HIGHLIGHTS

American Heart Association®

GUIDELINES CPR ECC 2010

Highlights of the 2010 American Heart Association Guidelines for CPR and ECC

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This "Guidelines Highlights" publication summarizes the key issues and changes in the 2010 American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC). It has been developed for resuscitation providers and for AHA instructors to focus on resuscitation science and guidelines recommendations that are most important or controversial or will result in changes in resuscitation practice or resuscitation training. In addition, it provides the rationale for the recommendations.

Because this publication is designed as a summary, it does not reference the supporting published studies and does not list Classes of Recommendations or Levels of Evidence. For more detailed information and references, the reader is encouraged to read the 2010 AHA Guidelines for CPR and ECC, including the Executive Summary,[1] published online in *Circulation* in October 2010 and to consult the detailed summary of resuscitation science in the 2010 International Consensus on CPR and ECC Science With Treatment Recommendations, published simultaneously in *Circulation*[2] and *Resuscitation*.[3]

This year marks the 50th anniversary of the first peer-reviewed medical publication documenting survival after closed chest compression for cardiac arrest,[4] and resuscitation experts and providers remain dedicated to reducing death and disability from cardiovascular diseases and stroke. Bystanders, first responders, and healthcare providers all play key roles in providing CPR for victims of cardiac arrest. In addition, advanced providers can provide excellent periarrest and postarrest care.

The 2010 AHA Guidelines for CPR and ECC are based on an international evidence evaluation process that involved hundreds of international resuscitation scientists and experts who evaluated, discussed, and debated thousands of peer-reviewed publications. Information about the 2010 evidence evaluation process is contained in Box 1.

MAJOR ISSUES AFFECTING ALL RESCUERS

This section summarizes major issues in the 2010 AHA Guidelines for CPR and ECC, primarily those in basic life support (BLS) that affect all rescuers, whether healthcare providers or lay rescuers. The 2005 AHA Guidelines for CPR and ECC emphasized the importance of high-quality chest compressions (compressing at an adequate rate and depth, allowing complete chest recoil after each compression, and minimizing interruptions in chest compressions). Studies published before and since 2005 have demonstrated that (1) the quality of chest compressions continues to require improvement, although implementation of the 2005 AHA Guidelines for CPR and ECC has been associated with better CPR quality and greater survival; (2) there is considerable variation in survival from out-of-hospital cardiac arrest across emergency medical services (EMS) systems; and (3) most victims of out-of-hospital sudden cardiac arrest do not receive any bystander CPR. The changes recommended in the 2010 AHA Guidelines for CPR and ECC attempt to address these issues and also make recommendations to improve outcome from cardiac arrest through a new emphasis on post–cardiac arrest care.

Continued Emphasis on High-Quality CPR

The 2010 AHA Guidelines for CPR and ECC once again emphasize the need for high-quality CPR, including

- A compression rate of at least 100/min (a change from "approximately" 100/min)
- A compression depth of at least 2 inches (5 cm) in adults and a compression depth of at least one third of the anterior-posterior diameter of the chest in infants and children (approximately 1.5 inches [4 cm] in infants and 2 inches [5 cm] in children). Note that the range of 1½ to 2 inches is no longer used for adults, and the absolute depth specified for children and infants is deeper than in previous versions of the AHA Guidelines for CPR and ECC.

BOX 1

Evidence Evaluation Process

The 2010 AHA Guidelines for CPR and ECC are based on an extensive review of resuscitation literature and many debates and discussions by international resuscitation experts and members of the AHA ECC Committee and Subcommittees. The ILCOR 2010 International Consensus on CPR and ECC Science With Treatment Recommendations, simultaneously published in *Circulation*[2] and *Resuscitation*,[3] summarizes the international consensus interpreting tens of thousands of peer-reviewed resuscitation studies. This 2010 international evidence evaluation process involved 356 resuscitation experts from 29 countries who analyzed, discussed, and debated the resuscitation research during in-person meetings, conference calls, and online sessions ("webinars") over a 36-month period, including the 2010 International Consensus Conference on CPR and ECC Science With Treatment Recommendations, held in Dallas, Texas, in early 2010. Worksheet experts produced 411 scientific evidence reviews of 277 topics in resuscitation and ECC. The process included structured evidence evaluation, analysis, and cataloging of the literature. It also included rigorous disclosure and management of potential conflicts of interest. The 2010 AHA Guidelines for CPR and ECC[1] contain the expert recommendations for application of the International Consensus on CPR and ECC Science With Treatment Recommendations with consideration of their effectiveness, ease of teaching and application, and local systems factors.

- Allowing for complete chest recoil after each compression
- Minimizing interruptions in chest compressions
- Avoiding excessive ventilation

There has been no change in the recommendation for a compression-to-ventilation ratio of 30:2 for single rescuers of adults, children, and infants (excluding newly born infants). The 2010 AHA Guidelines for CPR and ECC continue to recommend that rescue breaths be given in approximately 1 second. Once an advanced airway is in place, chest compressions can be continuous (at a rate of at least 100/min) and no longer cycled with ventilations. Rescue breaths can then be provided at about 1 breath every 6 to 8 seconds (about 8 to 10 breaths per minute). Excessive ventilation should be avoided.

A Change From A-B-C to C-A-B

The 2010 AHA Guidelines for CPR and ECC recommend a change in the BLS sequence of steps from A-B-C (Airway, Breathing, Chest compressions) to C-A-B (Chest compressions, Airway, Breathing) for adults, children, and infants (excluding the newly born; see Neonatal Resuscitation section). This fundamental change in CPR sequence will require reeducation of everyone who has ever learned CPR, but the consensus of the authors and experts involved in the creation of the 2010 AHA Guidelines for CPR and ECC is that the benefit will justify the effort.

Why: The vast majority of cardiac arrests occur in adults, and the highest survival rates from cardiac arrest are reported among patients of all ages who have a witnessed arrest and an initial rhythm of ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT). In these patients, the critical initial elements of BLS are chest compressions and early defibrillation. In the A-B-C sequence, chest compressions are often delayed while the responder opens the airway to give mouth-to-mouth breaths, retrieves a barrier device, or gathers and assembles ventilation equipment. By changing the sequence to C-A-B, chest compressions will be initiated sooner and the delay in ventilation should be minimal (ie, only the time required to deliver the first cycle of 30 chest compressions, or approximately 18 seconds; when 2 rescuers are present for resuscitation of the infant or child, the delay will be even shorter).

Most victims of out-of-hospital cardiac arrest do not receive any bystander CPR. There are probably many reasons for this, but one impediment may be the A-B-C sequence, which starts with the procedures that rescuers find most difficult, namely, opening the airway and delivering breaths. Starting with chest compressions might encourage more rescuers to begin CPR.

Basic life support is usually described as a sequence of actions, and this continues to be true for the lone rescuer. Most healthcare providers, however, work in teams, and team members typically perform BLS actions simultaneously. For example, one rescuer immediately initiates chest compressions while another rescuer gets an automated external defibrillator (AED) and calls for help, and a third rescuer opens the airway and provides ventilations.

Healthcare providers are again encouraged to tailor rescue actions to the most likely cause of arrest. For example, if a lone healthcare provider witnesses a victim suddenly collapse, the provider may assume that the victim has had a primary cardiac arrest with a shockable rhythm and should immediately activate the emergency response system, retrieve an AED, and return to the victim to provide CPR and use the AED. But for a presumed victim of asphyxial arrest such as drowning, the priority would be to provide chest compressions with rescue breathing for about 5 cycles (approximately 2 minutes) before activating the emergency response system.

Two new parts in the 2010 AHA Guidelines for CPR and ECC are Post–Cardiac Arrest Care and Education, Implementation, and Teams. The importance of post–cardiac arrest care is emphasized by the addition of a new fifth link in the AHA ECC Adult Chain of Survival (Figure 1). See the sections Post–Cardiac Arrest Care and Education, Implementation, and Teams in this publication for a summary of key recommendations contained in these new parts.

Figure 1
AHA ECC Adult Chain of Survival

The links in the new AHA ECC Adult Chain of Survival are as follows:

1. Immediate **recognition** of cardiac arrest and **activation** of the emergency response system
2. Early **CPR** with an emphasis on chest compressions
3. Rapid **defibrillation**
4. Effective **advanced life support**
5. Integrated **post–cardiac arrest care**

LAY RESCUER ADULT CPR

Summary of Key Issues and Major Changes

Key issues and major changes for the 2010 AHA Guidelines for CPR and ECC recommendations for lay rescuer adult CPR are the following:

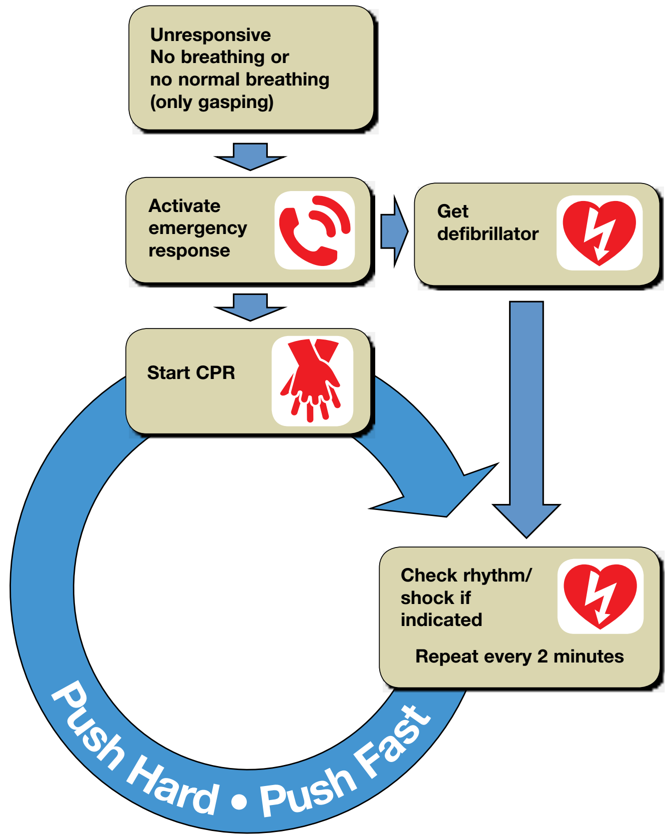
- The simplified universal adult BLS algorithm has been created (Figure 2).
- Refinements have been made to recommendations for immediate recognition and activation of the emergency response system based on signs of unresponsiveness, as well as initiation of CPR if the victim is unresponsive with no breathing or no normal breathing (ie, victim is only gasping).
- “Look, listen, and feel for breathing” has been removed from the algorithm.
- Continued emphasis has been placed on high-quality CPR (with chest compressions of adequate rate and depth, allowing complete chest recoil after each compression, minimizing interruptions in compressions, and avoiding excessive ventilation).
- There has been a change in the recommended sequence for the lone rescuer to initiate chest compressions before giving rescue breaths (C-A-B rather than A-B-C). The lone rescuer should begin CPR with 30 compressions rather than 2 ventilations to reduce delay to first compression.
- Compression rate should be at least 100/min (rather than “approximately” 100/min).
- Compression depth for adults has been changed from the range of 1½ to 2 inches to at least 2 inches (5 cm).

These changes are designed to simplify lay rescuer training and to continue to emphasize the need to provide early chest compressions for the victim of a sudden cardiac arrest. More information about these changes appears below. *Note:* In the following topics, changes or points of emphasis for lay rescuers that are similar to those for healthcare providers are noted with an asterisk (*).

Emphasis on Chest Compressions*

2010 (New): If a bystander is not trained in CPR, the bystander should provide Hands-Only™ (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 Hands-Only CPR until an AED arrives and is ready for use or EMS providers or other responders take over care of the victim.

Figure 2
Simplified Adult BLS Algorithm



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.

2005 (Old): The 2005 AHA Guidelines for CPR and ECC did not provide different recommendations for trained versus untrained rescuers but did recommend that dispatchers provide compression-only CPR instructions to untrained bystanders. The 2005 AHA Guidelines for CPR and ECC did note that if the rescuer was unwilling or unable to provide ventilations, the rescuer should provide chest compressions only.

Why: Hands-Only (compression-only) CPR is easier for an untrained rescuer to perform and can be more readily guided by dispatchers over the telephone. In addition, survival rates from cardiac arrests of cardiac etiology are similar with either Hands-Only CPR or CPR with both compressions and rescue breaths. However, for the trained lay rescuer who is able, the recommendation remains for the rescuer to perform both compressions and ventilations.

*Change in CPR Sequence: C-A-B Rather Than A-B-C**

2010 (New): Initiate chest compressions before ventilations.

2005 (Old): The sequence of adult CPR began with opening of the airway, checking for normal breathing, and then delivery of 2 rescue breaths followed by cycles of 30 chest compressions and 2 breaths.

