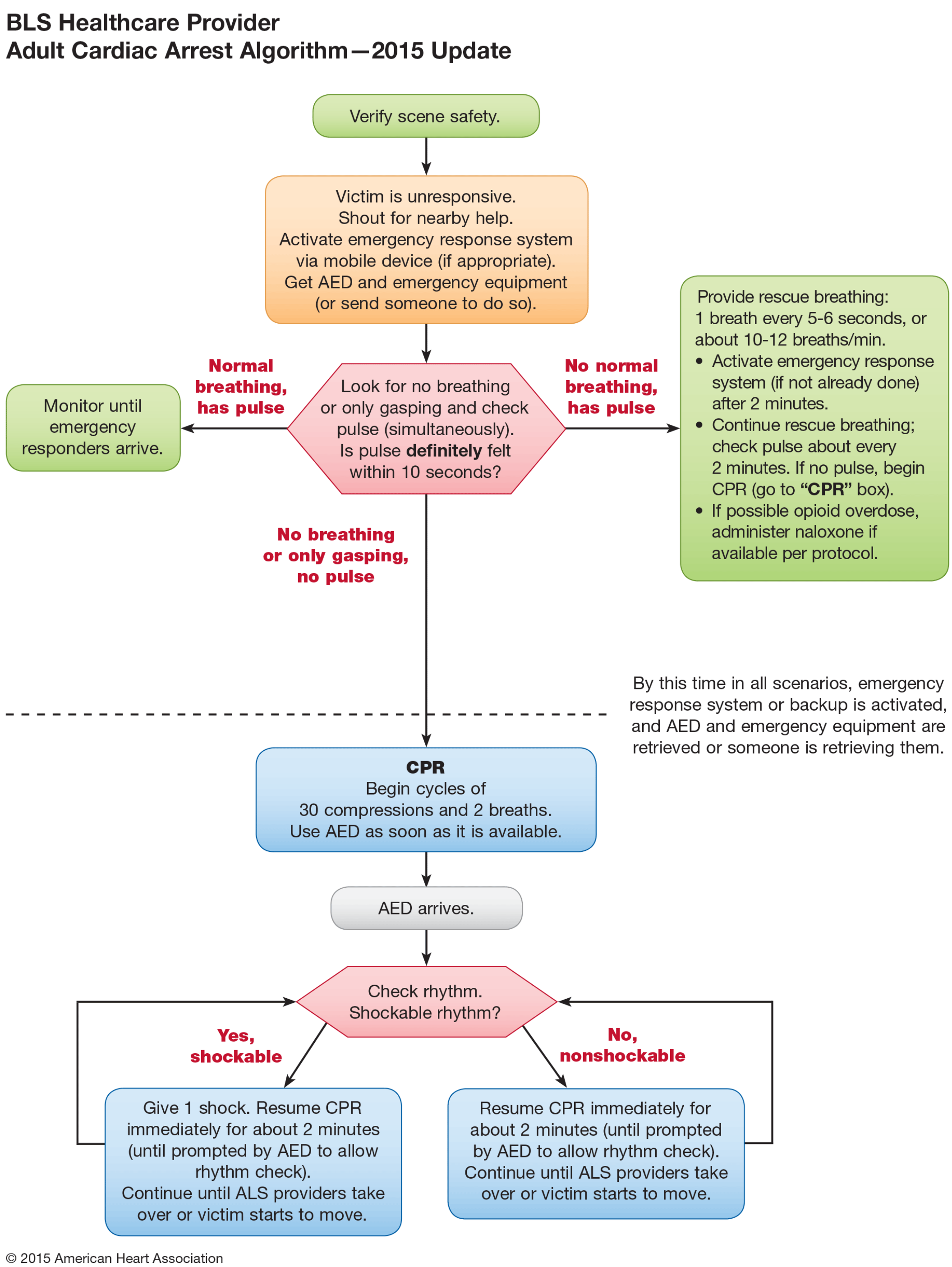
Why: This simple single rate for adults, children, and infants—rather than a range of breaths per minute—should be easier to learn, remember, and perform.

Team Resuscitation: Basic Principles

2015 (New): For HCPs, the 2015 Guidelines Update allows flexibility for activation of the emergency response and subsequent management in order to better match the provider's clinical setting (Figure 1).

Why: The steps in the BLS algorithms have traditionally been presented as a sequence in order to help a single rescuer prioritize actions. However, there are several factors in any resuscitation (eg, type of arrest, location, whether trained providers are nearby, whether the rescuer must leave a victim to activate the emergency response system) that may require modifications in the BLS sequence. The updated BLS HCP algorithms aim to communicate when and where flexibility in sequence is appropriate.

Figure 1: BLS Healthcare Provider Adult Cardiac Arrest Algorithm—2015 Update



1.3 Introduction - Updated

These Web-based Integrated Guidelines incorporate the relevant recommendations from 2010 and the new or updated recommendations from 2015.

As with other Parts of the *2015 American Heart Association* (AHA) *Guidelines Update for Cardiopulmonary Resuscitation* (CPR) *and Emergency Cardiovascular Care* (ECC), Part 5 is based on the International Liaison Committee on Resuscitation (ILCOR) 2015 international evidence review process. ILCOR Basic Life Support (BLS) Task Force members identified and prioritized topics and questions with the newest or most controversial evidence, or those that were thought to be most important for resuscitation. This 2015 Guidelines Update is based on the systematic reviews and recommendations of the *2015 International Consensus on CPR and ECC Science With Treatment Recommendations*, "Part 3: Adult Basic Life Support and Automated External

Defibrillation."[1,2] In the online version of this document, live links are provided so the reader can connect directly to the systematic reviews on the ILCOR Scientific Evidence Evaluation and Review System (SEERS) website. These links are indicated by a combination of letters and numbers (eg, BLS 740). We encourage readers to use the links and review the evidence and appendix.

As with all AHA Guidelines, each 2015 recommendation is labeled with a Class of Recommendation (COR) and a Level of Evidence (LOE). New or updated recommendations use the newest AHA COR and LOE classification system, which contains modifications of the Class III recommendation and introduces LOE B-R (randomized studies) and B-NR (non-randomized studies) as well as LOE C-LD (based on limited data) and LOE C-EO (consensus of expert opinion).

The AHA process for identification and management of potential conflicts of interest was used, and potential conflicts for writing group members are listed at the end of each Part of the 2015 Guidelines Update. For additional information about the systematic review process or management of potential conflicts of interest, see "Part 2: Evidence Evaluation and Management of Conflicts of Interest" in the 2015 Guidelines Update and the related publication, "Part 2: Evidence Evaluation and Management of Conflicts of Interest" in the ILCOR *2015 International Consensus on CPR and ECC Science With Treatment Recommendations.*[3]

Because the 2015 publication represents the first Guidelines Update, it includes an appendix with all the 2015 recommendations for adult BLS as well as the recommendations from the 2010 Guidelines. If the 2015 ILCOR review resulted in a new or significantly revised Guidelines recommendation, that recommendation will be labeled *New* or *Updated*.

It is important to note that the 2010 recommendations used a previous version of the AHA COR and LOE classification system that was current in 2010. Any of the 2010 algorithms that have been revised as a result of recommendations in the 2015 Guidelines Update are contained in this publication. To emphasize that the algorithm has been modified, the words *2015 Update* will appear in the title of the algorithm.

2 Adult BLS and CPR Quality Overview - Updated

Sudden cardiac arrest remains a leading cause of death in the United States. Seventy percent of out-of-hospital cardiac arrests (OHCAs) occur in the home, and approximately 50% are unwitnessed. Outcome from OHCA remains poor: only 10.8% of adult patients with nontraumatic cardiac arrest who have received resuscitative efforts from emergency medical services (EMS) survive to hospital discharge.[4] In-hospital cardiac arrest (IHCA) has a better outcome, with 22.3% to 25.5% of adults surviving to discharge.[5]

BLS is the foundation for saving lives after cardiac arrest. Fundamental aspects of adult BLS include immediate recognition of sudden cardiac arrest and activation of the emergency response system, early CPR, and rapid defibrillation with an automated external defibrillator (AED). Initial recognition and response to heart attack and stroke are also considered part of BLS. This section presents the updated recommendations for adult 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 out-of-hospital Chain of Survival 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.
- This Guidelines Update takes 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 showing that high-quality CPR improves survival from cardiac arrest, including
    - 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
- This Guidelines Update includes an updated recommendation for a simultaneous, choreographed approach to performance of chest compressions, airway management, rescue breathing, rhythm detection, and shocks (if indicated) by an integrated team of highly trained rescuers in applicable settings.

When the links in the Chain of Survival are implemented in an effective way, survival can approach 50% in EMS-treated patients after witnessed out-of-hospital ventricular fibrillation (VF) arrest.[6,7] Unfortunately, survival rates in many out-of-hospital and in-hospital settings fall far short of this figure. For example, survival rates after cardiac arrest due to VF vary from approximately 5% to 50% in both out-of-hospital and in-hospital settings.[8-10] This variation in outcome underscores the opportunity for improvement in many settings. The remaining links in the AHA Chain of Survival, namely advanced life support and integrated postarrest care, are covered in later Parts of this 2015 Guidelines Update (see "Part 7: Adult Advanced Cardiovascular Life Support" and "Part 8: Post–Cardiac Arrest Care").

3 Adult BLS Sequence - Updated

The steps of BLS consist of a series of sequential assessments and actions, which are illustrated in a simplified BLS algorithm that is unchanged from 2010.[11] The intent of the algorithm is to present the steps of BLS in a logical and concise manner that is easy for all types of rescuers to learn, remember, and perform. Integrated teams of highly trained rescuers may use a choreographed approach that accomplishes multiple steps and assessments simultaneously rather than in the sequential manner used by individual rescuers (eg, one rescuer activates the emergency response system while another begins chest compressions, a third either provides ventilation or retrieves the bag-mask device for rescue breaths, and a fourth retrieves and sets up a defibrillator). Moreover, trained rescuers are encouraged to simultaneously perform some steps (ie, checking for breathing and pulse at the same time) in an effort to reduce the time to first compressions. BLS assessments and actions for specific types of rescuers are summarized in (Table 3).

Table 3: 2015 - Basic Life Support Sequence

Open table in a new window

Basic Life Support Sequence

Step	Lay Rescuer Not Trained	Lay Rescuer Trained	Healthcare Provider
1	Ensure scene safety.	Ensure scene safety.	Ensure scene safety.
2	Check for response.	Check for response.	Check for response.
3	Shout for nearby help. Phone or ask someone to phone 9-1-1 (the phone or caller with the phone remains at the victim's side, with the phone on speaker).	Shout for nearby help and activate the emergency response system (9-1-1, emergency response). If someone responds, ensure that the phone is at the side of the victim if at all possible.	Shout for nearby help/activate the resuscitation team; can activate the resuscitation team at this time or after checking breathing and pulse.
4	Follow the dispatcher's instructions.	Check for no breathing or only gasping; if none, begin CPR with compressions.	Check for no breathing or only gasping and check pulse (ideally simultaneously). Activation and retrieval of the AED/emergency equipment by either the lone healthcare provider or by the second person sent by the rescuer must occur no later than immediately after the check for no normal breathing and no pulse identifies cardiac arrest.