Why: Although no published human or animal evidence demonstrates that starting CPR with 30 compressions rather than 2 ventilations leads to improved outcome, chest compressions provide vital blood flow to the heart and brain, and studies of out-of-hospital adult cardiac arrest showed that survival was higher when bystanders made some attempt rather than no attempt to provide CPR. Animal data demonstrated that delays or interruptions in chest compressions reduced survival, so such delays or interruptions should be minimized throughout the entire resuscitation. Chest compressions can be started almost immediately, whereas positioning the head and achieving a seal for mouth-to-mouth or bag-mask rescue breathing all take time. The delay in initiation of compressions can be reduced if 2 rescuers are present: the first rescuer begins chest compressions, and the second rescuer opens the airway and is prepared to deliver breaths as soon as the first rescuer has completed the first set of 30 chest compressions. Whether 1 or more rescuers are present, initiation of CPR with chest compressions ensures that the victim receives this critical intervention early, and any delay in rescue breaths should be brief.

BOX 2

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* 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 compressions delivered, whereas decreases in compression rate or compression fraction decrease the total compressions delivered. Compression fraction is improved if you reduce the number and length of any interruptions in compressions, and it is reduced by frequent or long interruptions in chest compressions. An analogy can be found in automobile travel. When you travel in an automobile, the number of miles you travel in a day is affected not only by the speed that you drive (your rate of travel) but also by the number and duration of any stops you make (interruptions in travel). During CPR, you want to deliver effective compressions at an appropriate rate (at least 100/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.

*Elimination of "Look, Listen, and Feel for Breathing"**

2010 (New): "Look, listen, and feel" was removed from the CPR sequence. After delivery of 30 compressions, the lone rescuer opens the victim's airway and delivers 2 breaths.

2005 (Old): "Look, listen, and feel" was used to assess breathing after the airway was opened.

Why: With the new "chest compressions first" sequence, CPR is performed if the adult is unresponsive and not breathing or not breathing normally (as noted above, lay rescuers will be taught to provide CPR if the unresponsive victim is "not breathing or only gasping"). The CPR sequence begins with compressions (C-A-B sequence). Therefore, breathing is briefly checked as part of a check for cardiac arrest; after the first set of chest compressions, the airway is opened, and the rescuer delivers 2 breaths.

*Chest Compression Rate: At Least 100 per Minute**

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

2005 (Old): Compress at a rate of about 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, or 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. For further information, see Box 2.

*Chest Compression Depth**

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

2005 (Old): The adult sternum should be depressed approximately 1½ to 2 inches (approximately 4 to 5 cm).

Why: Compressions create blood flow primarily by increasing intrathoracic pressure and directly compressing the heart. Compressions generate critical blood flow and oxygen and energy delivery to the heart and brain. Confusion may result when a range of depth is recommended, so 1 compression depth is now recommended. Rescuers often do not compress the chest enough despite recommendations to "push hard." In addition, the available science suggests that compressions of at least 2 inches are more effective than compressions of 1½ inches. For this reason the 2010 AHA Guidelines for CPR and ECC recommend a single minimum depth for compression of the adult chest.

HEALTHCARE PROVIDER BLS

Summary of Key Issues and Major Changes

Key issues and major changes in the 2010 AHA Guidelines for CPR and ECC recommendations for healthcare providers include the following:

- Because cardiac arrest victims may present with a short period of seizure-like activity or agonal gasps that may confuse potential rescuers, dispatchers should be specifically trained to identify these presentations of cardiac arrest to improve cardiac arrest recognition.
- Dispatchers should instruct untrained lay rescuers to provide Hands-Only CPR for adults with sudden cardiac arrest.
- Refinements have been made to recommendations for immediate recognition and activation of the emergency response system once the healthcare provider identifies the adult victim who is unresponsive with no breathing or no normal breathing (ie, only gasping). The healthcare provider briefly checks for no breathing or no normal breathing (ie, no breathing or only gasping) when the provider checks responsiveness. The provider then activates the emergency response system and retrieves the AED (or sends someone to do so). The healthcare provider should not spend more than 10 seconds checking for a pulse, and if a pulse is not definitely felt within 10 seconds, should begin CPR and use the AED when available.
- "Look, listen, and feel for breathing" has been removed from the algorithm.
- Increased emphasis has been placed on high-quality CPR (compressions of adequate rate and depth, allowing complete chest recoil between compressions, minimizing interruptions in compressions, and avoiding excessive ventilation).
- Use of cricoid pressure during ventilations is generally not recommended.
- Rescuers should initiate chest compressions before giving rescue breaths (C-A-B rather than A-B-C). Beginning CPR with 30 compressions rather than 2 ventilations leads to a shorter delay to first compression.
- Compression rate is modified to at least 100/min from approximately 100/min.
- Compression depth for adults has been slightly altered to at least 2 inches (about 5 cm) from the previous recommended range of about 1½ to 2 inches (4 to 5 cm).
- Continued emphasis has been placed on the need to reduce the time between the last compression and shock delivery and the time between shock delivery and resumption of compressions immediately after shock delivery.
- There is an increased focus on using a team approach during CPR.

These changes are designed to simplify training for the healthcare provider 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. *Note:* In the following topics for healthcare providers, those that are similar for healthcare providers and lay rescuers are noted with an asterisk (*).

Dispatcher Identification of Agonal Gasps

Cardiac arrest victims may present with seizure-like activity or agonal gasps that may confuse potential rescuers. Dispatchers should be specifically trained to identify these presentations of cardiac arrest to improve recognition of cardiac arrest and prompt provision of CPR.

2010 (New): 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. The lay rescuer should be taught to begin CPR if the victim is "not breathing or only gasping." The healthcare provider should be taught to begin CPR if the victim has "no breathing or no normal breathing (ie, only gasping)." Therefore, breathing is briefly checked as part of a check for cardiac arrest before the healthcare provider activates the emergency response system and retrieves the AED (or sends someone to do so), and then (quickly) checks for a pulse and begins CPR and uses the AED.

2005 (Old): Dispatcher CPR instructions should include questions to help bystanders identify patients with occasional gasps as likely victims of cardiac arrest to increase the likelihood of bystander CPR for such victims.

Why: There is evidence of considerable regional variation in the reported incidence and outcome of cardiac arrest in the United States. This variation is further evidence of the need for communities and systems to accurately identify each instance of treated cardiac arrest and measure outcomes. It also suggests additional opportunities for improving survival rates in many communities. Previous guidelines have recommended the development of programs to aid in recognition of cardiac arrest. The 2010 AHA Guidelines for CPR and ECC are more specific about the necessary components of resuscitation systems. Studies published since 2005 have demonstrated improved outcome from out-of-hospital cardiac arrest, particularly from shockable rhythms, and have reaffirmed the importance of a stronger emphasis on immediate provision of high-quality CPR (compressions of adequate rate and depth, allowing complete chest recoil after each compression, minimizing interruptions in chest compressions, and avoiding excessive ventilation).

To help bystanders immediately recognize cardiac arrest, dispatchers should specifically inquire about an adult victim's absence of response, if the victim is breathing, and if any breathing observed is normal. Dispatchers should be specifically educated in helping bystanders detect agonal gasps to improve cardiac arrest recognition.

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 responsive and breathing normally to identify patients with possible cardiac arrest. Dispatchers should provide Hands-Only (compression-only) CPR instructions to help untrained bystanders initiate CPR when cardiac arrest is suspected (see below).

Dispatcher Should Provide CPR Instructions

2010 (New): The 2010 AHA Guidelines for CPR and ECC more strongly recommend that dispatchers should instruct untrained lay rescuers to provide Hands-Only CPR for adults who are unresponsive with no breathing or no normal breathing. Dispatchers should provide instructions in conventional CPR for victims of likely asphyxial arrest.

2005 (Old): The 2005 AHA Guidelines for CPR and ECC noted that telephone instruction in chest compressions alone may be preferable.

Why: Unfortunately, most adults with out-of-hospital cardiac arrest do not receive any bystander CPR. Hands-Only (compression-only) bystander CPR substantially improves survival after adult out-of-hospital cardiac arrests compared with no bystander CPR. Other studies of adults with cardiac arrest treated by lay rescuers showed similar survival rates among victims receiving Hands-Only CPR versus those receiving conventional CPR (ie, with rescue breaths). Importantly, it is easier for dispatchers to instruct untrained rescuers to perform Hands-Only CPR than conventional CPR for adult victims, so the recommendation is now stronger for them to do so, unless the victim is likely to have had an asphyxial arrest (eg, drowning).

Cricoid Pressure

2010 (New): The routine use of cricoid pressure in cardiac arrest is not recommended.

2005 (Old): Cricoid pressure should be used only if the victim is deeply unconscious, and it usually requires a third rescuer not involved in rescue breaths or compressions.

Why: 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 studies showed that cricoid pressure can delay or prevent the placement of an advanced airway and that some aspiration can still occur despite application of cricoid pressure. In addition, it is difficult to appropriately train rescuers in use of the maneuver. Therefore, the routine use of cricoid pressure in cardiac arrest is not recommended.

*Emphasis on Chest Compressions**

2010 (New): Chest compressions are emphasized for both trained and untrained rescuers. If a bystander is not trained in CPR, the bystander should provide Hands-Only (compression-only) CPR for the adult who suddenly collapses, with an emphasis to "push hard and fast" on the center of the chest, or follow the directions of the emergency medical dispatcher. The rescuer should continue Hands-Only CPR until an AED arrives and is ready for use or EMS providers take over care of the victim.

Optimally all healthcare providers should be trained in BLS. In this trained population, it is reasonable for both EMS and in-hospital professional rescuers to provide chest compressions and rescue breaths for cardiac arrest victims.

2005 (Old): The 2005 AHA Guidelines for CPR and ECC did not provide different recommendations for trained and untrained rescuers and did not emphasize differences in instructions provided to lay rescuers versus healthcare providers, but did recommend that dispatchers provide compression-only CPR instructions to untrained bystanders. In addition, the 2005 AHA Guidelines for CPR and ECC noted that if the rescuer was unwilling or unable to provide ventilations, the rescuer should provide chest compressions. Note that the AHA Hands-Only CPR statement was published in 2008.

Why: Hands-Only (compression-only) CPR is easier for untrained rescuers to perform and can be more readily guided by dispatchers over the telephone. However, because the healthcare provider should be trained, the recommendation remains for the healthcare provider to perform both compressions and ventilations. If the healthcare provider is unable to perform ventilations, the provider should activate the emergency response system and provide chest compressions.

Activation of Emergency Response System

2010 (New): The healthcare provider should check for response while looking at the patient to determine if breathing is absent or not normal. The provider should suspect cardiac arrest if the victim is not breathing or only gasping.

2005 (Old): The healthcare provider activated the emergency response system after finding an unresponsive victim. The provider then returned to the victim and opened the airway and checked for breathing or abnormal breathing.

Why: The healthcare provider should not delay activation of the emergency response system but should obtain 2 pieces of information simultaneously: the provider should check the victim for response and check for no breathing or no normal breathing. If the victim is unresponsive and is not breathing at all or has no normal breathing (ie, only agonal gasps), the provider should activate the emergency response system and retrieve the AED if available (or send someone to do so). If the healthcare provider does not feel a pulse within 10 seconds, the provider should begin CPR and use the AED when it is available.

*Change in CPR Sequence: C-A-B Rather Than A-B-C**

2010 (New): A change in the 2010 AHA Guidelines for CPR and ECC is to recommend the initiation of chest compressions before ventilations.

2005 (Old): The sequence of adult CPR began with opening of the airway, checking for normal breathing, and then delivering 2 rescue breaths followed by cycles of 30 chest compressions and 2 breaths.

Why: Although no published human or animal evidence demonstrates that starting CPR with 30 compressions rather than 2 ventilations leads to improved outcome, chest compressions provide the blood flow, and studies of out-of-hospital adult cardiac arrest showed that survival was higher when bystanders provided chest compressions rather than no chest compressions. Animal data demonstrate that delays or interruptions in chest compressions reduce survival, so such delays and interruptions should be minimized throughout the entire resuscitation. Chest compressions can be started almost immediately, whereas positioning the head and achieving a seal for mouth-to-mouth or bag-mask rescue breathing all take time. The delay in initiation of compressions can be reduced if 2 rescuers are present: the first rescuer begins chest compressions, and the second rescuer opens the airway and is prepared to deliver breaths as soon as the first rescuer has completed the first set of 30 chest compressions. Whether 1 or more rescuers are present, initiation of CPR with chest compressions ensures that the victim receives this critical intervention early.

*Elimination of "Look, Listen, and Feel for Breathing"**

2010 (New): "Look, listen, and feel for breathing" was removed from the sequence for assessment of breathing after opening the airway. The healthcare provider briefly checks for breathing when checking responsiveness to detect signs of cardiac arrest. After delivery of 30 compressions, the lone rescuer opens the victim's airway and delivers 2 breaths.

2005 (Old): "Look, listen, and feel for breathing" was used to assess breathing after the airway was opened.

Why: With the new chest compression–first sequence, CPR is performed if the adult victim is unresponsive and not breathing or not breathing normally (ie, not breathing or only gasping) and begins with compressions (C-A-B sequence). Therefore, breathing is briefly checked as part of a check for cardiac arrest. After the first set of chest compressions, the airway is opened and the rescuer delivers 2 breaths.

*Chest Compression Rate: At Least 100 per Minute**

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

2005 (Old): Compress at a rate of about 100/min.

Why: The number of chest compressions delivered per minute during CPR is an important determinant of 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, or allow AED analysis). In most studies, delivery of more compressions during resuscitation is associated with better survival, and delivery of fewer compressions is associated with lower survival. 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. For further information, see Box 2 on page 4.

*Chest Compression Depth**

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

2005 (Old): The adult sternum should be depressed 1½ to 2 inches (approximately 4 to 5 cm).

Why: Compressions create blood flow primarily by increasing intrathoracic pressure and directly compressing the heart. Compressions generate critical blood flow and oxygen and energy delivery to the heart and brain. Confusion may result when a range of depth is recommended, so 1 compression depth is now recommended. Rescuers often do not adequately compress the chest despite recommendations to "push hard." In addition, the available science suggests that compressions of at least 2 inches are more effective than compressions of 1½ inches. For this reason the 2010 AHA Guidelines for CPR and ECC recommend a single minimum depth for compression of the adult chest, and that compression depth is deeper than in the old recommendation.

Table 1
Summary of Key BLS Components for Adults, Children, and Infants*

	Recommendations		
Component	**Adults**	**Children**	**Infants**
Recognition	Unresponsive (for all ages)		
	No breathing or no normal breathing (ie, only gasping)	No breathing or only gasping	
	No pulse palpated within 10 seconds for all ages (HCP only)		
CPR sequence	C-A-B		
Compression rate	At least 100/min		
Compression depth	At least 2 inches (5 cm)	At least ⅓ AP diameter About 2 inches (5 cm)	At least ⅓ AP diameter About 1½ inches (4 cm)
Chest wall recoil	Allow complete recoil between compressions HCPs rotate compressors every 2 minutes		
Compression interruptions	Minimize interruptions in chest compressions Attempt to limit interrruptions to <10 seconds		
Airway	Head tilt–chin lift (HCP suspected trauma: jaw thrust)		
Compression-to-ventilation ratio (until advanced airway placed)	30:2 1 or 2 rescuers	30:2 Single rescuer 15:2 2 HCP rescuers	
Ventilations: when rescuer untrained or trained and not proficient	Compressions only		
Ventilations with advanced airway (HCP)	1 breath every 6-8 seconds (8-10 breaths/min) Asynchronous with chest compressions About 1 second per breath Visible chest rise		
Defibrillation	Attach and use AED as soon as available. Minimize interruptions in chest compressions before and after shock; resume CPR beginning with compressions immediately after each shock.		

Abbreviations: AED, automated external defibrillator; AP, anterior-posterior; CPR, cardiopulmonary resuscitation; HCP, healthcare provider.
*Excluding the newly born, in whom the etiology of an arrest is nearly always asphyxial.

Team Resuscitation

2010 (New): The steps in the BLS algorithm have traditionally been presented as a sequence to help a single rescuer prioritize actions. There is increased focus on providing CPR as a team because resuscitations in most EMS and healthcare systems involve teams of rescuers, with rescuers performing several actions simultaneously. For example, one rescuer activates the emergency response system while a second begins chest compressions, a third is either providing ventilations or retrieving the bag-mask for rescue breathing, and a fourth is retrieving and setting up a defibrillator.

2005 (Old): The steps of BLS consist of a series of sequential assessments and actions. The intent of the algorithm is to present the steps in a logical and concise manner that will be easy for each rescuer to learn, remember, and perform.

Why: Some resuscitations start with a lone rescuer who calls for help, whereas other resuscitations begin with several willing rescuers. Training should focus on building a team as each rescuer arrives, or on designating a team leader if multiple rescuers are present. As additional personnel arrive, responsibilities for tasks that would ordinarily be performed sequentially by fewer rescuers may now be delegated to a team of providers who perform them simultaneously. For this reason, BLS healthcare provider training should not only teach individual skills but should also teach rescuers to work in effective teams.

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

As in the 2005 AHA Guidelines for CPR and ECC, the 2010 AHA Guidelines for CPR and ECC contain a comparison table that lists the key elements of adult, child, and infant BLS (excluding CPR for newly born infants). These key elements are included in Table 1.

ELECTRICAL THERAPIES

The 2010 AHA Guidelines for CPR and ECC have been updated to reflect new data regarding defibrillation and cardioversion for cardiac rhythm disturbances and the use of pacing in bradycardia. These data largely continue to support the recommendations in the 2005 AHA Guidelines for CPR and ECC. Therefore, no major changes were recommended regarding defibrillation, cardioversion, and pacing. Emphasis on early defibrillation integrated with high-quality CPR is the key to improving survival from sudden cardiac arrest.

Summary of Key Issues and Major Changes

Main topics include

- Integration of AEDs into the Chain of Survival system for public places
- Consideration of AED use in hospitals
- AEDs can now be used in infants if a manual defibrillator is not available
- Shock first versus CPR first in cardiac arrest
- 1-shock protocol versus 3-shock sequence for VF
- Biphasic and monophasic waveforms
- Escalating versus fixed doses for second and subsequent shocks
- Electrode placement
- External defibrillation with implantable cardioverter-defibrillator
- Synchronized cardioversion

Automated External Defibrillators

Community Lay Rescuer AED Programs

2010 (Slightly Modified): Cardiopulmonary resuscitation and the use of AEDs by public safety first responders are recommended to increase survival rates for out-of-hospital sudden cardiac arrest. The 2010 AHA Guidelines for CPR and ECC again recommend the establishment of AED programs in public locations where there is a relatively high likelihood of witnessed cardiac arrest (eg, airports, casinos, sports facilities). To maximize the effectiveness of these programs, the AHA continues to emphasize the importance of organizing, planning, training, linking with the EMS system, and establishing a process of continuous quality improvement.

2005 (Old): The 2005 AHA Guidelines for CPR and ECC identified 4 components for successful community lay rescuer AED programs:

- A planned and practiced response, typically requiring oversight by a healthcare provider
- Training of anticipated rescuers in CPR and use of the AED
- A link with the local EMS system
- A program of ongoing quality improvement

There is insufficient evidence to recommend for or against the deployment of AEDs in homes.

In-Hospital Use of AEDs

2010 (Reaffirmed 2005 Recommendation): Despite limited evidence, AEDs may be considered for the hospital setting as a way to facilitate early defibrillation (a goal of shock delivery ≤3 minutes from collapse), especially in areas where staff have no rhythm recognition skills or defibrillators are used infrequently. Hospitals should monitor collapse-to–first shock intervals and resuscitation outcomes.

AED Use in Children Now Includes Infants

2010 (New): For attempted defibrillation of children 1 to 8 years of age with an AED, the rescuer should use a pediatric dose-attenuator system if one is available. If the rescuer provides CPR to a child in cardiac arrest and does not have an AED with a pediatric dose-attenuator system, the rescuer should use a standard AED. For infants (<1 year of age), a manual defibrillator is preferred. If a manual defibrillator is not available, an AED with pediatric dose attenuation is desirable. If neither is available, an AED without a dose attenuator may be used.

2005 (Old): For children 1 to 8 years of age, the rescuer should use a pediatric dose-attenuator system if one is available. If the rescuer provides CPR to a child in cardiac arrest and does not have an AED with a pediatric attenuator system, the rescuer should use a standard AED. There are insufficient data to make a recommendation for or against the use of AEDs for infants <1 year of age.

Why: The lowest energy dose for effective defibrillation in infants and children is not known. The upper limit for safe defibrillation is also not known, but doses >4 J/kg (as high as 9 J/kg) have effectively defibrillated children and animal models of pediatric arrest with no significant adverse effects. Automated external defibrillators with relatively high-energy doses have been used successfully in infants in cardiac arrest with no clear adverse effects.

Shock First vs CPR First

2010 (Reaffirmed 2005 Recommendation): 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. Healthcare providers 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 out-of-hospital cardiac arrest 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 VF to shock delivery should be under 3 minutes, and CPR should be performed while the defibrillator is readied.

Why: When VF is present for more than a few minutes, the myocardium is depleted of oxygen and energy. A brief period of chest compressions can deliver oxygen and energy to the heart, increasing the likelihood that a shock will both eliminate VF (defibrillation) and be followed by ROSC. Before the publication of the 2005 AHA Guidelines for CPR and ECC, 2 studies suggested the potential benefit of CPR first rather than shock first. In both studies, although 1½ to 3 minutes of CPR before shock delivery did not improve overall survival from VF, the CPR-first strategy did improve survival among victims with VF if the EMS call-to-arrival interval was 4 to 5 minutes or longer. However, 2 subsequent randomized controlled trials found that CPR before attempted defibrillation by EMS personnel was not associated with a significant difference in survival to discharge. One retrospective study did find an improved neurologic status at 30 days and at 1 year when immediate CPR was compared with immediate defibrillation in patients with out-of-hospital VF.

1-Shock Protocol vs 3-Shock Sequence

2010 (No Change From 2005): At the time of the International Liaison Committee on Resuscitation (ILCOR) 2010 International Consensus Conference on CPR and ECC Science With Treatment Recommendations, 2 new published human studies compared a 1-shock protocol versus a 3-stacked-shock protocol for treatment of VF cardiac arrest. Evidence from these 2 studies suggests significant survival benefit with a single-shock defibrillation protocol compared with a 3-stacked-shock protocol. If 1 shock fails to eliminate VF, the incremental benefit of another shock is low, and resumption of CPR is likely to confer a greater value than another immediate shock. This fact, combined with the data from animal studies documenting harmful effects from interruptions to chest compressions and human studies suggesting a survival benefit from a CPR approach that includes a 1-shock compared with a 3-shock protocol, supports the recommendation of single shocks followed by immediate CPR rather than stacked shocks for attempted defibrillation.

Defibrillation Waveforms and Energy Levels

2010 (No Change From 2005): Data from both out-of-hospital and in-hospital studies indicate that biphasic waveform shocks at energy settings comparable to or lower than 200-J monophasic shocks have equivalent or higher success for termination of VF. However, the optimal energy for first-shock biphasic waveform defibrillation has not been determined. Likewise, no specific waveform characteristic (either monophasic or biphasic) is consistently associated with a greater incidence of ROSC or survival to hospital discharge after cardiac arrest.

In the absence of biphasic defibrillators, monophasic defibrillators are acceptable. Biphasic waveform shock configurations differ among manufacturers, and none have been directly compared in humans with regard to their relative efficacy. Because of such differences in waveform configuration, providers should use the manufacturer's recommended energy dose (eg, initial dose of 120 to 200 J) for its respective waveform. If the manufacturer's recommended dose is not known, defibrillation at the maximal dose may be considered.

Pediatric Defibrillation

2010 (Modification of Previous Recommendation): For pediatric patients, the optimal defibrillation dose is unknown. There are limited data regarding the lowest effective dose or the upper limit for safe defibrillation. A dose of 2 to 4 J/kg may be used for the initial defibrillation energy, but for ease of teaching, an initial dose of 2 J/kg may be considered. For subsequent shocks, energy levels should be at least 4 J/kg; higher energy levels may be considered, not to exceed 10 J/kg or the adult maximum dose.

2005 (Old): The initial dose for attempted defibrillation for infants and children when using a monophasic or biphasic manual defibrillator is 2 J/kg. The second and subsequent doses are 4 J/kg.

Why: There are insufficient data to make a substantial change in the existing recommended doses for pediatric defibrillation. Initial doses of 2 J/kg with monophasic waveforms are effective in terminating 18% to 50% of VF cases, with insufficient evidence to compare the success of higher doses. Case reports document successful defibrillation at doses up to 9 J/kg with no adverse effects detected. More data are needed.

Fixed and Escalating Energy

2010 (No Change From 2005): The optimal biphasic energy level for first or subsequent shocks has not been determined. Therefore, it is not possible to make a definitive recommendation for the selected energy for subsequent biphasic defibrillation attempts. On the basis of available evidence, if the initial biphasic shock is unsuccessful in terminating VF, subsequent energy levels should be at least equivalent, and higher energy levels may be considered, if available.

Electrode Placement

2010 (Modification of Previous Recommendation): For ease of placement and education, the anterior-lateral pad position is a reasonable default electrode placement. Any of 3 alternative pad positions (anterior-posterior, anterior–left infrascapular, and anterior–right infrascapular) may be considered on the basis of individual patient characteristics. Placement of AED electrode pads on the victim's bare chest in any of the 4 pad positions is reasonable for defibrillation.