Step	Lay Rescuer Not Trained	Lay Rescuer Trained	Healthcare Provider
5	Look for no breathing or only gasping, at the direction of the dispatcher.	Answer the dispatcher's questions, and follow the dispatcher's instructions.	Immediately begin CPR, and use the AED/ defibrillator when available.
6	Follow the dispatcher's instructions.	Send the second person to retrieve an AED, if one is available.	When the second rescuer arrives, provide 2-person CPR and use AED/defibrillator.
AED indicates automated external defibrillator; and CPR, cardiopulmonary resuscitation.			

3.1 Immediate Recognition and Activation of the Emergency Response System - Updated BLS 740 BLS 359

Emergency medical dispatch is an integral component of the EMS response.[12] Bystanders (lay responders) should immediately call their local emergency number to initiate a response any time they find an unresponsive adult victim. Healthcare providers should call for nearby help upon finding the victim unresponsive, but it would be practical for a healthcare provider to continue to assess for breathing and pulse simultaneously before fully activating the emergency response system.

For OHCA, a recent Scientific Statement recommended that all emergency dispatchers have protocols to guide the lay rescuer to check for breathing and to perform the steps of CPR, if needed.[13] When dispatchers ask bystanders to determine if breathing is present, bystanders often misinterpret agonal gasps or abnormal breathing as normal breathing. This erroneous information can result in failure by dispatchers to identify potential cardiac arrest and failure to instruct bystanders to initiate CPR immediately.[14-19] An important consideration is that brief, generalized seizures may be the first manifestation of cardiac arrest.[18,19]

3.1.1 2015 Evidence Review

Patients who are unresponsive and not breathing normally have a high likelihood of being in cardiac arrest.[16,19-26] Dispatcher CPR instructions substantially increase the likelihood of bystander CPR performance[27] and improve survival from cardiac arrest.[28-30]

3.1.2 2015 Recommendations - Updated

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)

In order to increase bystander willingness to perform CPR, dispatchers should provide telephone CPR instructions to callers reporting an adult who is unresponsive and not breathing or not breathing normally (ie, only gasping). (Class I, LOE B)

The EMS system quality improvement process, including review of the quality of dispatcher CPR

instructions provided to specific callers, is considered an important component of a high-quality lifesaving program.[31-33]***(Class IIa, LOE B)***

The role of dispatcher-guided CPR and recommendations for dispatcher training are more fully described in "Part 4: Systems of Care and Continuous Quality Improvement."

3.2 Pulse Check - Updated

Studies have shown that both lay rescuers and healthcare providers have difficulty detecting a pulse.[34-43] Healthcare providers also may take too long to check for a pulse.[37,40]

The lay rescuer should not check for a pulse and should assume that cardiac arrest is present if an adult suddenly collapses or an unresponsive victim is not breathing normally.

The healthcare provider should take no more than 10 seconds to check for a pulse and, if the rescuer does not definitely feel a pulse within that time period, the rescuer should start chest compressions.[44,45] ***(Class IIa, LOE C)***

Ideally, the pulse check is performed simultaneously with the check for no breathing or only gasping, to minimize delay in detection of cardiac arrest and initiation of CPR. Lay rescuers will not check for a pulse.

Interruptions of chest compressions to palpate for a spontaneous pulse or to otherwise check for return of spontaneous circulation (ROSC) can compromise vital organ perfusion.[46,47-52]

Accordingly lay rescuers should not interrupt chest compressions to palpate pulses or check for ROSC. (Class IIa, LOE C)

3.3 Early CPR - Updated[BLS 661]

Begin chest compressions as quickly as possible after recognition of cardiac arrest. The 2010 Guidelines included a major change for trained rescuers, who were instructed to begin the CPR sequence with chest compressions rather than breaths (C-A-B versus A-B-C) to minimize the time to initiation of chest compressions. The 2015 ILCOR BLS Task Force reviewed the most recent evidence evaluating the impact of this change in sequence on resuscitation.

3.3.1 2015 Evidence Review

Additional evidence published since 2010 showed that beginning the CPR sequence with compressions minimized time to first chest compression.[53-55]

3.3.2 2015 Recommendation - Updated

Similar to the 2010 Guidelines, it may be reasonable for rescuers to initiate CPR with chest compressions. (Class IIb, LOE C-LD)

The characteristics of effective chest compressions are described in the following section on BLS skills. As in the 2010 sequence, once chest compressions have been started, a trained rescuer delivers rescue breaths by mouth-to-mask or bag-mask device to provide oxygenation and ventilation. Recommendations regarding the duration of each breath and the need to make the chest rise were not updated in 2015.

3.4 Early Defibrillation With an AED - Updated

After activating the emergency response system, the lone rescuer retrieves an AED (if nearby and easily accessible) and then returns to the victim to attach and use the AED and provide CPR. When 2 or more trained rescuers are present, 1 rescuer begins CPR, starting with chest compressions, while a second rescuer activates the emergency response system and gets the AED (or a manual defibrillator in most hospitals) and other emergency equipment. The AED or manual defibrillator is used as rapidly as possible, and both rescuers are expected to provide CPR with chest compressions and ventilation. The sequence for using an AED has not been updated from the 2010 Guidelines.

3.5 Rescuer-Specific CPR Strategies: Putting It All Together - Updated BLS 359 BLS 372

This section summarizes the sequence of CPR interventions to be performed by 3 types of prototypical rescuers after they activate the emergency response system. The specific steps for rescuers and healthcare providers (compression-only [Hands-Only™] CPR, conventional CPR with rescue breaths, and CPR with AED use) are determined by the rescuer's level of training.

3.6 Untrained Lay Rescuer - Updated

Bystander CPR may prevent VF from deteriorating to asystole, and it also increases the chance of defibrillation, contributes to preservation of heart and brain function, and improves survival from OHCA.[56] Bystander CPR rates remain unacceptably low in many communities. Because compression-only CPR is easier to teach, remember, and perform, it is preferred for "just-in-time" teaching for untrained lay rescuers.

3.6.1 2015 Evidence Review

When telephone guidance is needed, survival is improved when compression-only CPR is provided as compared with conventional CPR for adult victims of cardiac arrest.[57] Multiple studies have shown no difference in survival when adult victims of OHCA receive compression-only CPR versus conventional CPR.[28,30,58-65]

3.6.2 2015 Recommendations - Updated

Untrained lay rescuers should provide compression-only CPR, with or without dispatcher assistance. (Class I, LOE C-LD)

The rescuer should continue compression-only CPR until the arrival of an AED or rescuers with additional training. (Class I, LOE C-LD)

3.7 Trained Lay Rescuer - Updated

The 2010 Guidelines recommended that trained rescuers should provide rescue breaths in addition to chest compressions because they may encounter victims with asphyxial causes of cardiac arrest or they may be providing CPR for prolonged periods of time before additional help arrives.

3.7.1 2015 Recommendations - Updated

All lay rescuers should, at a minimum, provide chest compressions for victims of cardiac arrest. (Class I, LOE C-LD) In addition, if the trained lay rescuer is able to perform rescue breaths, he or she should add rescue breaths in a ratio of 30 compressions to 2 breaths.

The rescuer should continue CPR until an AED arrives and is ready for use or EMS providers take over care of the victim. (Class I, LOE C-LD)

3.8 Healthcare Provider - Updated

Optimally, all healthcare providers should be trained in BLS. As in past Guidelines, healthcare providers are trained to provide both compressions and ventilation.

3.8.1 2015 Evidence Review

There is concern that delivery of chest compressions without assisted ventilation for prolonged periods could be less effective than conventional CPR (compressions plus breaths) because the arterial oxygen content will decrease as CPR duration increases. This concern is especially pertinent in the setting of asphyxial cardiac arrest.[59] For the 2015 ILCOR evidence review, the Adult BLS Task Force reviewed observational studies and randomized controlled trials (RCTs), including studies of dispatcher-guided CPR; much of the research involved patients whose arrests were presumed to be of cardiac origin and in settings with short EMS response times. It is likely that a time threshold exists beyond which the absence of ventilation may be harmful,[58,60] and the generalizability of the findings to all settings must be considered with caution.

3.8.2 2015 Recommendation - Updated

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)

In addition, it is realistic for healthcare providers to tailor the sequence of rescue actions to the most likely cause of arrest. For example, if a lone healthcare provider sees an adolescent suddenly collapse, the provider may assume that the victim has had a sudden arrhythmic arrest and call for help, get a nearby AED, return to the victim to use the AED, and then provide CPR.

The related 2010 recommendation is as follows:

If a lone healthcare provider aids an adult drowning victim or a victim of foreign body airway obstruction who becomes unconscious, the healthcare provider may give about 5 cycles (approximately 2 minutes) of CPR before activating the emergency response system. (Class IIa, LOE C)

3.9 Delayed Ventilation - Updated[BLS 360]

Several EMS systems have tested a strategy of initial continuous chest compressions with delayed positive-pressure ventilation for adult OHCA.

3.9.1 2015 Evidence Review

During adult OHCA, survival to hospital discharge was improved by the use of an initial period of continuous chest compressions.[66,67] Three observational studies showed improved survival with favorable neurologic status when EMS providers performed a set of continuous chest compressions with delayed ventilation for victims with witnessed arrest or shockable rhythm.[68-70] These studies were performed in systems that use priority-based, multitiered response in both urban and rural communities, and all included a “bundled” package of care that included up to 3 cycles of passive oxygen insufflation, airway adjunct insertion, and 200 continuous chest compressions with interposed shocks. Providers received additional training with emphasis on provision of high-quality chest compressions.

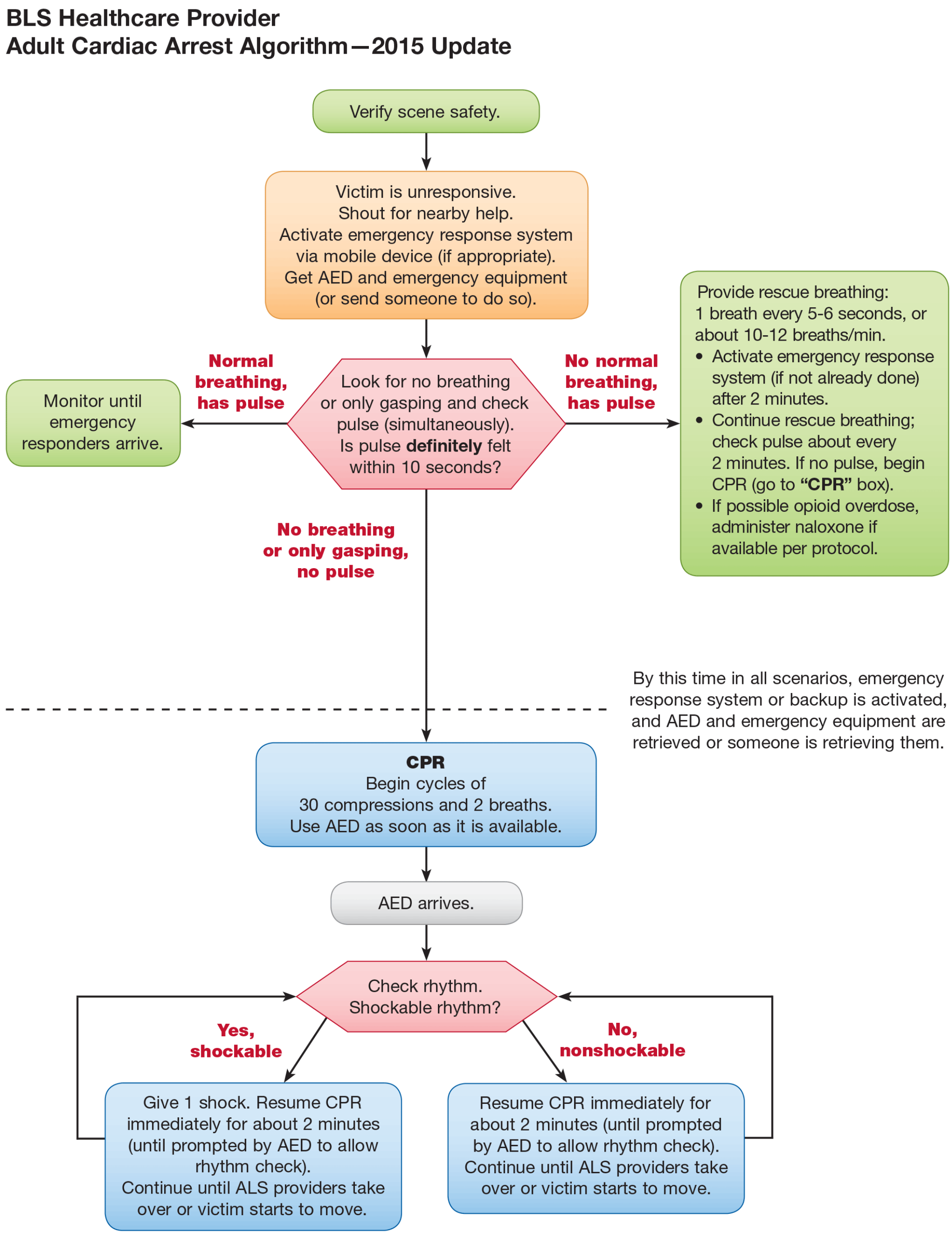
3.9.2 2015 Recommendation - New

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)

4 Adult BLS Skills - Updated

The sequence of BLS skills for the healthcare provider is depicted in the BLS Healthcare Provider Adult Cardiac Arrest Algorithm (Figure 1). There are minor changes to the 2010 Guidelines as the result of new evidence regarding compression rate, feedback received from the training network, and new evidence regarding the incidence of opioid overdose and the effects of naloxone-administration programs.

Figure 1: BLS Healthcare Provider Adult Cardiac Arrest Algorithm—2015 Update



4.1 Verify Scene Safety - Updated

Rescuers arriving on the scene of an emergency should verify that the environment in which they are approaching a patient is safe for the provider. This is accomplished by a quick scan of the patient's location and surroundings to make sure there are no imminent physical threats such as toxic or electrical hazards.

Because of the difficulty in providing effective chest compressions while moving the patient during CPR, the resuscitation should generally be conducted where the patient is found. (Class IIa, LOE C)

This may not be possible if the environment is dangerous.

4.2 Recognition of Arrest - Updated BLS 359 BLS 740

The necessary first step in the treatment of cardiac arrest is immediate recognition. Initial major steps for bystanders remain unchanged from the 2010 Guidelines and are provided below. CPR training, both formal classroom training and “just-in-time” training such as that given through a dispatch center, should emphasize how to recognize occasional gasps.

Dispatchers should instruct rescuers to provide CPR if the victim is unresponsive with no normal breathing, even when the victim demonstrates occasional gasps. (Class I, LOE C-LD)

The 2010 Guidelines are as follows:

Bystanders may witness the sudden collapse of a victim or find someone who appears lifeless. At that time several steps should be initiated. Before approaching a victim, the rescuer must ensure that the scene is safe and then check for response. To do this, tap the victim on the shoulder and shout, “Are you all right?” If the victim is responsive he or she will answer, move, or moan. If the victim remains unresponsive, the lay rescuer should activate the emergency response system.

When phoning 911 for help, the rescuer should be prepared to answer the dispatcher’s questions about the location of the incident, the events of the incident, the number and condition of the victim(s), and the type of aid provided. If rescuers never learned or have forgotten how to do CPR, they should also be prepared to follow the dispatcher’s instructions. Finally the rescuer making the phone call should hang up only when instructed to do so by the dispatcher.

After activation of the emergency response system, all rescuers should immediately begin CPR (see steps below) for adult victims who are unresponsive with no breathing or no normal breathing (only gasping).

Professional as well as lay rescuers may be unable to accurately determine the presence or absence of adequate or normal breathing in unresponsive victims[34,71] because the airway is not open[72] or because the victim has occasional gasps, which can occur in the first minutes after SCA and may be confused with adequate breathing. Occasional gasps do not necessarily result in adequate ventilation.

Studies have shown that both laypersons and healthcare providers have difficulty detecting a pulse.[34-43] For this reason pulse check was deleted from training for lay rescuers several years ago, and is deemphasized in training for healthcare providers. The lay rescuer should assume that cardiac arrest is present and should begin CPR if an adult suddenly collapses or an unresponsive victim is not breathing or not breathing normally (ie, only gasping).

Healthcare providers may take too long to check for a pulse[37,40]and have difficulty determining if a pulse is present or absent.[37,40,44] There is no evidence, however, that checking for breathing, coughing, or movement is superior for detection of circulation.[73]

The four related 2010 recommendations are as follows:

The rescuer should treat the victim who has occasional gasps as if he or she is not breathing. (Class I, LOE C)

If the victim also has absent or abnormal breathing (ie, only gasping), the rescuer should assume the victim is in cardiac arrest.[74,75,76](Class I, LOE C)

The health care provider should also check for no breathing or no normal breathing (ie, only gasping) while checking for responsiveness; if the healthcare provider finds the victim is unresponsive with no breathing or no normal breathing (ie, only gasping), the rescuer should assume the victim is in cardiac arrest and immediately activate the emergency response system.[74,75,76](Class I, LOE C)

Because delays in chest compressions should be minimized, the healthcare provider should take no more than 10 seconds to check for a pulse; and if the rescuer does not definitely feel a pulse within that time period the rescuer should start chest compressions.* *(Class IIa, LOE C)

4.2.1 Scenario: Pulse Present, Normal Breathing - Updated

Closely monitor the patient, and activate the emergency response system as indicated by location and patient condition.

4.2.2 Scenario: Pulse Present, No Normal Breathing - Updated BLS 811 BLS 891

This topic was last reviewed in 2010. The 2015 ILCOR systematic review addressed whether bystander-administered naloxone to patients with suspected opioid-associated cardio-pulmonary arrest affected resuscitation outcomes. The evaluation did not focus on opioid-associated respiratory arrest.

The authors acknowledge the epidemiologic data demonstrating the large burden of disease from lethal opioid overdoses as well as targeted national strategies for bystander-administered naloxone for people at risk. Since the 2014 US Food and Drug Administration approval of the use of a naloxone autoinjector by lay rescuers and healthcare providers,[77] the training network has requested information regarding the best way to incorporate such a device in the BLS sequence. In response to requests, the ILCOR BLS Task Force performed an additional search for evidence of effectiveness of the use of naloxone for opioid overdose.

4.2.2.1 2015 Summary of Evidence

There were no published studies to determine if adding intranasal or intramuscular naloxone to conventional CPR is superior to conventional CPR alone for the management of adults and children with suspected opioid-associated cardiac or respiratory arrest in the prehospital setting. However, the additional search for available evidence regarding overdose education and naloxone distribution programs yielded 3 observational before-and-after studies. One study observed a dose-response effect with 0.73 (95% confidence interval [CI], 0.57–0.91) and 0.54 (95% CI, 0.39–0.76) adjusted rate ratios for lethal overdose in communities with low and high implementation, respectively.[78] The remaining 2 observational studies reported reductions in rate ratios for lethal overdose of 0.62 (95% CI, 0.54–0.72)[79] and 0.70 (95% CI, 0.65–0.74) in individual communities that implemented programs to address opioid overdose.[80]

4.2.2.2 2015 Recommendations - New

For a patient with known or suspected opioid overdose who has 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 intramuscular or intranasal naloxone.* *(Class IIa, LOE C-LD)

For patients in cardiac arrest, medication administration is ineffective without concomitant chest compressions for drug delivery to the tissues, so naloxone administration may be considered after initiation of CPR if there is high suspicion for opiate overdose.* *(Class IIb, LOE C-EO)

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)

Information regarding lay rescuer education and the use of naloxone for known or suspected victims of opioid overdose is discussed in "Part 10: Special Circumstances of Resuscitation."

4.2.3 Scenario: Pulse Absent, No Breathing or Only Gasping - Updated

As in the 2010 Guidelines, rescuers should initiate CPR and use an AED as soon as possible. By this point in all potential scenarios, the emergency response system is activated, and a defibrillator and emergency equipment are retrieved or requested.

4.3 Technique: Chest Compressions - Updated

Chest compressions are the key component of effective CPR. Chest compressions consist of forceful rhythmic applications of pressure over the lower half of the sternum. These compressions create blood flow by increasing intrathoracic pressure and directly compressing the heart. This generates blood flow and oxygen delivery to the myocardium and brain.

Characteristics of chest compressions include their depth, rate, and degree of recoil. The quality of CPR can also be characterized by the frequency and duration of interruptions in chest compressions—when such interruptions are minimized, the chest compression fraction (percent of total resuscitation time that compressions are performed) is higher. Finally, with high-quality CPR, the rescuer avoids excessive ventilation. These CPR performance elements affect intrathoracic pressure, coronary perfusion pressure, cardiac output, and, in turn, clinical outcomes.

Effective chest compressions are essential for providing blood flow during CPR. For this reason all patients in cardiac arrest should receive chest compressions.[81-85]***(Class I, LOE B)***

4.3.1 Hand Position During Compressions - Updated[BLS 357]

The 2015 ILCOR systematic review addressed whether hand position placement for chest compressions affected resuscitation outcomes. Different rescuer hand positions alter the mechanics of chest compressions and may, in turn, influence their quality and effectiveness.

4.3.1.1 2015 Summary of Evidence

Only a few human studies involving a total of fewer than 100 cardiac arrest patients have evaluated hand position during CPR.[86-88] These investigations assessed hand placement on the lower third of the sternum compared with the center of the chest in a crossover design, and they measured physiologic endpoints, such as blood pressure and end-tidal carbon dioxide (ETCO$_2$). The studies have not provided conclusive or consistent results about the effects of hand placement on resuscitation outcomes.

4.3.1.2 2015 Recommendation - Unchanged

Consistent with the 2010 Guidelines, it is reasonable to position hands for chest compressions on the lower half of the sternum in adults with cardiac arrest. (Class IIa, LOE C-LD)

The full 2010 recommendation is as follows.

The rescuer should place the heel of one hand on the center (middle) of the victim's chest (which is the lower half of the sternum) and the heel of the other hand on top of the first so that the hands are overlapped and parallel.[89-92]***(Class IIa, LOE B)***

4.3.2 Chest Compression Rate - Updated[BLS 343]

In the 2010 Guidelines, the recommended compression rate was *at least* 100 compressions per minute. The 2015 Guidelines Update incorporates new evidence about the potential for an upper threshold of rate beyond which outcome may be adversely affected.