2005 (Old): Rescuers should place AED electrode pads on the victim's bare chest in the conventional sternal-apical (anterior-lateral) position. The right (sternal) chest pad is placed on the victim's right superior-anterior (infraclavicular) chest, and the apical (left) pad is placed on the victim's inferior-lateral left chest, lateral to the left breast. Other acceptable pad positions are placement on the lateral chest wall on the right and left sides (biaxillary) or the left pad in the standard apical position and the other pad on the right or left upper back.

Why: New data demonstrate that the 4 pad positions (anterior-lateral, anterior-posterior, anterior–left infrascapular, and anterior–right infrascapular) appear to be equally effective to treat atrial or ventricular arrhythmias. Again, for ease of teaching, the default position taught in AHA courses will not change from the 2005 recommended position. No studies were identified that directly evaluated the effect of placement of pads or paddles on defibrillation success with the endpoint of ROSC.

Defibrillation With Implantable Cardioverter-Defibrillator

2010 (New): The anterior-posterior and anterior-lateral locations are generally acceptable in patients with implanted pacemakers and defibrillators. In patients with implantable cardioverter-defibrillators or pacemakers, pad or paddle placement should not delay defibrillation. It might be reasonable to avoid placing the pads or paddles directly over the implanted device.

2005 (Old): When an implantable medical device is located in an area where a pad would normally be placed, position the pad at least 1 inch (2.5 cm) away from the device.

Why: The language of this recommendation is a bit softer than the language used in 2005. There is the potential for pacemaker or implantable cardioverter-defibrillator malfunction after defibrillation when the pads are in close proximity to the device. One study with cardioversion demonstrated that positioning the pads at least 8 cm away from the device did not damage device pacing, sensing, or capturing. Pacemaker spikes with unipolar pacing may confuse AED software and may prevent VF detection (and therefore shock delivery). The key message to rescuers is that concern about precise pad or paddle placement in relation to an implanted medical device should not delay attempted defibrillation.

Synchronized Cardioversion

Supraventricular Tachyarrhythmia

2010 (New): The recommended initial biphasic energy dose for cardioversion of atrial fibrillation is 120 to 200 J. The initial monophasic dose for cardioversion of atrial fibrillation is 200 J. Cardioversion of adult atrial flutter and other supraventricular rhythms generally requires less energy; an initial energy of 50 to 100 J with either a monophasic or a biphasic device is often sufficient. If the initial cardioversion shock fails, providers should increase the dose in a stepwise fashion.

2005 (Old): The recommended initial monophasic energy dose for cardioversion of atrial fibrillation is 100 to 200 J. Cardioversion with biphasic waveforms is now available, but the optimal doses for cardioversion with biphasic waveforms have not been established with certainty. Extrapolation from published experience with elective cardioversion of atrial fibrillation with the use of rectilinear and truncated exponential waveforms supports an initial dose of 100 to 120 J with escalation as needed. This initial dose has been shown to be 80% to 85% effective in terminating atrial fibrillation. Until further evidence becomes available, this information can be used to extrapolate biphasic cardioversion doses to other tachyarrhythmias.

Why: The writing group reviewed interim data on all biphasic studies conducted since the 2005 AHA Guidelines for CPR and ECC were published and made minor changes to update cardioversion dose recommendations. A number of studies attest to the efficacy of biphasic waveform cardioversion of atrial fibrillation with energy settings from 120 to 200 J, depending on the specific waveform.

Ventricular Tachycardia

2010 (New): Adult stable monomorphic VT responds well to monophasic or biphasic waveform cardioversion (synchronized) shocks at initial energies of 100 J. If there is no response to the first shock, it may be reasonable to increase the dose in a stepwise fashion. No interim studies were found that addressed this rhythm, so the recommendations were made by writing group expert consensus.

Synchronized cardioversion must not be used for treatment of VF because the device is unlikely to sense a QRS wave, and thus, a shock may not be delivered. Synchronized cardioversion should also not be used for pulseless VT or polymorphic VT (irregular VT).These rhythms require delivery of high-energy *unsynchronized* shocks (ie, defibrillation doses).

2005 (Old): There was insufficient evidence to recommend a biphasic dose for cardioversion of monomorphic VT. The 2005 AHA Guidelines for CPR and ECC recommended use of an unsynchronized shock for treatment of the unstable patient with polymorphic VT.

Why: The writing group agreed that it would be helpful to add a biphasic dose recommendation to the 2010 AHA Guidelines for CPR and ECC for cardioversion of monomorphic VT but wanted to emphasize the need to treat polymorphic VT as unstable and as an arrest rhythm.

Fibrillation Waveform Analysis to Predict Outcome

2010 (No Change From 2005): The value of VF waveform analysis to guide defibrillation management during resuscitation is uncertain.

Pacing

2010 (No Change From 2005): Pacing is not routinely recommended for patients in asystolic cardiac arrest. In patients with symptomatic bradycardia with a pulse, it is reasonable for healthcare providers to be prepared to initiate transcutaneous pacing in patients who do not respond to drugs. If transcutaneous pacing fails, transvenous pacing initiated by a trained provider with experience in central venous access and intracardiac pacing is probably indicated.

CPR TECHNIQUES AND DEVICES

Summary of Key Issues and Major Changes

To date, no CPR device has consistently been shown to be superior to standard conventional (manual) CPR for out-of-hospital BLS, and no device other than a defibrillator has consistently improved long-term survival from out-of-hospital cardiac arrest. This part of the 2010 AHA Guidelines for CPR and ECC does contain summaries of recent clinical trials.

CPR Techniques

Alternatives to conventional manual CPR have been developed in an effort to enhance perfusion during resuscitation from cardiac arrest and to improve survival. Compared with conventional CPR, these techniques typically require more personnel, training, and equipment, or they apply to a specific setting. Some alternative CPR techniques may improve hemodynamics or short-term survival when used by well-trained providers in selected patients.

2010 (New): The precordial thump should not be used for unwitnessed out-of-hospital cardiac arrest. The precordial thump may be considered for patients with witnessed, monitored, unstable VT (including pulseless VT) if a defibrillator is not immediately ready for use, but it should not delay CPR and shock delivery.

2005 (Old): No recommendation was provided previously.

Why: A precordial thump has been reported to convert ventricular tachyarrhythmias in some studies. However, 2 larger case series found that the precordial thump did not result in ROSC for cases of VF. Reported complications associated with precordial thump include sternal fracture, osteomyelitis, stroke, and triggering of malignant arrhythmias in adults and children. The precordial thump should not delay initiation of CPR or defibrillation.

CPR Devices

Several mechanical CPR devices have been the focus of recent clinical trials. Initiation of therapy with these devices (ie, application and positioning of the device) has the potential to delay or interrupt CPR for the victim of cardiac arrest, so rescuers should be trained to minimize any interruption of chest compressions or defibrillation and should be retrained as needed.

Use of the impedance threshold device improved ROSC and short-term survival in adults with out-of-hospital cardiac arrest, but it has not improved long-term survival in patients with cardiac arrest.

One multicenter, prospective, randomized controlled trial comparing load-distributing band CPR (AutoPulse®) with manual CPR for out-of-hospital cardiac arrest demonstrated no improvement in 4-hour survival and worse neurologic outcome when the device was used. Further studies are required to determine if site-specific factors and experience with deployment of the device could influence its efficacy. There is insufficient evidence to support the routine use of this device.

Case series employing mechanical piston devices have reported variable degrees of success. Such devices may be considered for use when conventional CPR would be difficult to maintain (eg, during diagnostic studies).

To prevent delays and maximize efficiency, initial training, ongoing monitoring, and retraining programs should be offered on a frequent basis to providers using CPR devices.

ADVANCED CARDIOVASCULAR LIFE SUPPORT

Summary of Key Issues and Major Changes

The major changes in advanced cardiovascular life support (ACLS) for 2010 include the following:

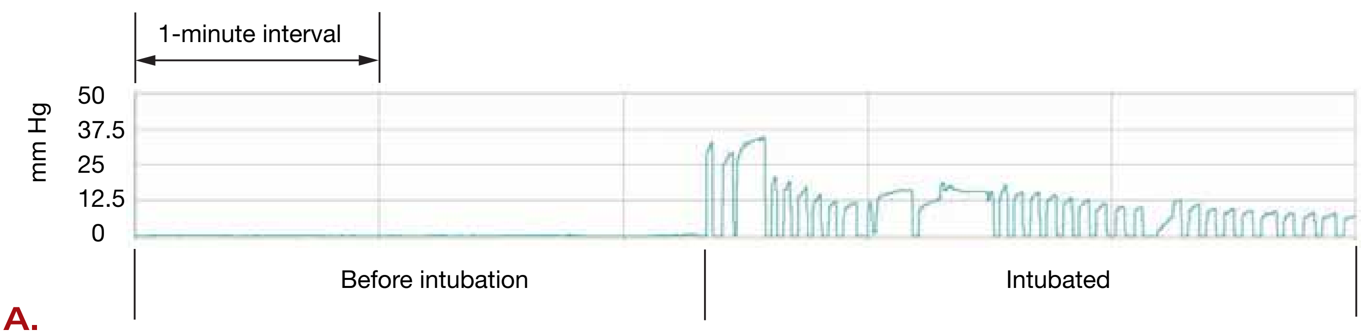
- Quantitative waveform capnography is recommended for confirmation and monitoring of endotracheal tube placement and CPR quality.
- The traditional cardiac arrest algorithm was simplified and an alternative conceptual design was created to emphasize the importance of high-quality CPR.
- There is an increased emphasis on physiologic monitoring to optimize CPR quality and detect ROSC.
- Atropine is no longer recommended for routine use in the management of pulseless electrical activity (PEA)/asystole.
- Chronotropic drug infusions are recommended as an alternative to pacing in symptomatic and unstable bradycardia.
- Adenosine is recommended as safe and potentially effective for both treatment and diagnosis in the initial management of undifferentiated regular monomorphic wide-complex tachycardia.
- Systematic post–cardiac arrest care after ROSC should continue in a critical care unit with expert multidisciplinary management and assessment of the neurologic and physiologic status of the patient. This often includes the use of therapeutic hypothermia.

Capnography Recommendation

2010 (New): Continuous quantitative waveform capnography is now recommended for intubated patients throughout the periarrest period. When quantitative waveform capnography is used for adults, applications now include recommendations for confirming tracheal tube placement and for monitoring CPR quality and detecting ROSC based on end-tidal carbon dioxide (P_{ETCO_2}) values (Figures 3A and 3B).

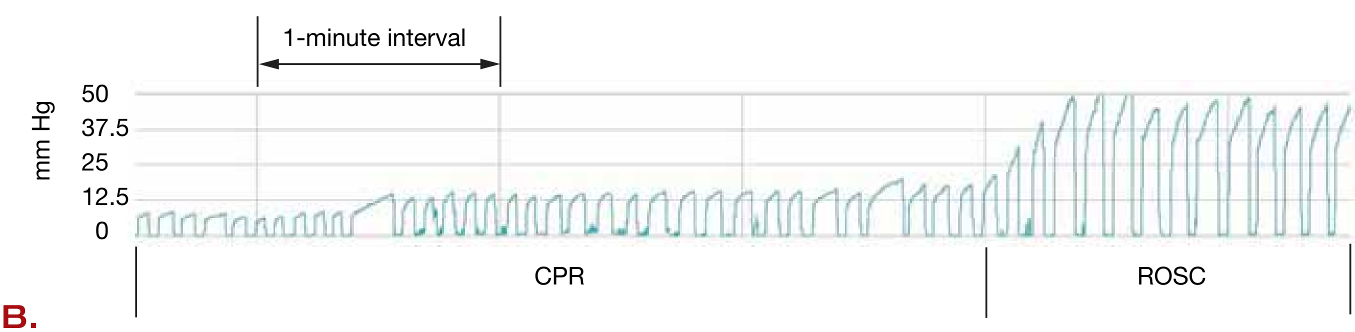
Figure 3

Capnography Waveforms



A.

Capnography to confirm endotracheal tube placement. This capnography tracing displays the partial pressure of exhaled carbon dioxide (P_{ETCO_2}) in mm Hg on the vertical axis over time when intubation is performed. Once the patient is intubated, exhaled carbon dioxide is detected, confirming tracheal tube placement. The P_{ETCO_2} varies during the respiratory cycle, with highest values at end-expiration.