The 2015 ILCOR systematic review addressed whether compression rates different from 100/min influence physiologic or clinical outcomes. Chest compression rate is defined as the actual rate used during each continuous period of chest compressions. This rate differs from the number of chest compressions delivered per unit of time, which takes into account any interruptions in chest compressions.

4.3.2.1 2015 Summary of Evidence

Evidence involving compression rate is derived from observational human studies that evaluate the relationship between compression rate and outcomes including survival to hospital discharge, return of spontaneous circulation (ROSC), and various physiologic measures, such as blood pressure and end-tidal CO_2. These investigations suggest that there may be an optimal zone for the rate of manual chest compressions—between 100/min and 120/min—that on average is associated with improved survival.[93,94] Importantly, there is an interdependent relationship between compression rate and compression depth during manual chest compressions: as rate increases to greater than 120/min, depth decreases in a dose-dependent manner.[93] For example, the proportion of compressions less than 38 mm (less than 3.8 cm or 1.5 inches) was about 35% for a compression rate of 100 to 119/min but increased to 50% for a compression rate of 120 to 139/min and 70% for a compression rate of greater than 140/min.

4.3.2.2 2015 Recommendation - Updated

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)

4.3.3 Chest Compression Depth - Updated[BLS 366]

The 2015 ILCOR systematic review addressed whether a chest compression depth different from 2 inches (5 cm) influences physiologic or clinical outcomes. The depth of chest compression can affect the relative increase in intrathoracic pressure and, in turn, influence forward blood flow from the heart and great vessels to the systemic circulation. In the 2010 Guidelines, the recommended compression depth was *at least* 2 inches (5 cm). The 2015 Guidelines Update incorporates new evidence about the potential for an upper threshold of compression depth beyond which outcomes may be adversely affected.

4.3.3.1 2015 Summary of Evidence

Evidence involving compression depth is derived from observational human studies that evaluate the relationship between compression depth and outcomes including survival with favorable neurologic outcome, survival to hospital discharge, and ROSC. Studies often classify compression depth differently, using distinct categories of depth or using an average depth for a given portion of the resuscitation.

Even with this heterogeneity, there is consistent evidence that achieving compression depth of approximately 5 cm is associated with greater likelihood of favorable outcomes compared with shallower compressions.[95-103] In the largest study to date (n=9136), the optimal compression depth with regard to survival occurred within the range of 41 to 55 mm (4.1 to 5.5 cm, or 1.61 to 2.2 inches).[98] Less evidence is available about whether there is an upper threshold beyond which compressions may be too deep. During manual CPR, injuries are more common when compression depth is greater than 6 cm (2.4 inches) than when it is between 5 and 6 cm (2 and 2.4 inches).[104] Importantly, chest compressions performed by professional rescuers are more likely to be too shallow (ie, less than 40 mm [4 cm] or 1.6 inches) and less likely to exceed 55 mm (5.5 cm or 2.2 inches).[98]

4.3.3.2 2015 Recommendation - Updated

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)

Additionally, the 2010 Guidelines further specified that chest compressions should be performed with chest compression and chest recoil/relaxation times approximately equal.[105,106] (Class IIb, LOE C)

4.3.4 Chest Wall Recoil - Updated[BLS 367]

The 2015 ILCOR systematic reviews addressed whether full chest wall recoil compared with incomplete recoil influenced physiologic or clinical outcomes. Full chest wall recoil occurs when the sternum returns to its natural or neutral position during the decompression phase of CPR. Chest wall recoil creates a relative negative intrathoracic pressure that promotes venous return and cardiopulmonary blood flow. Leaning on the chest wall between compressions precludes full chest wall recoil. Incomplete recoil could increase intrathoracic pressure and reduce venous return, coronary perfusion pressure, and myocardial blood flow and could potentially influence resuscitation outcomes.[107,108] Observational studies indicate that leaning is common during CPR in adults and children.[109,110]

4.3.4.1 2015 Summary of Evidence

There are no human studies reporting the relationship between chest wall recoil and clinical outcomes. The evidence is derived from 2 animal studies and a pediatric study of patients not in cardiac arrest.[107,111,112] In all 3 studies, an increased force of leaning (incomplete recoil) was associated with a dose-dependent decrease in coronary perfusion pressure. Based on 2 studies, the relationship between leaning and cardiac output was inconsistent.[107,111]

4.3.4.2 2015 Recommendation - Updated

It is reasonable for rescuers to avoid leaning on the chest between compressions to allow full chest wall recoil for adults in cardiac arrest. (Class IIa, LOE C-LD)

4.4 Minimizing Interruptions in Chest Compressions - Updated[BLS 358]

As in the 2010 Guidelines, minimizing interruptions in chest compressions remains a point of emphasis. The 2015 ILCOR systematic review addressed whether shorter compared with longer interruptions in chest compressions influenced physiologic or clinical outcomes. Interruptions in chest compressions can be intended as part of required care (ie, rhythm analysis and ventilation) or unintended (ie, rescuer distraction).

Chest compression fraction is a measurement of the proportion of time that compressions are performed during a cardiac arrest. An increase in chest compression fraction can be achieved by minimizing pauses in chest compressions. The optimal goal for chest compression fraction has not been defined. The AHA expert consensus is that a chest compression fraction of 80% is achievable in a variety of settings.[113]

4.4.1 2015 Summary of Evidence

Evidence involving the consequences of compression interruptions is derived from observational and randomized human studies of cardiac arrest. These studies provide heterogeneous results. Observational studies demonstrate an association between a shorter duration of compression interruption for the perishock period and a greater likelihood of shock success,[100] ROSC,[114] and survival to hospital discharge.[115],[116] Other observational studies have demonstrated an association between higher chest compression fraction and likelihood of survival among patients with shockable rhythms, and return of circulation among patients with nonshockable rhythms.[117],[118] In contrast, the results of a randomized trial comparing a bundle of changes between the 2000 and 2005 Guidelines showed no survival difference when perishock pauses were reduced.[119] In an investigation of first responders equipped with AEDs, the duration of pauses specific to ventilation was not associated with survival.[120]

4.4.2 2015 Recommendations - Updated

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

For adults in cardiac arrest receiving CPR without an advanced airway, it is reasonable to pause compressions for less than 10 seconds to deliver 2 breaths. (Class IIa, LOE C-LD)

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)

4.4.3 Rescuer Fatigue

The 2010 Guidelines provided specific guidance for switching compressors:

Rescuer fatigue may lead to inadequate compression rates or depth.[121-123] Significant fatigue and shallow compressions are common after 1 minute of CPR, although rescuers may not recognize that fatigue is present for ?5 minutes.[122]

When 2 or more rescuers are available it is reasonable to switch chest compressors approximately every 2 minutes (or after about 5 cycles of compressions and ventilations at a ratio of 30:2) to prevent decreases in the quality of compressions. (Class IIa, LOE B)

Consider switching compressors during any intervention associated with appropriate interruptions in chest compressions (eg, when an AED is delivering a shock). Every effort should be made to accomplish this switch in <5 seconds. If the 2 rescuers are positioned on either side of the patient, 1 rescuer will be ready and waiting to relieve the "working compressor" every 2 minutes.

4.5 Compression-to-Ventilation Ratio - Updated[BLS 362]

In 2005, the recommended compression-to-ventilation ratio for adults in cardiac arrest was changed from 15:2 to 30:2. The 2015 ILCOR systematic review addressed whether compression-to-ventilation ratios different from 30:2 influenced physiologic or clinical outcomes. In cardiac arrest patients without an advanced airway, chest compressions are briefly paused to provide rescue breaths in order to achieve adequate air entry.

4.5.1 2015 Summary of Evidence

Evidence involving the compression-to-ventilation ratio is derived from observational before-and-after human studies in the out-of-hospital setting.[124-127] These studies compared the compression-to-ventilation ratio of 30:2 with 15:2 for survival and other outcomes. However, the treatment of the comparison groups also differed in other respects that typically reflected changes from the 2000 to 2005 Guidelines, such as an increase in the duration of CPR cycles between rhythm analyses from 1 to 2 minutes. Overall, outcomes were typically better in the 30:2 group compared with the 15:2 group.

4.5.2 2015 Recommendation - Unchanged

Consistent with the 2010 Guidelines, it is reasonable for rescuers to provide a compression-to-ventilation ratio of 30:2 for adults in cardiac arrest. (Class IIa, LOE C-LD)

4.6 Layperson - Compression-Only CPR Versus Conventional CPR (Chest Compressions Plus Rescue Breaths) - Updated[BLS 372]

The 2015 ILCOR systematic review addressed whether lay-person CPR consisting of chest compressions alone compared with conventional CPR (compressions plus rescue breaths) influenced physiologic or clinical outcomes.

4.6.1 2015 Summary of Evidence

Evidence comparing layperson compression-only CPR with conventional CPR is derived from RCTs of dispatcher-guided CPR and observational studies. There were no short-term survival differences in any of the 3 individual randomized trials comparing the 2 types of dispatcher instructions.[28,30,128] Based on meta-analysis of the 2 largest randomized trials (total n=2496), dispatcher instruction in compression-only CPR was associated with long-term survival benefit compared with instruction in chest compressions and rescue breathing.[57] Among the observational studies, survival outcomes were not different when comparing the 2 types of CPR.[58-65,129-133]

4.6.2 2015 Recommendations - Updated

The following recommendations are consistent with 2010 Guidelines involving layperson CPR.

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

For lay rescuers, compression-only CPR is a reasonable alternative to conventional CPR in the adult cardiac arrest patient. (Class IIa, LOE C-LD)

For trained lay rescuers, it is reasonable to provide ventilation in addition to chest compressions for the adult in cardiac arrest. (Class IIa, LOE C-LD)

4.7 Managing the Airway - Updated

A significant change in the 2010 Guidelines was the initiation of chest compressions before ventilation (ie, a change in the sequence from A-B-C to C-A-B). The prioritization of circulation (C) over ventilation reflected the overriding importance of blood flow generation for successful resuscitation and practical delays inherent to initiation of rescue breaths (B). Physiologically, in cases of sudden cardiac arrest, the need for assisted ventilation is a lower priority because of the availability of adequate arterial oxygen content at the time of a sudden cardiac arrest. The presence of this oxygen and its renewal through gasping and chest compressions (provided there is a patent airway) also supported the use of compression-only CPR and the use of passive oxygen delivery.

4.7.1 Open the Airway: Lay Rescuer - Updated FA 772

The recommendation for trained and untrained lay rescuers remains the same as in 2010.

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)

Spinal immobilization devices may interfere with maintaining a patent airway,[134,135] but ultimately the use of such a device may be necessary to maintain spinal alignment during transport. This treatment recommendation is explored in depth in "Part 15: First Aid."

The trained lay rescuer who feels confident that he or she can perform both compressions and ventilations should open the airway using a head tilt–chin lift maneuver. (Class IIa, LOE B)

For the rescuer providing Hands-Only CPR, there is insufficient evidence to recommend the use of any specific passive airway (such as hyperextending the neck to allow passive ventilation).