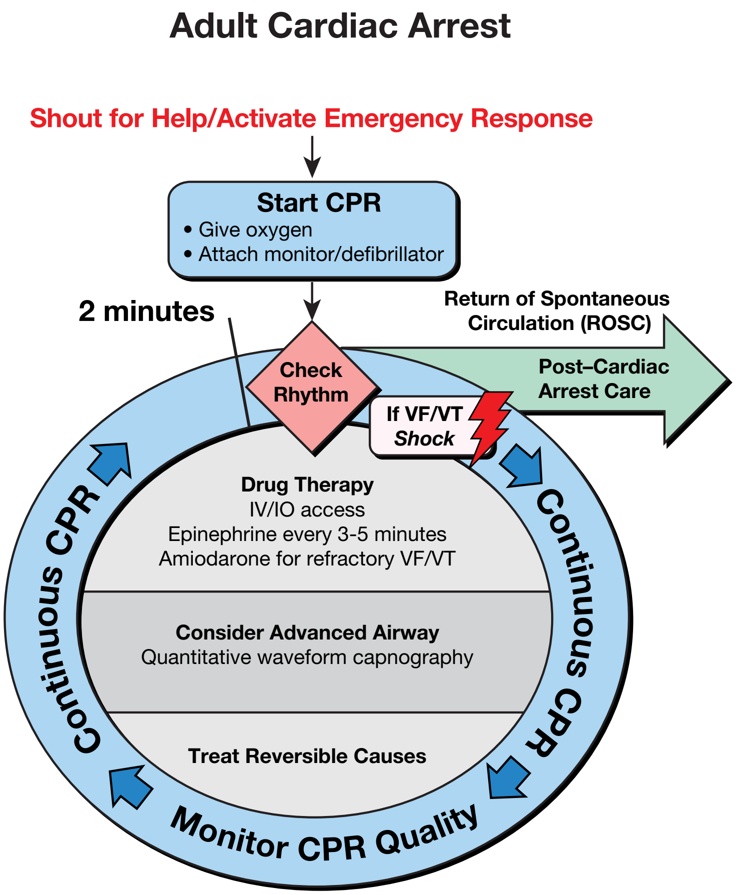


B.

Capnography to monitor effectiveness of resuscitation efforts. This second capnography tracing displays the P_{ETCO_2} in mm Hg on the vertical axis over time. This patient is intubated and receiving CPR. Note that the ventilation rate is approximately 8 to 10 breaths per minute. Chest compressions are given continuously at a rate of slightly faster than 100/min but are not visible with this tracing. The initial P_{ETCO_2} is less than 12.5 mm Hg during the first minute, indicating very low blood flow. The P_{ETCO_2} increases to between 12.5 and 25 mm Hg during the second and third minutes, consistent with the increase in blood flow with ongoing resuscitation. Return of spontaneous circulation (ROSC) occurs during the fourth minute. ROSC is recognized by the abrupt increase in the P_{ETCO_2} (visible just after the fourth vertical line) to over 40 mm Hg, which is consistent with a substantial improvement in blood flow.

Figure 4

Circular ACLS Algorithm



CPR Quality
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio
- Quantitative waveform capnography
  – If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality
- Intra-arterial pressure
  – If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Shock Energy
- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy
- **Epinephrine IV/IO Dose:** 1 mg every 3-5 minutes
- **Vasopressin IV/IO Dose:** 40 units can replace first or second dose of epinephrine
- **Amiodarone IV/IO Dose:** First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway
- Supraglottic advanced airway or endotracheal intubation
- Waveform capnography to confirm and monitor ET tube placement
- 8-10 breaths per minute with continuous chest compressions

Reversible Causes

– **H**ypovolemia	– **T**ension pneumothorax
– **H**ypoxia	– **T**amponade, cardiac
– **H**ydrogen ion (acidosis)	– **T**oxins
– **H**ypo-/hyperkalemia	– **T**hrombosis, pulmonary
– **H**ypothermia	– **T**hrombosis, coronary

2005 (Old): An exhaled carbon dioxide (CO_2) detector or an esophageal detector device was recommended to confirm endotracheal tube placement. The 2005 AHA Guidelines for CPR and ECC noted that P_{ETCO_2} monitoring can be useful as a noninvasive indicator of cardiac output generated during CPR.

Why: Continuous waveform capnography is the most reliable method of confirming and monitoring correct placement of an endotracheal tube. Although other means of confirming endotracheal tube placement are available, they are not more reliable than continuous waveform capnography. Patients are at increased risk of endotracheal tube displacement during transport or transfer; providers should observe a persistent capnographic waveform with ventilation to confirm and monitor endotracheal tube placement.

Because blood must circulate through the lungs for CO_2 to be exhaled and measured, capnography can also serve as a physiologic monitor of the effectiveness of chest compressions and to detect ROSC. Ineffective chest compressions (due to either patient characteristics or rescuer performance) are associated with a low P_{ETCO_2}. Falling cardiac output or rearrest in the patient with ROSC also causes a decrease in P_{ETCO_2}. In contrast, ROSC may cause an abrupt increase in P_{ETCO_2}.

Simplified ACLS Algorithm and New Algorithm

2010 (New): The conventional ACLS Cardiac Arrest Algorithm has been simplified and streamlined to emphasize the importance of high-quality CPR (including compressions of adequate rate and depth, allowing complete chest recoil after each compression, minimizing interruptions in chest compressions, and avoiding excessive ventilation) and the fact that ACLS actions should be organized around uninterrupted periods of CPR. A new circular algorithm is also introduced (Figure 4, above).

2005 (Old): The same priorities were cited in the 2005 AHA Guidelines for CPR and ECC. The box and arrow algorithm listed key actions performed during the resuscitation in a sequential fashion.

Why: For the treatment of cardiac arrest, ACLS interventions build on the BLS foundation of high-quality CPR to increase the likelihood of ROSC. Before 2005, ACLS courses assumed that excellent CPR was provided, and they focused mainly on added interventions of manual defibrillation, drug therapy, and advanced airway management, as well as alternative and additional management options for special resuscitation situations. Although adjunctive drug therapy and advanced airway management are still part of ACLS, in 2005 the emphasis in advanced life support (ALS) returned to the basics, with an increased emphasis on what is known to work: high-quality CPR (providing compressions of adequate rate and depth, allowing complete chest recoil after each compression, minimizing interruptions in chest compressions, and avoiding excessive ventilation). The 2010 AHA Guidelines for CPR and ECC continue this emphasis. The 2010 AHA Guidelines for CPR and ECC note that CPR is ideally guided by physiologic monitoring and includes adequate oxygenation and early defibrillation while the ACLS provider assesses and treats possible underlying causes of the arrest. There is no definitive clinical evidence that early intubation or drug therapy improves neurologically intact survival to hospital discharge.

De-emphasis of Devices, Drugs, and Other Distracters

Both ACLS algorithms use simple formats that focus on interventions that have the greatest impact on outcome. To that end, emphasis has been placed on delivery of high-quality CPR and early defibrillation for VF/pulseless VT. Vascular access, drug delivery, and advanced airway placement, while still recommended, should not cause significant interruptions in chest compressions and should not delay shocks.

New Medication Protocols

2010 (New): Atropine is not recommended for routine use in the management of PEA/asystole and has been removed from the ACLS Cardiac Arrest Algorithm. The treatment of PEA/asystole is now consistent in the ACLS and pediatric advanced life support (PALS) recommendations and algorithms.

The algorithm for treatment of tachycardia with pulses has been simplified. Adenosine is recommended in the initial diagnosis and treatment of stable, undifferentiated regular, monomorphic wide-complex tachycardia (this is also consistent in ACLS and PALS recommendations). It is important to note that adenosine should ***not*** be used for ***irregular*** wide-complex tachycardias because it may cause degeneration of the rhythm to VF.

For the treatment of the adult with symptomatic and unstable bradycardia, chronotropic drug infusions are recommended as an alternative to pacing.

2005 (Old): Atropine was included in the ACLS Pulseless Arrest Algorithm: for a patient in asystole or slow PEA, atropine could be considered. In the Tachycardia Algorithm, adenosine was recommended only for suspected regular narrow-complex reentry supraventricular tachycardia. In the Bradycardia Algorithm, chronotropic drug infusions were listed in the algorithm after atropine and while awaiting a pacer or if pacing was ineffective.

Why: There are several important changes regarding management of symptomatic arrhythmias in adults. Available evidence suggests that the routine use of atropine during PEA or asystole is unlikely to have a therapeutic benefit. For this reason, atropine has been removed from the Cardiac Arrest Algorithm.

On the basis of new evidence of safety and potential efficacy, adenosine can now be considered in the initial assessment and treatment of stable, undifferentiated regular, monomorphic wide-complex tachycardia when the rhythm is regular. For symptomatic or unstable bradycardia, intravenous (IV) infusion of chronotropic agents is now recommended as an equally effective alternative to external transcutaneous pacing when atropine is ineffective.

Organized Post–Cardiac Arrest Care

2010 (New): Post–Cardiac Arrest Care is a new section in the 2010 AHA Guidelines for CPR and ECC. To improve survival for victims of cardiac arrest who are admitted to a hospital after ROSC, a comprehensive, structured, integrated, multidisciplinary system of post–cardiac arrest care should be implemented in a consistent manner (Box 3). Treatment should include cardiopulmonary and neurologic support. Therapeutic hypothermia and percutaneous coronary interventions (PCIs) should be provided when indicated (see also Acute Coronary Syndromes section). Because seizures are common after cardiac arrest, an electroencephalogram for the diagnosis of seizures should be performed with prompt interpretation as soon as possible and should be monitored frequently or continuously in comatose patients after ROSC.

2005 (Old): Post–cardiac arrest care was included within the ACLS section of the 2005 AHA Guidelines for CPR and ECC. Therapeutic hypothermia was recommended to improve outcome for comatose adult victims of witnessed out-of-hospital cardiac arrest when the presenting rhythm was VF. In addition, recommendations were made to optimize hemodynamic, respiratory, and neurologic support, identify and treat reversible causes of arrest, monitor temperature, and consider treatment for disturbances in temperature regulation. However, there was limited evidence to support these recommendations.

Why: Since 2005, two nonrandomized studies with concurrent controls and other studies using historic controls have indicated the possible benefit of therapeutic hypothermia after in-hospital cardiac arrest and out-of-hospital cardiac arrest with PEA/asystole as the presenting rhythm. Organized post–cardiac arrest care with an emphasis on multidisciplinary programs that focus on optimizing hemodynamic, neurologic, and metabolic function (including therapeutic hypothermia) may improve survival to hospital discharge among victims who achieve ROSC after cardiac arrest either in or out of hospital. Although it is not yet possible to determine the individual effect of many of these therapies, when bundled as an integrated system of care, their deployment has been shown to improve survival to hospital discharge.

Effect of Hypothermia on Prognostication

Many studies have attempted to identify comatose post–cardiac arrest patients who have no prospect for meaningful neurologic recovery, and decision rules for prognostication of poor outcome have been proposed, but those developed in previous years were established from studies of post–cardiac arrest patients who were not treated with hypothermia. Recent reports have documented occasional good outcomes in post–cardiac arrest patients who were treated with therapeutic hypothermia, despite neurologic examination or neuroelectrophysiologic studies that predicted poor outcome within the traditional prognostic time frame of the third day after arrest. Thus, characteristics or test results that were predictive of poor outcome in post–cardiac arrest patients in the past may not be as predictive of poor outcome after use of therapeutic hypothermia.

Identifying patients during the post–cardiac arrest period who do not have the potential for meaningful neurologic recovery is a major clinical challenge that requires further research. Caution is advised when considering limiting care or withdrawing life-sustaining therapy, especially early after ROSC.

Because of the growing need for transplant tissue and organs, all provider teams who treat postarrest patients should implement appropriate procedures for possible tissue and organ donation that are timely, effective, and supportive of the family members' and patient's desires.

Tapering of Inspired Oxygen Concentration After ROSC Based on Monitored Oxyhemoglobin Saturation

2010 (New): Once the circulation is restored, monitor arterial oxyhemoglobin saturation. It may be reasonable, when the appropriate equipment is available, to titrate oxygen administration to maintain the arterial oxyhemoglobin saturation ≥94%. Provided that appropriate equipment is available, once ROSC is achieved, the fraction of inspired oxygen (F_{IO_2}) should be adjusted to the minimum concentration needed to achieve arterial oxyhemoglobin saturation ≥94%, with the goal of avoiding hyperoxia while ensuring adequate oxygen delivery. Because an oxyhemoglobin saturation of 100% may correspond to a Pa_{O_2} anywhere between approximately 80 and 500 mm Hg, in general it is appropriate to wean the F_{IO_2} for a saturation of 100%, provided that the saturation can be maintained ≥94%.

2005 (Old): No specific information about weaning was provided.

Why: In effect, the oxyhemoglobin saturation should be maintained at 94% to 99% when possible. Although the ACLS Task Force of the 2010 International Consensus on CPR and ECC Science With Treatment Recommendations[2,3] did not find sufficient evidence to recommend a specific weaning protocol, a recent study[5] documented harmful effects of hyperoxia after ROSC. As noted above, an oxygen saturation of 100% may correspond to a Pa_{O_2} anywhere between approximately 80 and 500 mm Hg. The ACLS and PALS expert consensus is that if equipment is available, it may be reasonable to titrate inspired oxygen on the basis of monitored oxyhemoglobin saturation to maintain a saturation of ≥94% but <100%.

BOX 3

Initial and Later Key Objectives of Post-Cardiac Arrest Care

1. **Optimize cardiopulmonary function and vital organ perfusion after ROSC**
2. **Transport/transfer to an appropriate hospital or critical care unit with a comprehensive post–cardiac arrest treatment system of care**
3. **Identify and treat ACS and other reversible causes**
4. **Control temperature to optimize neurologic recovery**
5. **Anticipate, treat, and prevent multiple organ dysfunction. This includes avoiding excessive ventilation and hyperoxia.**

The primary goal of a bundled treatment strategy for the patient after cardiac arrest is for a comprehensive therapeutic plan to be delivered consistently in a trained multidisciplinary environment leading to the return of normal or near-normal functional status. Patients with suspected ACS should be triaged to a facility with coronary angiography and interventional reperfusion capabilities (primary PCI) and a multidisciplinary team experienced in monitoring patients for multiorgan dysfunction and initiating timely appropriate post–cardiac arrest therapy, including hypothermia.

With renewed focus on improving functional outcome, neurologic evaluation is a key component in the routine assessment of survivors. Early recognition of potentially treatable neurologic disorders, such as seizures, is important. The diagnosis of seizures may be challenging, especially in the setting of hypothermia and neuromuscular blockade, and electroencephalographic monitoring has become an important diagnostic tool in this patient population.

Prognostic assessment in the setting of hypothermia is changing, and experts qualified in neurologic assessment in this patient population and integration of appropriate prognostic tools are essential for patients, caregivers, and families.

Special Resuscitation Situations

2010 (New): Fifteen specific cardiac arrest situations now have specific treatment recommendations. The topics reviewed include asthma, anaphylaxis, pregnancy, morbid obesity (new), pulmonary embolism (new), electrolyte imbalance, ingestion of toxic substances, trauma, accidental hypothermia, avalanche (new), drowning, electric shock/lightning strikes, PCI (new), cardiac tamponade (new), and cardiac surgery (new).

2005 (Old): Ten specific situations related to patient compromise (ie, periarrest conditions) were included.

Why: Cardiac arrest in special situations may require special treatments or procedures beyond those provided during normal BLS or ACLS. These conditions occur infrequently, so it is difficult to conduct randomized clinical trials to compare therapies. As a result, these unique situations call for experienced providers to go beyond basics, using clinical consensus and extrapolation from limited evidence. The topics covered in the 2005 AHA Guidelines for CPR and ECC have been reviewed, updated, and expanded to 15 specific cardiac arrest situations. Topics include significant periarrest treatment that may be important to prevent cardiac arrest or that require treatment beyond the routine or typical care defined in the BLS and ACLS guidelines.

ACUTE CORONARY SYNDROMES

Summary of Key Issues and Major Changes

The 2010 AHA Guidelines for CPR and ECC recommendations for the evaluation and management of acute coronary syndromes (ACS) have been updated to define the scope of treatment for healthcare providers who care for patients with suspected or definite ACS within the first hours after onset of symptoms.

The primary goals of therapy for patients with ACS are consistent with those in previous AHA Guidelines for CPR and ECC and AHA/American College of Cardiology Guidelines, which include

- Reducing the amount of myocardial necrosis that occurs in patients with acute myocardial infarction, thus preserving left ventricular function, preventing heart failure, and limiting other cardiovascular complications
- Preventing major adverse cardiac events: death, nonfatal myocardial infarction, and the need for urgent revascularization
- Treating acute, life-threatening complications of ACS, such as VF, pulseless VT, unstable tachycardias, and symptomatic bradycardias

Within this context, several important strategies and components of care are defined.

Systems of Care for Patients With ST-Segment Elevation Myocardial Infarction

A well-organized approach to ST-segment elevation myocardial infarction (STEMI) care requires integration of community, EMS, physician, and hospital resources in a bundled STEMI system of care. This includes educational programs for recognition of ACS symptoms, development of EMS protocols for initial call center instruction and out-of-hospital intervention, and emergency department (ED) and hospital-based programs for intrafacility and interfacility transport once ACS is diagnosed and definitive care is determined.

Out-of-Hospital 12-Lead ECGs

An important and key component of STEMI systems of care is the performance of out-of-hospital 12-lead ECGs with transmission or interpretation by EMS providers and with advance notification of the receiving facility. Use of out-of-hospital 12-lead ECGs has been recommended by the AHA Guidelines for CPR and ECC since 2000 and has been documented to reduce time to reperfusion with fibrinolytic therapy. More recently, out-of-hospital 12-lead ECGs have also been shown to reduce the time to primary PCI and can facilitate triage to specific hospitals when PCI is the chosen strategy. When EMS or ED physicians activate the cardiac care team, including the cardiac catheterization laboratory, significant reductions in reperfusion times are observed.

Triage to Hospitals Capable of Performing PCI

These recommendations provide criteria for triage of patients to PCI centers after cardiac arrest.

Comprehensive Care for Patients After Cardiac Arrest With Confirmed STEMI or Suspected ACS

The performance of PCI has been associated with favorable outcomes in adult patients resuscitated from cardiac arrest. It is reasonable to include cardiac catheterization in standardized post–cardiac arrest protocols as part of an overall strategy to improve neurologically intact survival in this patient group. In patients with out-of-hospital cardiac arrest due to VF, emergent angiography with prompt revascularization of the infarct-related artery is recommended. The ECG may be insensitive or misleading after cardiac arrest, and coronary angiography after ROSC in subjects with arrest of presumed ischemic cardiac etiology may be reasonable, even in the absence of a clearly defined STEMI. Clinical findings of coma in patients before PCI are common after out-of-hospital cardiac arrest and should not be a contraindication to consideration of immediate angiography and PCI (see also Post–Cardiac Arrest Care section).

Changes in Immediate General Treatment (Including Oxygen and Morphine)

2010 (New): Supplementary oxygen is not needed for patients without evidence of respiratory distress if the oxyhemoglobin saturation is ≥94%. Morphine should be given with caution to patients with unstable angina.

2005 (Old): Oxygen was recommended for all patients with overt pulmonary edema or arterial oxyhemoglobin saturation <90%. It was also reasonable to administer oxygen to all patients with ACS for the first 6 hours of therapy. Morphine was the analgesic of choice for pain unresponsive to nitrates, but it was not recommended for use in patients with possible hypovolemia.

Why: Emergency medical services providers administer oxygen during the initial assessment of patients with suspected ACS. However, there is insufficient evidence to support its routine use in uncomplicated ACS. If the patient is dyspneic, is hypoxemic, or has obvious signs of heart failure, providers should titrate oxygen therapy to maintain oxyhemoglobin saturation ≥94%. Morphine is indicated in STEMI when chest discomfort is unresponsive to nitrates. Morphine should be used with caution in unstable angina/non-STEMI, because morphine administration was associated with increased mortality in a large registry.

STROKE

Summary of Key Issues and Major Changes

The overall goal of stroke care is to minimize acute brain injury and maximize patient recovery. Treatment of stroke is time sensitive, and these stroke guidelines again emphasize the "D's of Stroke Care" to highlight important steps in care (and potential steps that may contribute to delays in care). By integrating public education, 911 dispatch, prehospital detection and triage, hospital stroke system development, and stroke unit management, the outcome of stroke care has improved significantly.

- The time-sensitive nature of stroke care requires the establishment of local partnerships between academic medical centers and community hospitals. The concept of a "stroke-prepared" hospital has emerged with the goal of ensuring that best practices for stroke care (acute and beyond) are offered in an organized fashion throughout the region. Additional work is needed to expand the reach of regional stroke networks.
- Each EMS system should work within a regional stroke system of care to ensure prompt triage and transport to a stroke hospital when possible.
- Although blood pressure management is a component of the ED care of stroke patients, unless the patient is hypotensive (systolic blood pressure <90 mm Hg), prehospital treatment of blood pressure is not recommended.
- A growing body of evidence indicates improvement in 1-year survival rate, functional outcomes, and quality of life when patients hospitalized with acute stroke are cared for in a dedicated stroke unit by a multidisciplinary team experienced in managing stroke.
- Guidelines for indications, contraindications, and cautions when considering use of recombinant tissue plasminogen activator (rtPA) have been updated to be consistent with the American Stroke Association/AHA recommendations.
- Although a higher likelihood of good functional outcome is reported when patients with acute ischemic stroke receive rtPA within 3 hours of stroke symptom onset, treatment of carefully selected patients with acute ischemic stroke with IV rtPA between 3 and 4.5 hours after symptom onset has also been shown to improve clinical outcome; however, the degree of clinical benefit is smaller than that achieved with treatment within 3 hours. At present, the use of IV rtPA within 3 to 4.5 hours after symptom onset has not been approved by the US Food and Drug Administration.
- Recent studies showed that stroke unit care is superior to care in general medical wards, and the positive effects of stroke unit care can persist for years. The magnitude of benefits from treatment in a stroke unit is comparable to the magnitude of effects achieved with IV rtPA.
- The table for management of hypertension in stroke patients has been updated.

PEDIATRIC BASIC LIFE SUPPORT

Summary of Key Issues and Major Changes

Many key issues in pediatric BLS are the same as those in adult BLS. These include the following:

- Initiation of CPR with chest compressions rather than rescue breaths (C-A-B rather than A-B-C); beginning CPR with compressions rather than ventilations leads to a shorter delay to first compression.
- Continued emphasis on provision of high-quality CPR.
- Modification of recommendations regarding adequate depth of compressions to at least one third of the anterior-posterior diameter of the chest; this corresponds to approximately 1½ inches (about 4 cm) in most infants and about 2 inches (5 cm) in most children.
- Removal of "look, listen, and feel for breathing" from the sequence.

- De-emphasis of the pulse check for healthcare providers: Additional data suggest that healthcare providers cannot quickly and reliably determine the presence or absence of a pulse. For a child who is unresponsive and not breathing, if a pulse cannot be detected within 10 seconds, healthcare providers should begin CPR.
- Use of an AED for infants: For infants, a manual defibrillator is preferred to an AED for defibrillation. If a manual defibrillator is not available, an AED equipped with a pediatric dose attenuator is preferred. If neither is available, an AED without a pediatric dose attenuator may be used.

Change in CPR Sequence (C-A-B Rather Than A-B-C)

2010 (New): Initiate CPR for infants and children with chest compressions rather than rescue breaths (C-A-B rather than A-B-C). CPR should begin with 30 compressions (any lone rescuer) or 15 compressions (for resuscitation of infants and children by 2 healthcare providers) rather than with 2 ventilations. For resuscitation of the newly born, see the Neonatal Resuscitation section.

2005 (Old): Cardiopulmonary resuscitation was initiated with opening of the airway and the provision of 2 breaths before chest compressions.

Why: This proposed major change in CPR sequencing to compressions before ventilations (C-A-B) led to vigorous debate among experts in pediatric resuscitation. Because most pediatric cardiac arrests are asphyxial, rather than sudden primary cardiac arrests, both intuition and clinical data support the need for ventilations and compressions for pediatric CPR. However, pediatric cardiac arrests are much less common than adult sudden (primary) cardiac arrests, and many rescuers do nothing because they are uncertain or confused. Most pediatric cardiac arrest victims do not receive any bystander CPR, so any strategy that improves the likelihood of bystander action may save lives. Therefore, the C-A-B approach for victims of all ages was adopted with the hope of improving the chance that bystander CPR would be performed. The new sequence should theoretically only delay rescue breaths by about 18 seconds (the time it takes to deliver 30 compressions) or less (with 2 rescuers).

Chest Compression Depth

2010 (New): To achieve effective chest compressions, rescuers should compress at least one third of the anterior-posterior diameter of the chest. This corresponds to approximately 1½ inches (about 4 cm) in most infants and about 2 inches (5 cm) in most children.

2005 (Old): Push with sufficient force to depress the chest approximately one third to one half the anterior-posterior diameter of the chest.

Why: Evidence from radiologic studies of the chest in children suggests that compression to one half the anterior-posterior diameter may not be achievable. However, effective chest compressions require pushing hard, and based on new data, the depth of about 1½ inches (4 cm) for most infants and about 2 inches (5 cm) in most children is recommended.

Elimination of "Look, Listen, and Feel for Breathing"

2010 (New): "Look, listen, and feel" was removed from the sequence for assessment of breathing after opening the airway.

2005 (Old): "Look, listen, and feel" was used to assess breathing after the airway was opened.

Why: With the new chest compression–first sequence, CPR is performed if the infant or child is unresponsive and not breathing (or only gasping) and begins with compressions (C-A-B sequence).

Pulse Check Again De-emphasized

2010 (New): If the infant or child is unresponsive and not breathing or only gasping, healthcare providers may take up to 10 seconds to attempt to feel for a pulse (brachial in an infant and carotid or femoral in a child). If, within 10 seconds, you don't feel a pulse or are not sure if you feel a pulse, begin chest compressions. It can be difficult to determine the presence or absence of a pulse, especially in an emergency, and studies show that both healthcare providers and lay rescuers are unable to reliably detect a pulse.

2005 (Old): If you are a healthcare provider, try to palpate a pulse. Take no more than 10 seconds.