4.7.2 Open the Airway: Healthcare Provider - Updated

A healthcare provider uses the head tilt–chin lift maneuver to open the airway of a victim with no evidence of head or neck trauma. The evidence for this was last reviewed in 2010. For victims with suspected spinal cord injury, this evidence was last reviewed in 2010 and there is no change in treatment recommendation.

A healthcare provider should use the head tilt–chin lift maneuver to open the airway of a victim with no evidence of head or neck trauma.

Although the head tilt–chin lift technique was developed using unconscious, paralyzed adult volunteers and has not been studied in victims with cardiac arrest, clinical[136] and radiographic evidence[137,138] and a case series[139] have shown it to be effective. (Class IIa, LOE B)

Between 0.12 and 3.7% of victims with blunt trauma have a spinal injury,[140-142] and the risk of spinal injury is increased if the victim has a craniofacial injury,[143,144] a Glasgow Coma Scale score of <8,[145,146] or both.[144,145]

If healthcare providers suspect a cervical spine injury, they should open the airway using a jaw thrust without head extension.[139] (Class IIb, LOE C)

Because maintaining a patent airway and providing adequate ventilation are priorities in CPR (Class I, LOE C), use the head tilt–chin lift maneuver if the jaw thrust does not adequately open the airway.

4.7.3 Rescue Breathing - Updated

The 2015 Guidelines Update makes many of the same recommendations regarding rescue breathing as were made in 2005 and 2010. Effective performance of rescue breathing or bag-mask or bag-tube ventilation is an essential skill and requires training and practice. During CPR without an advanced airway, a compression-to-ventilation ratio of 30:2 is used.

Deliver each rescue breath over 1 second. (Class IIa, LOE C)

Give a sufficient tidal volume to produce visible chest rise.[147] (Class IIa, LOE C)

Studies in anesthetized adults (with normal perfusion) suggest that a tidal volume of 8 to 10 mL/kg maintains normal oxygenation and elimination of CO2. During CPR, cardiac output is ?25% to 33% of normal, so oxygen uptake from the lungs and CO2 delivery to the lungs are also reduced. As a result, a low minute ventilation (lower than normal tidal volume and respiratory rate) can maintain effective oxygenation and ventilation.[147,148,149,150]

For that reason during adult CPR tidal volumes of approximately 500 to 600 mL (6 to 7 mL/kg) should suffice.[151-153] (Class IIa, LOE B)

This is consistent with a tidal volume that produces visible chest rise.

Patients with airway obstruction or poor lung compliance may require high pressures to be properly ventilated (to make the chest visibly rise). A pressure-relief valve on a resuscitation bag-mask may prevent the delivery of a sufficient tidal volume in these patients.[154] Ensure that the bag-mask device allows you to bypass the pressure-relief valve and use high pressures, if necessary, to achieve visible chest expansion.[155]

Excessive ventilation is unnecessary and can cause gastric inflation and its resultant complications, such as regurgitation and aspiration.[156-158] (Class III, LOE B)

More important, excessive ventilation can be harmful because it increases intrathoracic pressure, decreases venous return to the heart, and diminishes cardiac output and survival.[158]

In summary, rescuers should avoid excessive ventilation (too many breaths or too large a volume) during CPR. (Class III, LOE B)

During CPR the primary purpose of assisted ventilation is to maintain adequate oxygenation; the secondary purpose is to eliminate CO_2. However, the optimal inspired oxygen concentration, tidal volume and respiratory rate to achieve those purposes are not known. As noted above, during the first minutes of sudden VF cardiac arrest, rescue breaths are not as important as chest compressions[159,160,161] because the oxygen content in the noncirculating arterial blood remains unchanged until CPR is started; the blood oxygen content then continues to be adequate during the first several minutes of CPR. In addition, attempts to open the airway and give rescue breaths (or to access and set up airway equipment) may delay the initiation of chest compressions.[162]These issues support the CAB approach of the *2010 AHA Guidelines for CPR and ECC* (ie, starting with **C**hest Compressions prior to **A**irway and **B**reathing).

For victims of prolonged cardiac arrest both ventilations and compressions are important because over time oxygen in the blood is consumed and oxygen in the lungs is depleted (although the precise time course is unknown). Ventilations and compressions are also important for victims of asphyxial arrest, such as children and drowning victims, because they are hypoxemic at the time of cardiac arrest.[163,164]

4.7.3.1 Mouth-to-Mouth Rescue Breathing

The technique for mouth-to-mouth rescue breathing was last reviewed in 2010.[11]

Mouth-to-mouth rescue breathing provides oxygen and ventilation to the victim.[165] To provide mouth-to-mouth rescue breaths, open the victim's airway, pinch the victim's nose, and create an airtight mouth-to-mouth seal.

Give 1 breath over 1 second, take a "regular" (not a deep) breath, and give a second rescue breath over 1 second. (Class IIb, LOE C)

Taking a regular rather than a deep breath prevents the rescuer from getting dizzy or lightheaded and prevents overinflation of the victim's lungs. The most common cause of ventilation difficulty is an improperly opened airway,[72] so if the victim's chest does not rise with the first rescue breath, reposition the head by performing the head tilt–chin lift again and then give the second rescue breath.

If an adult victim with spontaneous circulation (ie, strong and easily palpable pulses) requires support of ventilation, the healthcare provider should give rescue breaths at a rate of about 1 breath every 5 to 6 seconds, or about 10 to 12 breaths per minute. (Class IIb, LOE C)

Each breath should be given over 1 second regardless of whether an advanced airway is in place. Each breath should cause visible chest rise.

4.7.3.2 Mouth–to–Barrier Device Breathing

The technique for mouth–to–barrier device breathing was last reviewed in 2010.[11]

Some healthcare providers[166-168] and lay rescuers state that they may hesitate to give mouth-to-mouth rescue breathing and prefer to use a barrier device. The risk of disease transmission through mouth to mouth ventilation is very low, and it is reasonable to initiate rescue breathing with or without a barrier device. When using a barrier device the rescuer should not delay chest compressions while setting up the device.

4.7.3.3 Mouth-to-Nose and Mouth-to-Stoma Ventilation

The technique for mouth-to-nose and mouth-to-stoma ventilation was last reviewed in 2010.[11]

Mouth-to-nose ventilation is recommended if ventilation through the victim's mouth is impossible (eg, the mouth is seriously injured), the mouth cannot be opened, the victim is in water, or a mouth-to-mouth seal is difficult to achieve. (Class IIa, LOE C)

A case series suggests that mouth-to-nose ventilation in adults is feasible, safe, and effective.[169] Give mouth-to-stoma rescue breaths to a victim with a tracheal stoma who requires rescue breathing.

A reasonable alternative is to create a tight seal over the stoma with a round, pediatric face mask. (Class IIb, LOE C)

There is no published evidence on the safety, effectiveness, or feasibility of mouth-to-stoma ventilation. One study of patients with laryngectomies showed that a pediatric face mask created a better peristomal seal than a standard ventilation mask.[170]

4.7.3.4 Ventilation With Bag-Mask Device - Updated

When using a self-inflating bag, rescuers can provide bag-mask ventilation with room air or oxygen. A bag-mask device can provide positive-pressure ventilation without an advanced airway and may result in gastric inflation and its potential complications.

4.7.3.4.1 The Bag-Mask Device - Updated

The elements of a bag-mask device are the same as those used in 2010.[11]

A bag-mask device should have the following[171]: a nonjam inlet valve; either no pressure relief valve or a pressure relief valve that can be bypassed; standard 15-mm/22-mm fittings; an oxygen reservoir to allow delivery of high oxygen concentrations; a nonrebreathing outlet valve that cannot be obstructed by foreign material and will not jam with an oxygen flow of 30 L/min; and the capability to function satisfactorily under common environmental conditions and extremes of temperature.

Masks should be made of transparent material to allow detection of regurgitation. They should be capable of creating a tight seal on the face, covering both mouth and nose. Masks should be fitted with an oxygen (insufflation) inlet and have a standard 15-mm/22-mm connector.[172] They should be available in one adult and several pediatric sizes.

4.7.3.4.2 Bag-Mask Ventilation

Bag-mask ventilation is a challenging skill that requires considerable practice for competency.[173,174] Bag-mask ventilation is not the recommended method of ventilation for a lone rescuer during CPR. It is most effective when provided by 2 trained and experienced rescuers. One rescuer opens the airway and seals the mask to the face while the other squeezes the bag. Both rescuers watch for visible chest rise.[173,175]

The rescuer should use an adult (1 to 2 L) bag to deliver approximately 600 mL tidal volume[176-178] for adult victims. This amount is usually sufficient to produce visible chest rise and maintain oxygenation and normocarbia in apneic patients.[151-153] (Class IIa, LOE C)

If the airway is open and a good, tight seal is established between face and mask, this volume can be delivered by squeezing a 1-L adult bag about two thirds of its volume or a 2-L adult bag about one third of its volume.

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. (Class IIa, LOE C-LD)

The healthcare provider should use supplementary oxygen (O2 concentration >40%, at a minimum flow rate of 10 to 12 L/min) when available.

4.7.3.5 Ventilation With a Supraglottic Airway

Supraglottic airway devices such as the LMA, the esophageal-tracheal combitube and the King airway device, are currently within the scope of BLS practice in a number of regions (with specific authorization from medical control).

Ventilation with a bag through these devices provides an acceptable alternative to bag-mask ventilation for well-trained healthcare providers who have sufficient experience to use the devices for airway management during cardiac arrest.[179-184] ***(Class IIa, LOE B)***

It is not clear that these devices are any more or less complicated to use than a bag and mask; training is needed for safe and effective use of both the bag-mask device and each of the advanced airways. These devices are discussed in greater detail in Part 7: Adult Advanced Cardiovascular Life Support of the Web-based Integrated Guidelines.

4.7.3.6 Ventilation With an Advanced Airway - Updated BLS 808

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 represents a simplification of the 2010 Guidelines recommendations, to provide a single number that rescuers will need to remember for ventilation rate, rather than a range of numbers.

4.7.4 Passive Oxygen Versus Positive-Pressure Oxygen During CPR - Updated BLS 352

Some EMS systems have studied the use of passive oxygen flow during chest compressions without positive-pressure ventilation, an option known as passive oxygen administration.

4.7.4.1 2015 Evidence Summary

Two studies compared positive-pressure ventilation through an endotracheal tube to continuous delivery of oxygen or air directly into the trachea after intubation by using a modified endotracheal tube that had microcannulas inserted into its inner wall.[185,186] A third study compared bag-mask ventilation to high-flow oxygen delivery by nonrebreather face mask after oropharyngeal airway insertion as part of a resuscitation bundle that also included uninterrupted preshock and postshock chest compressions and early epinephrine administration.[68] Continuous tracheal delivery of oxygen or air through the modified endotracheal tube was associated with lower arterial PCO_2[185] but no additional improvement in ROSC,[185,186] hospital admission,[186] or ICU discharge[186] when compared with positive-pressure ventilation. High-flow oxygen delivery via a face mask with an oropharyngeal airway as part of a resuscitation bundle was associated with improved survival with favorable neurologic outcome. This study, however, included only victims who had witnessed arrest from VF or pulseless ventricular tachycardia (pVT).[68]

4.7.4.2 2015 Recommendations - New

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)

4.7.5 Cricoid Pressure

Cricoid pressure is a technique of applying pressure to the victim’s cricoid cartilage to push the trachea posteriorly and compress the esophagus against the cervical vertebrae. Cricoid pressure can prevent gastric inflation and reduce the risk of regurgitation and aspiration during bag-mask ventilation, but it may also impede ventilation. Seven randomized, controlled studies demonstrated that cricoid pressure can delay or prevent the placement of an advanced airway and that aspiration can occur despite application of pressure.[187-193] Additional manikin studies[194-207] found training in the maneuver to be difficult for both expert and nonexpert rescuers. Neither expert nor nonexpert rescuers demonstrated mastery of the technique, and the applied pressure was frequently inconsistent and outside of effective limits. Cricoid pressure might be used in a few special circumstances (eg, to aid in viewing the vocal cords during tracheal intubation).