Why: The recommendation is the same, but there is additional evidence to suggest that healthcare providers cannot reliably and rapidly detect either the presence or the absence of a pulse in children. Given the risk of not providing chest compressions for a cardiac arrest victim and the relatively minimal risk of providing chest compressions when a pulse is present, the 2010 AHA Guidelines for CPR and ECC recommend compressions if a rescuer is unsure about the presence of a pulse.

Defibrillation and Use of the AED in Infants

2010 (New): For infants, a manual defibrillator is preferred to an AED for defibrillation. If a manual defibrillator is not available, an AED equipped with a pediatric dose attenuator is preferred. If neither is available, an AED without a pediatric dose attenuator may be used.

2005 (Old): Data have shown that AEDs can be used safely and effectively in children 1 to 8 years of age. However, there are insufficient data to make a recommendation for or against using an AED in infants <1 year of age.

Why: Newer case reports suggest that an AED may be safe and effective in infants. Because survival requires defibrillation when a shockable rhythm is present during cardiac arrest, delivery of a high-dose shock is preferable to no shock. Limited evidence supports the safety of AED use in infants.

PEDIATRIC ADVANCED LIFE SUPPORT

Summary of Key Issues and Major Changes

- Many key issues in the review of the PALS literature resulted in refinement of existing recommendations rather than new recommendations; new information is provided for resuscitation of infants and children with selected congenital heart defects and pulmonary hypertension.
- Monitoring capnography/capnometry is again recommended to confirm proper endotracheal tube position and may be useful during CPR to assess and optimize the quality of chest compressions.
- The PALS cardiac arrest algorithm was simplified to emphasize organization of care around 2-minute periods of uninterrupted CPR.
- The initial defibrillation energy dose of 2 to 4 J/kg of either monophasic or biphasic waveform is reasonable; for ease of teaching, a dose of 2 J/kg may be used (this dose is the same as in the 2005 recommendation). For second and subsequent doses, give at least 4 J/kg. Doses higher than 4 J/kg (not to exceed 10 J/kg or the adult dose) may also be safe and effective, especially if delivered with a biphasic defibrillator.
- On the basis of increasing evidence of potential harm from high oxygen exposure, a new recommendation has been added to titrate inspired oxygen (when appropriate equipment is available), once spontaneous circulation has been restored, to maintain an arterial oxyhemoglobin saturation ≥94% but <100% to limit the risk of hyperoxemia.
- New sections have been added on resuscitation of infants and children with congenital heart defects, including single ventricle, palliated single ventricle, and pulmonary hypertension.
- Several recommendations for medications have been revised. These include not administering calcium except in very specific circumstances and limiting the use of etomidate in septic shock.
- Indications for postresuscitation therapeutic hypothermia have been clarified somewhat.
- New diagnostic considerations have been developed for sudden cardiac death of unknown etiology.
- Providers are advised to seek expert consultation, if possible, when administering amiodarone or procainamide to hemodynamically stable patients with arrhythmias.
- The definition of wide-complex tachycardia has been changed from >0.08 second to >0.09 second.

Recommendations for Monitoring Exhaled CO_2

2010 (New): Exhaled CO_2 detection (capnography or colorimetry) is recommended in addition to clinical assessment to confirm tracheal tube position for neonates, infants, and children with a perfusing cardiac rhythm in all settings (eg, prehospital, ED, intensive care unit, ward, operating room) and during intrahospital or interhospital transport (Figure 3A on page 13). Continuous capnography or capnometry monitoring, if available, may be beneficial during CPR to help guide therapy, especially the effectiveness of chest compressions (Figure 3B on page 13).

2005 (Old): In infants and children with a perfusing rhythm, use a colorimetric detector or capnography to detect exhaled CO_2 to confirm endotracheal tube position in the prehospital and in-hospital settings and during intrahospital and interhospital transport.

Why: Exhaled CO_2 monitoring (capnography or colorimetry) generally confirms placement of the endotracheal tube in the airway and may more rapidly indicate endotracheal tube misplacement/displacement than monitoring of oxyhemoglobin saturation. Because patient transport increases the risk for tube displacement, continuous CO_2 monitoring is especially important at these times.

Animal and adult studies show a strong correlation between P_{ETCO_2} concentration and interventions that increase cardiac output during CPR. P_{ETCO_2} values consistently <10 to 15 mm Hg suggest that efforts should be focused on improving chest compressions and making sure that ventilation is not excessive. An abrupt and sustained rise in P_{ETCO_2} may be observed just before clinical identification of ROSC, so use of P_{ETCO_2} monitoring may reduce the need to interrupt chest compressions for a pulse check.

Defibrillation Energy Doses

2010 (New): It is acceptable to use an initial dose of 2 to 4 J/kg for defibrillation, but for ease of teaching, an initial dose of 2 J/kg may be used. For refractory VF, it is reasonable to increase the dose. Subsequent energy levels should be at least 4 J/kg, and higher energy levels, not to exceed 10 J/kg or the adult maximum dose, may be considered.

2005 (Old): With a manual defibrillator (monophasic or biphasic), use a dose of 2 J/kg for the first attempt and 4 J/kg for subsequent attempts.

Why: More data are needed to identify the optimal energy dose for pediatric defibrillation. Limited evidence is available about effective or maximum energy doses for pediatric defibrillation, but some data suggest that higher doses may be safe and potentially more effective. Given the limited evidence to support a change, the new recommendation is a minor modification that allows higher doses up to the maximum dose most experts believe is safe.

Limiting Oxygen to Normal Levels After Resuscitation

2010 (New): Once the circulation is restored, monitor arterial oxyhemoglobin saturation. It may be reasonable, when the appropriate equipment is available, to titrate oxygen administration to maintain the arterial oxyhemoglobin saturation ≥94%. Provided appropriate equipment is available, once ROSC is achieved, adjust the F_{IO_2} to the minimum concentration needed to achieve arterial oxyhemoglobin saturation ≥94%, with the goal of avoiding hyperoxia while ensuring adequate oxygen delivery. Because an arterial oxyhemoglobin saturation of 100% may correspond to a Pa_{O_2} anywhere between approximately 80 and 500 mm Hg, in general it is appropriate to wean the F_{IO_2} when the saturation is 100%, provided the saturation can be maintained ≥94%.

2005 (Old): Hyperoxia and the risk for reperfusion injury were addressed in the 2005 AHA Guidelines for CPR and ECC in general, but recommendations for titration of inspired oxygen were not as specific.

Why: In effect, if equipment to titrate oxygen is available, titrate oxygen to keep the oxyhemoglobin saturation 94% to 99%. Data suggest that hyperoxemia (ie, a high Pa_{O_2}) enhances the oxidative injury observed after ischemia-reperfusion such as occurs after resuscitation from cardiac arrest. The risk of oxidative injury may be reduced by titrating the F_{IO_2} to reduce the Pa_{O_2} (this is accomplished by monitoring arterial oxyhemoglobin saturation) while ensuring adequate arterial oxygen content. Recent data from an adult study[5] demonstrated worse outcomes with hyperoxia after resuscitation from cardiac arrest.

Resuscitation of Infants and Children With Congenital Heart Disease

2010 (New): Specific resuscitation guidance has been added for management of cardiac arrest in infants and children with single-ventricle anatomy, Fontan or hemi-Fontan/bidirectional Glenn physiology, and pulmonary hypertension.

2005 (Old): These topics were not addressed in the 2005 AHA Guidelines for CPR and ECC.

Why: Specific anatomical variants with congenital heart disease present unique challenges for resuscitation. The 2010 AHA Guidelines for CPR and ECC outline recommendations in each of these clinical scenarios. Common to all scenarios is the potential early use of extracorporeal membrane oxygenation as rescue therapy in centers with this advanced capability.

Management of Tachycardia

2010 (New): Wide-complex tachycardia is present if the QRS width is >0.09 second.

2005 (Old): Wide-complex tachycardia is present if the QRS width is >0.08 second.

Why: In a recent scientific statement,[6] QRS duration was considered prolonged if it was >0.09 second for a child under the age of 4 years, and ≥0.1 second was considered prolonged for a child between the ages of 4 and 16 years. For this reason, the PALS guidelines writing group concluded that it would be most appropriate to consider a QRS width >0.09 second as prolonged for the pediatric patient. Although the human eye is not likely to appreciate a difference of 0.01 second, a computer interpretation of the ECG can document the QRS width in milliseconds.

Medications During Cardiac Arrest and Shock

2010 (New): The recommendation regarding calcium administration is stronger than in past AHA Guidelines: routine calcium administration is not recommended for pediatric cardiopulmonary arrest in the absence of documented hypocalcemia, calcium channel blocker overdose, hypermagnesemia, or hyperkalemia. Routine calcium administration in cardiac arrest provides no benefit and may be harmful.

Etomidate has been shown to facilitate endotracheal intubation in infants and children with minimal hemodynamic effect but is not recommended for routine use in pediatric patients with evidence of septic shock.

2005 (Old): Although the 2005 AHA Guidelines for CPR and ECC noted that routine administration of calcium does not improve the outcome of cardiac arrest, the words "is not recommended" in the 2010 AHA Guidelines for CPR and ECC provide a stronger statement and indicate potential harm. Etomidate was not addressed in the 2005 AHA Guidelines for CPR and ECC.

Why: Stronger evidence against the use of calcium during cardiopulmonary arrest resulted in increased emphasis on avoiding the routine use of this drug except for patients with documented hypocalcemia, calcium channel blocker overdose, hypermagnesemia, or hyperkalemia.

Evidence of potential harm from the use of etomidate in both adults and children with septic shock led to the recommendation to avoid its routine use in this setting. Etomidate causes adrenal suppression, and the endogenous steroid response may be critically important in patients with septic shock.

Post–Cardiac Arrest Care

2010 (New): Although there have been no published results of prospective randomized pediatric trials of therapeutic hypothermia, based on adult evidence, therapeutic hypothermia (to 32°C to 34°C) may be beneficial for adolescents who remain comatose after resuscitation from sudden witnessed out-of-hospital VF cardiac arrest. Therapeutic hypothermia (to 32°C to 34°C) may also be considered for infants and children who remain comatose after resuscitation from cardiac arrest.

2005 (Old): Based on extrapolation from adult and neonatal studies, when pediatric patients remain comatose after resuscitation, consider cooling them to 32°C to 34°C for 12 to 24 hours.

Why: Additional adult studies have continued to show the benefit of therapeutic hypothermia for comatose patients after cardiac arrest, including those with rhythms other than VF. Pediatric data are needed.

Evaluation of Sudden Cardiac Death Victims

2010 (New Topic): When a sudden, unexplained cardiac death occurs in a child or young adult, obtain a complete past medical and family history (including a history of syncopal episodes, seizures, unexplained accidents/drowning, or sudden unexpected death at <50 years of age) and review previous ECGs. All infants, children, and young adults with sudden, unexpected death should, where resources allow, have an unrestricted complete autopsy, preferably performed by a pathologist with training and experience in cardiovascular pathology. Tissue should be preserved for genetic analysis to determine the presence of channelopathy.

Why: There is increasing evidence that some cases of sudden death in infants, children, and young adults may be associated with genetic mutations that cause cardiac ion transport defects known as channelopathies. These can cause fatal arrhythmias, and their correct diagnosis may be critically important for living relatives.

NEONATAL RESUSCITATION

Summary of Key Issues and Major Changes

Neonatal cardiac arrest is predominantly asphyxial, so the A-B-C resuscitation sequence with a 3:1 compression-to-ventilation ratio has been maintained except when the etiology is clearly cardiac. The following were the major neonatal topics in 2010:

- Once positive-pressure ventilation or supplementary oxygen administration is begun, assessment should consist of simultaneous evaluation of 3 clinical characteristics: heart rate, respiratory rate, and evaluation of the state of oxygenation (optimally determined by pulse oximetry rather than assessment of color)
- Anticipation of the need to resuscitate: elective cesarean section (new topic)
- Ongoing assessment
- Supplementary oxygen administration
- Suctioning
- Ventilation strategies (no change from 2005)
- Recommendations for monitoring exhaled CO_2
- Compression-to-ventilation ratio
- Thermoregulation of the preterm infant (no change from 2005)
- Postresuscitation therapeutic hypothermia
- Delayed cord clamping (new in 2010)
- Withholding or discontinuing resuscitative efforts (no change from 2005)

Anticipation of the Need to Resuscitate: Elective Cesarean Section

2010 (New): Infants without antenatal risk factors who are born by elective cesarean section performed under regional anesthesia at 37 to 39 weeks of gestation have a decreased requirement for intubation but a slightly increased need for mask ventilation compared with infants after normal vaginal delivery. Such deliveries must be attended by a person capable of providing mask ventilation but not necessarily by a person skilled in neonatal intubation.

Assessment of Heart Rate, Respiratory Rate, and Oxygenation

2010 (New): Once positive-pressure ventilation or supplementary oxygen administration is begun, assessment should consist of simultaneous evaluation of 3 clinical characteristics: heart rate, respiratory rate, and evaluation of the state of oxygenation. State of oxygenation is optimally determined by a pulse oximeter rather than by simple assessment of color.