However, the routine use of cricoid pressure in adult cardiac arrest is not recommended.
(Class III, LOE B)

5 AED Defibrillation - Updated

Ideally, all BLS providers are trained on use of an AED given that VF and pVT are treatable cardiac arrest rhythms with outcomes closely related to the rapidity of recognition and treatment.[208] Survival in victims of VF/pVT is highest when bystanders deliver CPR and defibrillation is attempted within 3 to 5 minutes of collapse.[9,56,209-212] Accordingly, in 2010, we recommended that BLS providers immediately apply an AED in witnessed OHCA or for monitored patients who develop IHCA. In 2015, the review focused on (1) the evidence surrounding the clinical benefit of automatic external defibrillators in the out-of-hospital setting by laypeople and healthcare providers, and (2) the complex choreography of care needed to ensure high-quality CPR and effective defibrillation.

The 2010 Guidelines are as follows:

Rapid defibrillation is the treatment of choice for VF of short duration, such as for victims of witnessed out-of-hospital cardiac arrest or for hospitalized patients whose heart rhythm is monitored.
(Class I, LOE A)

There is insufficient evidence to recommend for or against delaying defibrillation to provide a period of CPR for patients in VF/pulseless VT out-of-hospital cardiac arrest. In settings with lay rescuer AED programs (AED onsite and available) and for in-hospital environments, or if the EMS rescuer witnesses the collapse, the rescuer should use the defibrillator as soon as it is available. (Class IIa, LOE C)

5.1 CPR Before Defibrillation - Updated[BLS 363]

The 2015 ILCOR systematic review addressed whether a specified period (typically 1.5 to 3 minutes) of chest compressions before shock delivery compared with a short period of chest compressions before shock delivery affected resuscitation outcomes. When cardiac arrest is unwitnessed, experts have debated whether a period of CPR might be beneficial before attempting defibrillation, especially in the out-of-hospital setting when access to defibrillation may be delayed until arrival of professional rescuers. Observational clinical studies and mechanistic studies in animal models suggest that CPR under conditions of prolonged untreated VF might help restore metabolic conditions of the heart favorable to defibrillation. Others have suggested that prolonged VF is energetically detrimental to the ischemic heart, justifying rapid defibrillation attempts regardless of the duration of arrest.

5.1.1 2015 Evidence Summary

Five RCTs,[213-217] 4 observational cohort studies,[218-221] 3 meta-analyses,[222-224] and 1 subgroup analysis of an RCT[225] addressed the question of CPR before defibrillation. The duration of CPR before defibrillation ranged from 90 to 180 seconds, with the control group having a shorter CPR interval lasting only as long as the time required for defibrillator deployment, pad placement, initial rhythm analysis, and AED charging. These studies showed that outcomes were not different when CPR was provided for a period of up to 180 seconds before attempted defibrillation compared with rhythm analysis and attempted defibrillation first for the various outcomes examined, ranging from 1-year survival with favorable neurologic outcome to ROSC. Subgroup analysis suggested potential benefit from CPR before defibrillation in patients with prolonged EMS response intervals (4 to 5 minutes or longer)[213] and in EMS agencies with high baseline survival to hospital discharge,[225] but these findings conflict with other subset analyses.[216] Accordingly, the current evidence suggests that for unmonitored patients with cardiac arrest outside of the hospital and an initial rhythm of VF or pVT, there is no benefit from a period of CPR of 90 to 180 seconds before attempted defibrillation.

5.1.2 2015 Recommendations - Updated

For witnessed adult cardiac arrest when an AED is immediately available, it is reasonable that the defibrillator be used as soon as possible. (Class IIa, LOE C-LD)

For adults with unmonitored cardiac arrest or for whom an AED is not immediately available, it is reasonable that CPR be initiated while the defibrillator equipment is being retrieved and applied and that defibrillation, if indicated, be attempted as soon as the device is ready for use. (Class IIa, LOE B-R)

Additional guidance is given for either situation in the 2010 Guidelines recommendations where 2 or more rescuers are present:

When 2 or more rescuers are present, one rescuer should begin chest compressions while a second rescuer activates the emergency response system and gets the AED (or a manual defibrillator in most hospitals). (Class IIa, LOE C)

5.2 Analysis of Rhythm During Compressions - Updated[BLS 373]

The 2015 ILCOR systematic review addressed whether analysis of cardiac rhythm during chest compressions compared with analysis of cardiac rhythm during pauses in chest compressions affected resuscitation outcomes.

Although the performance of chest compressions during AED rhythm analysis would reduce the time that CPR is paused, motion artifacts currently preclude reliable AED assessment of heart rhythm during chest compressions and may delay VF/pVT identification and defibrillation.

5.2.1 2015 Evidence Summary

There are currently no published human studies that address whether compressions during manual defibrillator or AED rhythm analysis affect patient outcome. New technology to assess the potential benefit of filtering electrocardiogram (ECG) compression artifacts has not been evaluated in humans.

5.2.2 2015 Recommendation - New

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)

5.3 Timing of Rhythm Check - Updated[BLS 346]

The 2015 ILCOR evidence review process considered whether the assessment of rhythm immediately after shock delivery, as opposed to immediate resumption of chest compressions, affected resuscitation outcomes. In 2010, the Guidelines emphasized the importance of avoiding pauses in cardiac compressions during CPR. Assessment of rhythm after shock delivery lengthens the period of time that chest compressions are not delivered.

5.3.1 2015 Evidence Summary

Three before-and-after observational studies of OHCA[67,70,226] evaluated the impact of omitting a rhythm check immediately after attempted defibrillation as part of a bundle of interventions to minimize pauses in chest compressions (eg, elimination of 3 stacked shocks and postshock rhythm and pulse checks). The observational studies documented improved survival with favorable neurologic outcome at hospital discharge associated with the bundle of care, including resumption of chest compressions immediately after shock delivery. One RCT[119] comparing immediate postshock CPR to rhythm checks failed to demonstrate improved ROSC or survival to hospital admission or discharge. One small, low-quality RCT evaluated the ability to identify recurrence of VF and showed no benefit to checking rhythm immediately after defibrillation.[227]

5.3.2 2015 Recommendation - Updated

It may be reasonable to immediately resume chest compressions after shock delivery for adults in cardiac arrest in any setting. (Class IIb, LOE C-LD)

6 CPR Quality, Accountability, and Healthcare Systems - Updated

The quality of CPR in both in-hospital and OHCA events is variable. CPR quality encompasses the traditional metrics of chest compression rate and depth and chest recoil, but it also includes parameters such as chest compression fraction and avoiding excessive ventilation. Other important aspects of CPR quality include resuscitation team dynamics, system performance, and quality monitoring.

Today, despite clear evidence that providing high-quality CPR significantly improves cardiac resuscitation outcomes, few healthcare organizations consistently apply strategies of systematically monitoring CPR quality.[228] As a consequence, there is an unacceptable disparity in the quality of resuscitation care and outcomes, as well an enormous opportunity to save more lives.[97]

Like other urgent healthcare conditions, the use of a relatively simple, iterative continuous quality improvement approach to CPR can dramatically improve CPR quality and optimize outcomes.[229-231] Similar to successful approaches toward mitigating medical errors, programs aimed at system-wide CPR data collection, implementation of best practices, and continuous feedback on performance have been shown to be effective.[113]

6.1 Chest Compression Feedback - Updated[BLS 361]

Technology allows for real-time monitoring, recording, and feedback about CPR quality, including both physiologic patient parameters and rescuer performance metrics. This important data can be used in real time during resuscitation, for debriefing after resuscitation, and for system-wide quality improvement programs.[113]

6.1.1 2015 Evidence Review

In studies to date, the use of CPR feedback devices has not been shown to significantly improve performance of chest compression depth, chest compression fraction, and ventilation rate.[96,99,103,232-234] There is some evidence that the use of CPR feedback may be effective in modifying chest compression rates that are too fast.[99,233] Additionally, there is evidence that CPR feedback decreases the leaning force during chest compressions.[110] For the outcome of ROSC, there is conflicting evidence,[99,103,232,233,235-237] with the majority of studies showing no difference in the number of patients that achieved ROSC and only 2 studies showing an increase in ROSC with the use of CPR feedback.[96,103,234,237] However, studies to date have not demonstrated a significant improvement in favorable neurologic outcome[96,233,234,237] or survival to hospital discharge[96,99,232-234,237] related to the use of CPR feedback devices during actual cardiac arrest events.

6.1.2 2015 Recommendation - Updated

It may be reasonable to use audiovisual feedback devices during CPR for real-time optimization of CPR performance. (Class IIb, LOE B-R)

6.2 Team-Based Resuscitation - Updated

Resuscitation from cardiac arrest most often involves a team of caregivers, with team composition and level of experience varying depending on location (in-versus out-of-hospital), setting (field, emergency department, hospital ward), and circumstances. Despite the varied environments and team members, a designated team leader is needed to direct and coordinate all components of the resuscitation with a central focus on delivering high-quality CPR. The team leader choreographs team activities with an aim to minimize interruptions in CPR and, through the use of real-time feedback, ensures delivery of adequate compression rate and depth, minimization of leaning, and interruptions in chest compressions, and avoidance of excessive ventilation.[113] More information on team training is available in “Part 14: Education” and “Part 4: Systems of Care and Continuous Quality Improvement.”

6.3 Duration of Resuscitation - Updated

Investigators have published relatively few studies that examine the impact of resuscitation duration on clinical outcomes, and most of these studies have important limitations. In an older series of 313 IHCA patients, the percentage who survived to discharge was 45% when resuscitation lasted less than 5 minutes and less than 5% when the resuscitation extended beyond 20 minutes.[238] More recently, an analysis from a single-hospital registry in Taiwan suggested that the rate of achieving ROSC was higher than 90% among patients resuscitated for less than 10 minutes but approximately 50% for those resuscitated for 30 minutes or more.[239]

Two observational cohort studies of patients with in-hospital arrests from the Get With The Guidelines®-Resuscitation registry were recently published suggesting that extending the duration of resuscitation efforts may result in improved cardiac arrest survival. For adult patients, hospitals that systematically practiced longer durations of resuscitation had improved outcomes of ROSC and survival to discharge, with no apparent detriment in neurologic outcomes.[240] Another report of pediatric patients demonstrated an intact survival of 16.2% after more than 35 minutes of CPR in certain patient populations.[241] While investigators can define neither an optimal duration of resuscitation before the termination of efforts nor which patients may benefit from prolonged efforts at resuscitation, extending the duration of resuscitation may be a means of improving survival in selected hospitalized patients.

For information on ethical implications on termination of resuscitative efforts see Part 3: Ethical Issues.

6.4 CPR Registry Data - Updated

Ideally, RCTs will be used to advance the science and practice of resuscitation. However, conducting clinical trials in cardiac arrest patients is exceedingly challenging, given the small number of patients at single-center sites. Moreover, such research confers unique limitations and ethical concerns. Given these challenges, real-world observational data from registries can be a valuable resource for studying and reporting resuscitation processes and outcomes. Registries are available for both in-hospital and out-of-hospital arrests.[242]

Formerly known as the National Registry of Cardiopulmonary Resuscitation, the AHA's Get With The Guidelines-Resuscitation registry is the largest prospective, multicenter, observational registry of IHCA.[243,244] At present, more than 600 hospitals in the United States and Canada participate in the registry, and more than 200 000 index arrests have been recorded since 2000.

To date, the Get With The Guidelines-Resuscitation registry has provided important insights into several aspects of IHCA. Recent work has highlighted the survival gains by reducing time to defibrillation,[245] reducing racial differences and trends in IHCA incidence and survival,[246] and gathering evidence to support lengthier durations of CPR.[247]

The Resuscitation Outcomes Consortium (ROC) is a clinical research network designed to evaluate the effectiveness of prehospital emergency care for patients with OHCA or life-threatening injury.[248] Data collection began in 2007 and stems from 264 EMS agencies in 11 sites (8 in the United States and 3 in Canada), altogether representing 10% of the North American population. The ROC has afforded insights on several aspects of OHCA,[249-251] including regional variation in incidence and outcomes[8] and chest compression rates.[94]

The Cardiac Arrest Registry to Enhance Survival (CARES) is a central repository of OHCA events of presumed cardiac etiology treated with CPR and/or defibrillation throughout the United States.[4,252,253] CARES was designed as a quality improvement project, with the aims of providing performance indicators to EMS medical and administrative directors to improve processes and outcomes. As of 2011, it has collected data on more than 31 000 OHCAs from 46 EMS agencies in 36 communities in 20 states.[254] CARES has offered important insight into bystander CPR,[255] prehospital termination of resuscitation,[256] and variation in EMS systems of care.[257]

7 Family Presence During Resuscitation - Updated

Studies that explicitly examined the association between family presence and outcomes have shown mixed results. In an analysis of simulated resuscitations in an urban emergency department, investigators demonstrated that family presence may have a significant effect on physicians' ability to perform critical interventions as well as on resuscitation-based performance outcomes.[258] Specifically, the presence of a witness to resuscitation was associated with longer mean times to defibrillation (2.6 versus 1.7 minutes) and fewer shocks (4.0 versus 6.0).

A recent observational study using the Get With The Guidelines-Resuscitation registry demonstrated that implementing a hospital policy that allows family presence had no impact on survival or the processes of attempted resuscitations.[259] Overall, given the evidence for improved psychological benefits for families present during out-of-hospital resuscitation, and without an apparent negative effect on outcomes at hospitals that allow families to be present, family presence represents an important dimension in the paradigm of resuscitation quality.

8 Recovery Position

The recovery position is used for unresponsive adult victims who clearly have normal breathing and effective circulation. This position is designed to maintain a patent airway and reduce the risk of airway obstruction and aspiration. The victim is placed on his or her side with the lower arm in front of the body.

There are several variations of the recovery position, each with its own advantages. No single position is perfect for all victims.[260,261]

The position should be stable, near a true lateral position, with the head dependent and with no pressure on the chest to impair breathing. (Class IIa, LOE C)

Studies in normal volunteers[262] show that extending the lower arm above the head and rolling the head onto the arm, while bending both legs, may be feasible for victims with known or suspected spinal injury.[263]

9 Special Resuscitation Situations - Updated

9.1 Acute Coronary Syndrome - Updated

Acute coronary syndrome (ACS) is a term that subtends a spectrum of diseases leading to myocardial ischemia or infarction. The subtypes of ACS are principally stratified through a combination of electrocardiographic changes and/ or the elevations of cardiac biomarkers, in the context of symptoms consistent with ACS (eg, substernal chest pain or discomfort with or without characteristic radiation, shortness of breath, weakness, diaphoresis, nausea or vomiting, light-headedness). ACS may manifest as an ST-segment elevation myocardial infarction (STEMI) or non–ST-segment elevation myocardial infarction (NSTEMI)/unstable angina (UA), now called *non?ST-segment acute coronary syndromes* (NSTE-ACS). Both diagnoses are pathophysiologically linked to varying degrees of a reduction in coronary blood flow due to atherosclerotic plaque progression, instability, or rupture with or without luminal thrombosis and vasospasm.

Since 2010, the American College of Cardiology and the AHA have published targeted clinical practice guidelines pertaining to the management of patients with STEMI[264] and NSTE-ACS.[265] These guidelines should be referred to for full details on the specific management of ACS. In addition, other parts of the *2015 AHA Guidelines Update for CPR and ECC* include updates on basic and advanced life support for prehospital providers who care for these patients ("Part 9: Acute Coronary Syndromes," "Part 4: Systems of Care and Continuous Quality Improvement," and "Part 10: Special Circumstances of Resuscitation"; aspirin and chest pain are presented in "Part 15: First Aid").

The 2010 Guidelines are as follows:

In the United States coronary heart disease was responsible for 1 of every 6 hospital admissions in 2005 and 1 in every 6 deaths in 2006.[266] The American Heart Association estimates that in 2010, 785 000 Americans will have a new coronary attack and 470 000 will have a recurrent attack.[266] Approximately 70% of deaths from acute myocardial infarction (AMI) occur outside of the hospital, most within the first 4 hours after the onset of symptoms.[266,267]

Early recognition, diagnosis, and treatment of AMI can improve outcome by limiting damage to the heart,[268] but treatment is most effective if provided within a few hours of the onset of symptoms.[269] Patients at risk for acute coronary syndromes (ACS) and their families should be taught to recognize the symptoms of ACS and to immediately activate the EMS system when symptoms appear, rather than delaying care by contacting family, calling a physician, or driving themselves to the hospital.

The classic symptoms associated with ACS are chest discomfort, discomfort in other areas of the upper body, shortness of breath, sweating, nausea, and lightheadedness. The symptoms of AMI characteristically last more than 15 minutes. Atypical symptoms of ACS may be more common in the elderly, women, and diabetic patients, but any patient may present with atypical signs and symptoms.[270-272] Signs and symptoms cannot be used to confirm or exclude the diagnosis of ACS because reported sensitivity ranges from 35% to 92% and specificity ranges from 28% of 91%. Numerous studies do not support the use of any clinical signs and symptoms independent of electrocardiograph (ECG) tracings, cardiac biomarkers, or other diagnostic tests to rule in or rule out ACS in prehospital or emergency department (ED) settings.[273-286]

To improve ACS outcome, all dispatchers and EMS providers must be trained to recognize ACS symptoms, even if atypical.

It is reasonable for dispatchers to advise patients with potential cardiac symptoms to chew an aspirin (160 to 325 mg), providing the patient has no history of aspirin allergy and no signs of active or recent gastrointestinal bleeding.[287-291](Class IIa, LOE C)

EMS providers should obtain a 12-lead ECG, determine onset of ACS symptoms, and provide prearrival notification to the destination hospital.[287,292] Clinical trials have shown improved outcomes in ST-segment elevation myocardial infarction (STEMI) patients transported by EMS directly to a percutaneous coronary intervention (PCI)–capable hospital.[293-295]

If the patient has a STEMI on ECG and if PCI is the chosen method of reperfusion, it is reasonable to transport the patient directly to a PCI facility, bypassing closer emergency departments as necessary, in systems where time intervals between first medical contact and balloon times are less than 90 minutes, and transport times are relatively short (ie, less than 30 minutes), or based on regional EMS protocols. (Class IIa, LOE B)

Common practice has been for basic EMT's to administer oxygen during the initial assessment of patients with suspected ACS. However, there is insufficient evidence to 'support or refute oxygen use in uncomplicated ACS.

If the patient is dyspneic, hypoxemic, has obvious signs of heart failure, or an oxyhemoglobin saturation <94%, providers should administer oxygen and titrate therapy to provide the lowest administered oxygen concentration that will maintain the oxyhemoglobin saturation ?94%.[296](Class I, LOE C)

If the patient has not taken aspirin and has no history of aspirin allergy and no evidence of recent gastrointestinal bleeding, EMS providers should give the patient nonenteric aspirin (160 to 325 mg) to chew.[287,292,297,298](Class I, LOE C)

EMS providers can administer nitroglycerin for patients with chest discomfort and suspected ACS.

Although it is reasonable to consider the early administration of nitroglycerin in select hemodynamically stable patients, insufficient evidence exists to support or refute the routine administration of nitroglycerin in the ED or prehospital setting in patients with a suspected ACS.[299-301](Class IIb, LOE B)

Nitrates in all forms are contraindicated in patients with initial systolic blood pressure <90 mm Hg or ?30 mm Hg below baseline and in patients with right ventricular infarction (see Part 10). Caution is advised in patients with known inferior wall STEMI, and a right-sided ECG should be performed to evaluate right ventricular infarction. Administer nitrates with extreme caution, if at all, to patients with inferior STEMI and suspected RV involvement because these patients require adequate RV preload. Nitrates are contraindicated when patients have taken a phosphodiesterase-5 (PDE-5) inhibitor within 24 hours (48 hours for tadalafil).

For patients diagnosed with STEMI in the prehospital setting, EMS providers should administer appropriate analgesics, such as intravenous morphine, for persistent chest pain. (Class IIa, LOE C)

EMS providers may consider administering intravenous morphine for undifferentiated chest pain unresponsive to nitroglycerin. (Class IIb, LOE C)

However, morphine should be used with caution in unstable angina (UA)/NSTEMI due to an association with increased mortality in a large registry.

9.2 Stroke - Updated

Approximately 800 000 people have a stroke each year in the United States, and stroke is a leading cause of severe, long-term disability and death.[5] Fibrinolytic therapy administered within the first hours of the onset of symptoms limits neurologic injury and improves outcome in selected patients with acute ischemic stroke. Effective therapy requires early detection of the signs of stroke; prompt activation of the EMS system and dispatch of EMS personnel; appropriate triage to a stroke center; prearrival notification; rapid triage, evaluation, and management in the emergency department; and prompt delivery of fibrinolytic therapy to eligible patients. Since 2010, the AHA and the American Stroke Association have published clinical practice guidelines pertaining to the early management of patients with acute ischemic stroke.[302,303]

The 2010 CPR & ECC Guidelines are included below, but please view **Guidelines for the Early Management of Patients With Acute Ischemic Stroke** on Circulation to see the most current recommendations.

Patients at high risk for stroke, their family members, and BLS providers should learn to recognize the signs and symptoms of stroke and to call EMS as soon as any signs of stroke are present. (Class I, LOE C)

The signs and symptoms of stroke are sudden numbness or weakness of the face, arm, or leg, especially on one side of the body; sudden confusion, trouble speaking or understanding; sudden trouble seeing in one or both eyes; sudden trouble walking, dizziness, loss of balance or coordination; and sudden severe headache with no known cause.[304,305] Community and professional education is essential to improve stroke recognition and early EMS activation.[306-308]

EMS dispatchers should be trained to suspect stroke and rapidly dispatch emergency responders. EMS personnel should be able to perform an out-of-hospital stroke assessment*, establish the time of symptom onset when possible, provide cardiopulmonary support, and notify the receiving hospital that a patient with possible stroke is being transported.[309-311,312-314] (*Class I, LOE B)

EMS systems should have protocols that address triaging the patient when possible directly to a stroke center.[313,315,316] (Class I, LOE B)

It may be important for a family member to accompany the patient during transport to verify the time of symptom onset and provide consent for interventional therapy.

Patients with acute stroke are at risk for respiratory compromise, and the combination of poor perfusion and hypoxemia will exacerbate and extend ischemic brain injury leading to worse outcomes.[317]

Both out-of-hospital and in-hospital medical personnel should administer supplementary oxygen to hypoxemic (ie, oxygen saturation <94%) stroke patients (Class 1, LOE C) or those with unknown oxygen saturation.

There are no data to support initiation of hypertension intervention in the prehospital environment.

Unless the patient is hypotensive (systolic blood pressure <90 mm Hg), prehospital intervention for blood pressure is not recommended. (Class III, LOE C)

9.3 Drowning - Updated

Drowning is a leading cause of unintentional injury and death worldwide and a preventable cause of death for more than 4000 Americans annually.[318,319] The highest rates of morbidity and mortality are among children aged 1 to 4 years.[319] The incidence of fatal drowning has declined from 1.45 deaths per 100 000 population in 2000 to 1.26 in 2013.[319] Immediate resuscitation to restore oxygenation and ventilation—especially by bystanders—is essential for survival after a drowning incident.

This topic was last reviewed in 2010, and the treatment recommendations have not changed.

Since the 2010 Guidelines, there has been a growing appreciation for the fact that the response to the submersion victim often involves a multiagency approach with several different organizations responsible for different phases of the victim's care, from the initial aquatic rescue, on-scene resuscitation, transport to hospital, and in-hospital care. Attempting the rescue of a submerged victim has substantial resource implications and may place rescuers at risk themselves.

The 2010 Guidelines are as follows:

Rescuers should provide CPR, particularly rescue breathing, as soon as an unresponsive submersion victim is removed from the water. (Class I, LOE C)

When rescuing a drowning victim of any age, it is reasonable for the lone healthcare provider to give 5 cycles (about 2 minutes) of CPR before leaving the victim to activate the EMS system.

Mouth-to-mouth ventilation in the water may be helpful when administered by a trained rescuer.[320] (Class IIb, LOE C)

Chest compressions are difficult to perform in water; they may not be effective and they could potentially cause harm to both the rescuer and the victim. There is no evidence that water acts as an obstructive foreign body. Maneuvers to relieve foreign-body airway obstruction (FBAO) are not recommended for drowning victims because such maneuvers are not necessary and they can cause injury, vomiting, aspiration, and delay of CPR.[321]

Rescuers should remove drowning victims from the water by the fastest means available and should begin resuscitation as quickly as possible. Spinal cord injury is rare among fatal drowning victims.[322] Victims with obvious clinical signs of injury, alcohol intoxication, or a history of diving into shallow water are at a higher risk of spinal cord injury, and health care providers may consider stabilization and possible immobilization of the cervical and thoracic spine for these victims.[323]

9.4 Unintentional Hypothermia - Updated

This topic was last reviewed in 2010, and the treatment recommendations have not changed.

9.5 Foreign-Body Airway Obstruction (Choking)

This topic was last reviewed in 2010, and the treatment recommendations are as follows.

FBAO is an uncommon, but preventable, cause of death.[324] Most reported cases of FBAO occur in adults while they are eating.[325] Most reported episodes of choking in infants and children occur during eating or play when parents or childcare providers are present. The choking event is therefore commonly witnessed, and the rescuer usually intervenes while the victim is still responsive. Treatment is usually successful, and survival rates can exceed 95%.[326]

9.5.1 Recognition of Foreign-Body Airway Obstruction

Because recognition of FBAO is the key to successful outcome, it is important to distinguish this emergency from fainting, heart attack, seizure, or other conditions that may cause sudden respiratory distress, cyanosis, or loss of consciousness.

Foreign bodies may cause either mild or severe airway obstruction. The rescuer should intervene if the choking victim shows signs of severe airway obstruction. These include signs of poor air exchange and increased breathing difficulty, such as a silent cough, cyanosis, or inability to speak or breathe. The victim may clutch the neck, demonstrating the universal choking sign. Quickly ask, “Are you choking?” If the victim indicates “yes” by nodding his head without speaking, this will verify that the victim has severe airway obstruction.

9.5.2 Relief of Foreign-Body Airway Obstruction

When FBAO produces signs of severe airway obstruction, rescuers must act quickly to relieve the obstruction. If mild obstruction is present and the victim is coughing forcefully, do not interfere with the patient’s spontaneous coughing and breathing efforts. Attempt to relieve the obstruction only if signs of severe obstruction develop: the cough becomes silent, respiratory difficulty increases and is accompanied by stridor, or the victim becomes unresponsive. Activate the EMS system quickly if the patient is having difficulty breathing. If more than one rescuer is present, one rescuer should phone 911 while the other rescuer attends to the choking victim.

The clinical data about effectiveness of maneuvers to relieve FBAO are largely retrospective and anecdotal. For responsive adults and children >1 year of age with severe FBAO, case reports show the feasibility and effectiveness of back blows or “slaps,”[327-329] abdominal thrusts,[326-328,330,331] and chest thrusts.[327,332] In 1 case series of 513 choking episodes for which EMS was summoned,[326] approximately 50% of the episodes of airway obstruction were relieved prior to arrival of EMS. EMS intervention with abdominal thrusts successfully relieved the obstruction in more than 85% of the remaining cases. The few patients with persistent obstruction usually responded to suction or the use of Magill forceps. Less than 4% died.[326]

Although chest thrusts, back slaps, and abdominal thrusts are feasible and effective for relieving severe FBAO in conscious (responsive) adults and children ?1 year of age, for simplicity in training it is recommended that abdominal thrusts be applied in rapid sequence until the obstruction is relieved. (Class IIb, LOE B)

If abdominal thrusts are not effective, the rescuer may consider chest thrusts. (Class IIb, LOE B)

It is important to note that abdominal thrusts are not recommended for infants <1 year of age because thrusts may cause injuries.

Chest thrusts should be used for obese patients if the rescuer is unable to encircle the victim’s abdomen. If the choking victim is in the late stages of pregnancy, the rescuer should use chest thrusts instead of abdominal thrusts.

If the adult victim with FBAO becomes unresponsive, the rescuer should carefully support the patient to the ground, immediately activate (or send someone to activate) EMS, and then begin CPR. The healthcare provider should carefully lower the victim to the ground, send someone to activate the emergency response system and begin CPR (without a pulse check). After 2 minutes, if someone has not already done so, the healthcare provider should activate the emergency response system. A randomized trial of maneuvers to open the airway in cadavers [333] and 2 prospective studies in anesthetized volunteers[332,334] showed that higher sustained airway pressures can be generated using the chest thrust rather than the abdominal thrust. Each time the airway is opened during CPR, the rescuer should look for an object in the victim’s mouth and if found, remove it. Simply looking into the mouth should not significantly increase the time needed to attempt the ventilations and proceed to the 30 chest compressions.

No studies have evaluated the routine use of the finger sweep to clear an airway in the absence of visible airway obstruction. The recommendation to use the finger sweep in past guidelines was based on anecdotal reports that suggested that it was helpful for relieving an airway obstruction.[327,328,335] However, case reports have also documented harm to the victim[294,336,337] or rescuer.

10 Authorship and Disclosures - Updated

10.1 2015 Writing Team

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Table 4: Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality: 2015 Guidelines Update Writing Group Disclosures

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Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality: 2015 Guidelines Update Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honora	Expert Witness	Ownership Interest	Consultant/Advis Board	Other
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Erin E. Brennan	Queen's University	None	None	None	None	None	None	None

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Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honora	Expert Witness	Ownership Interest	Consultant/Advis Board	Other
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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.

10.2 2010 Writing Team

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Table 5: 2010 - Guidelines Part 5: Adult Basic Life Support: Writing Group Disclosures

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2010 Guidelines Part 5: Adult Basic Life Support: Writing Group Disclosures

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Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
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Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honorari	Ownership Interest	Consultant/Adviso Board	Other
Tom P. Aufderheide	Medical College of Wisconsin–Pro of Emergency Medicine	†NIH-ROC Consortium-PI of Milwaukee site NETT-PI of Milwaukee site * ResQTrial (Advanced Circulatory Systems, Inc.)-PI of Oshkosh study site, In Kind NHLBI Trial-PI for Milwaukee site, In Kind Medtronics-Consultant JoLife-Consultant Take Heart America-Board Member	*Zoll Medical Corp.-Supplied AEDs and software capturing CPR performance data for ROC Consortium Advanced Circulatory Systems, Inc.-Supplied impedance threshold devices for ROC Consortium	*EMS Today-Compensated speaker, $2,000	None	*Take Heart *America-Board Member * Medtronic-Consultant * JoLife-Consultant	None

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honorari	Ownership Interest	Consultant/Adviso Board	Other
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Mary Fran Hazinski	Vanderbilt University School of Nursing—Profe AHA ECC Product Development–Science Editor † Significant compensation from the AHA to write and edit the AHA Guidelines and resuscitation statements and training materials	None	None	None	None	None	None

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
E. Brooke Lerner	Medical College of Wisconsin–Associate Professor	None	†Title: Circulation Improving Resuscitation Care Trial Source: Zoll Medical Corporation Role: Consultant Principal Investigator: Lars Wik, M.D. Dates: 12/2006–8/2010 Total Funding to MCW: $345 000 (funding is received by my employer to support my time on this trial. My institution receives support for 20% of my time and the remaining funds are used for other members of our staff and supplies. My role is to advise them on human subject protection issues and to assist with data management and report generation for the trial)	None	* Stockholder in Medtronic, Pfizer, and General Electric	None	None

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honorari	Ownership Interest	Consultant/Adviso Board	Other
Thomas D. Rea	University of Washington: Physician–Ass Professor of Medicine; Emergency Medical Services Division of Public Health-Seattle & King County–Progra Medical Director	*In the past, I have received unrestricted (modest) grant support from Philips Inc and PhysioControl. The topics were related to improving resuscitation generally (changing resuscitation protocols) and not specific to proprietary information or equipment. I am currently an investigator in the ROC. As part of this, I am directly involved in the Feedback Trial to evaluate dynamic fdbk available on the Philips MRX. The ROC is also evaluating the impedance threshold device. These studies are supported by the NIH primarily and I receive no support from Philips or the company that makes the impedance	*We conducted an AED training study that recently completed where Philips and PhysioControl contributed equipment for the research. I did not receive any of this equipment	None	None	None	*I serve on a DSMB for a trial sponsored by Philips to evaluate quantitative VF waveform algorhithm to guide care. I receive no support for this effort in order to minimize (eliminate) any conflict

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honorari	Ownership Interest	Consultant/Advisc Board	Other
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- 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.

11 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 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality. ECCguidelines.heart.org.

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