2005 (Old): In 2005, assessment was based on heart rate, respiratory rate, and evaluation of color.

Why: Assessment of color is subjective. There are now data regarding normal trends in oxyhemoglobin saturation monitored by pulse oximeter.

Supplementary Oxygen

2010 (New): Pulse oximetry, with the probe attached to the right upper extremity, should be used to assess any need for supplementary oxygen. For babies born at term, it is best to begin resuscitation with air rather than 100% oxygen. Administration of supplementary oxygen should be regulated by blending oxygen and air, and the amount to be delivered should be guided by oximetry monitored from the right upper extremity (ie, usually the wrist or palm).

2005 (Old): If cyanosis, bradycardia, or other signs of distress are noted in a breathing newborn during stabilization, administration of 100% oxygen is indicated while the need for additional intervention is determined.

Why: Evidence is now strong that healthy babies born at term start with an arterial oxyhemoglobin saturation of <60% and can require more than 10 minutes to reach saturations of >90%. Hyperoxia can be toxic, particularly to the preterm baby.

Suctioning

2010 (New): Suctioning immediately after birth (including suctioning with a bulb syringe) should be reserved for babies who have an obvious obstruction to spontaneous breathing or require positive-pressure ventilation. There is insufficient evidence to recommend a change in the current practice of performing endotracheal suctioning of nonvigorous babies with meconium-stained amniotic fluid.

2005 (Old): The person assisting delivery of the infant should suction the infant's nose and mouth with a bulb syringe after delivery of the shoulders but before delivery of the chest. Healthy, vigorous newly born infants generally do not require suctioning after delivery. When the amniotic fluid is meconium stained, suction the mouth, pharynx, and nose as soon as the head is delivered (intrapartum suctioning) regardless of whether the meconium is thin or thick. If the fluid contains meconium and the infant has absent or depressed respirations, decreased muscle tone, or heart rate <100/min, perform direct laryngoscopy immediately after birth for suctioning of residual meconium from the hypopharynx (under direct vision) and intubation/suction of the trachea.

Why: There is no evidence that active babies benefit from airway suctioning, even in the presence of meconium, and there is evidence of risk associated with this suctioning. The available evidence does not support or refute the routine endotracheal suctioning of depressed infants born through meconium-stained amniotic fluid.

Ventilation Strategies

2010 (No Change From 2005): Positive-pressure ventilation should be administered with sufficient pressure to increase the heart rate or create chest expansion; excessive pressure can seriously injure the preterm lung. However, the optimum pressure, inflation time, tidal volumes, and amount of positive end-expiratory pressure required to establish an effective functional residual capacity have not been defined. Continuous positive airway pressure may be helpful in the transitioning of the preterm baby. Use of the laryngeal mask airway should be considered if face-mask ventilation is unsuccessful and tracheal intubation is unsuccessful or not feasible.

Recommendations for Monitoring Exhaled CO_2

2010 (New): Exhaled CO_2 detectors are recommended to confirm endotracheal intubation, although there are rare false-negatives in the face of inadequate cardiac output and false-positives with contamination of the detectors.

2005 (Old): An exhaled CO_2 monitor may be used to verify tracheal tube placement.

Why: Further evidence is available regarding the efficacy of this monitoring device as an adjunct to confirming endotracheal intubation.

Compression-to-Ventilation Ratio

2010 (New): The recommended compression-to-ventilation ratio remains 3:1. If the arrest is known to be of cardiac etiology, a higher ratio (15:2) should be considered.

2005 (Old): There should be a 3:1 ratio of compressions to ventilations, with 90 compressions and 30 breaths to achieve approximately 120 events per minute.

Why: The optimal compression-to-ventilation ratio remains unknown. The 3:1 ratio for newborns facilitates provision of adequate minute ventilation, which is considered critical for the vast majority of newborns who have an asphyxial arrest. The consideration of a 15:2 ratio (for 2 rescuers) recognizes that newborns with a cardiac etiology of arrest may benefit from a higher compression-to-ventilation ratio.

Postresuscitation Therapeutic Hypothermia

2010 (New): It is recommended that infants born at ≥36 weeks of gestation with evolving moderate to severe hypoxic-ischemic encephalopathy should be offered therapeutic hypothermia. Therapeutic hypothermia should be administered under clearly defined protocols similar to those used in published clinical trials and in facilities with the capabilities for multidisciplinary care and longitudinal follow-up.

2005 (Old): Recent animal and human studies suggested that selective (cerebral) hypothermia of the asphyxiated infant may protect against brain injury. Although this is a promising area of research, we cannot recommend routine implementation until appropriate controlled studies in humans have been performed.

Why: Several randomized controlled multicenter trials of induced hypothermia (33.5°C to 34.5°C) of newborns ≥36 weeks' gestational age with moderate to severe hypoxic ischemic encephalopathy showed that babies who were cooled had significantly lower mortality and less neurodevelopmental disability at 18-month follow-up.

Delayed Cord Clamping

2010 (New): There is increasing evidence of benefit of delaying cord clamping for at least 1 minute in term and preterm infants not requiring resuscitation. There is insufficient evidence to support or refute a recommendation to delay cord clamping in babies requiring resuscitation.

Withholding or Discontinuing Resuscitative Efforts

2010 (Reaffirmed 2005 Recommendation): In a newly born baby with no detectable heart rate, which remains undetectable for 10 minutes, it is appropriate to consider stopping resuscitation. The decision to continue resuscitation efforts beyond 10 minutes of no heart rate should take into consideration factors such as the presumed etiology of the arrest, the gestation of the baby, the presence or absence of complications, the potential role of therapeutic hypothermia, and the parents' previously expressed feelings about acceptable risk of morbidity. When gestation, birth weight, or congenital anomalies are associated with almost certain early death and an unacceptably high morbidity is likely among the rare survivors, resuscitation is not indicated.

ETHICAL ISSUES

Summary of Key Issues and Major Changes

The ethical issues relating to resuscitation are complex, occurring in different settings (in or out of the hospital) and among different providers (lay rescuers or healthcare personnel) and involving initiation or termination of basic and/or advanced life support. All healthcare providers should consider the ethical, legal, and cultural factors associated with providing care for individuals in need of resuscitation. Although providers play a role in the decision-making process during resuscitation, they should be guided by science, the preferences of the individual or their surrogates, and local policy and legal requirements.

Terminating Resuscitative Efforts in Adults With Out-of-Hospital Cardiac Arrest

2010 (New): For adults experiencing out-of-hospital cardiac arrest who are receiving only BLS, the "BLS termination of resuscitation rule" was established to consider terminating BLS support before ambulance transport if all of the following criteria are met:

- Arrest not witnessed by EMS provider or first responder
- No ROSC after 3 complete rounds of CPR and AED analyses
- No AED shocks delivered

For situations when ALS EMS personnel are present to provide care for an adult with out-of-hospital cardiac arrest, an "ALS termination of resuscitation" rule was established to consider terminating resuscitative efforts before ambulance transport if all of the following criteria are met:

- Arrest not witnessed (by anyone)
- No bystander CPR provided
- No ROSC after complete ALS care in the field
- No shocks delivered

Implementation of these rules includes contacting online medical control when the criteria are met. Emergency medical service providers should receive training in sensitive communication with the family about the outcome of the resuscitation. Support for the rules should be sought from collaborating agencies such as hospital EDs, the medical coroner's office, online medical directors, and the police.

2005 (Old): No specific criteria were established previously.

Why: Both BLS and ALS termination of resuscitation rules were validated externally in multiple EMS settings across the United States, Canada, and Europe. Implementation of these rules can reduce the rate of unnecessary hospital transport by 40% to 60%, thereby decreasing associated road hazards, which place providers and the public at risk, inadvertent exposure of EMS personnel to potential biohazards, and the higher cost of ED pronouncement. *Note:* No such criteria have been established for pediatric (neonate, infant, or child) out-of-hospital cardiac arrest, because no predictors of resuscitation outcome have been validated for out-of-hospital cardiac arrest in this population.

Prognostic Indicators in the Adult Postarrest Patient Treated With Therapeutic Hypothermia

2010 (New): In adult post–cardiac arrest patients treated with therapeutic hypothermia, it is recommended that clinical neurologic signs, electrophysiologic studies, biomarkers, and imaging be performed where available at 3 days after cardiac arrest. Currently, there is limited evidence to guide decisions regarding withdrawal of life support. The clinician should document all available prognostic testing 72 hours after cardiac arrest treated with therapeutic hypothermia and use best clinical judgment based on this testing to make a decision to withdraw life support when appropriate.

2005 (Old): No prognostic indicators had been established for patients undergoing therapeutic hypothermia.

For those not undergoing therapeutic hypothermia, a meta-analysis of 33 studies of outcome of anoxic-ischemic coma documented that the following 3 factors were associated with poor outcome:

- Absence of pupillary response to light on the third day
- Absence of motor response to pain by the third day

- Bilateral absence of cortical response to median nerve somatosensory-evoked potentials when used in normothermic patients who were comatose for at least 72 hours after a hypoxic-ischemic insult

Withdrawal of life support is ethically permissible under these circumstances.

Why: On the basis of the limited available evidence, potentially reliable prognosticators of poor outcome in patients treated with therapeutic hypothermia after cardiac arrest include bilateral absence of N20 peak on somatosensory evoked potential ≥24 hours after cardiac arrest and the absence of both corneal and pupillary reflexes ≥3 days after cardiac arrest. Limited available evidence also suggests that a Glasgow Coma Scale Motor Score of 2 or less at day 3 after sustained ROSC and the presence of status epilepticus are potentially unreliable prognosticators of poor outcome in post–cardiac arrest patients treated with therapeutic hypothermia. Similarly, recovery of consciousness and cognitive functions is possible in a few post–cardiac arrest patients treated with therapeutic hypothermia despite bilateral absent or minimally present N20 responses of median nerve somatosensory evoked potentials, which suggests they may be unreliable as well. The reliability of serum biomarkers as prognostic indicators is also limited by the relatively few patients who have been studied.

EDUCATION, IMPLEMENTATION, AND TEAMS

Education, Implementation, and Teams is a new section in the 2010 AHA Guidelines for CPR and ECC to address the growing body of evidence guiding best practices for teaching and learning resuscitation skills, implementation of the Chain of Survival, and best practice related to teams and systems of care. Because this information will likely impact course content and format, the recommendations are highlighted here.

Summary of Key Issues

Major recommendations and points of emphasis in this new section include the following:

- The current 2-year certification period for basic and advanced life support courses should include periodic assessment of rescuer knowledge and skills, with reinforcement or refresher information provided as needed. The optimal timing and method for this reassessment and reinforcement are not known and warrant further investigation.
- Methods to improve bystander willingness to perform CPR include formal training in CPR.
- Hands-Only (compression-only) CPR should be taught to those who may be unwilling or unable to perform conventional CPR, and providers should be educated to overcome barriers to provision of CPR (eg, fear or panic when faced with an actual cardiac arrest victim).
- Emergency medical services dispatchers should provide instructions over the telephone to help bystanders recognize victims of cardiac arrest, including victims who may still be gasping, and to encourage bystanders to provide CPR if arrest is likely. Dispatchers may instruct untrained bystanders in the performance of Hands-Only (compression-only) CPR.
- Basic life support skills can be learned equally well with "practice while watching" a video presentation as with longer, traditional, instructor-led courses.
- To reduce the time to defibrillation for cardiac arrest victims, AED use should not be limited only to persons with formal training in their use. However, AED training does improve performance in simulation and continues to be recommended.
- Training in teamwork and leadership skills should continue to be included in ACLS and PALS courses.
- Manikins with realistic features such as the capability to demonstrate chest expansion and breath sounds, generate a pulse and blood pressure, and speak may be useful for integrating the knowledge, skills, and behaviors required in ACLS and PALS training. However, there is insufficient evidence to recommend for or against their routine use in courses.
- Written tests should not be used exclusively to assess the competence of a participant in an advanced life support (ACLS or PALS) course; performance assessment is also needed.
- Formal assessment should continue to be included in resuscitation courses, as a method of evaluating both the success of the student in achieving the learning objectives and the effectiveness of the course.
- Cardiopulmonary resuscitation prompt and feedback devices may be useful for training rescuers and may be useful as part of an overall strategy to improve the quality of CPR for actual cardiac arrests.
- Debriefing is a learner-focused, nonthreatening technique to help individual rescuers and teams reflect on and improve performance. Debriefing should be included in ALS courses to facilitate learning and can be used to review performance in the clinical setting to improve subsequent performance.
- Systems-based approaches to improving resuscitation performance, such as regional systems of care and rapid response systems or medical emergency teams, may be useful to reduce the variability in survival from cardiac arrest.

Two Years Is Too Long an Interval for Skills Practice and Reassessment

2010 (New): Skill performance should be assessed during the 2-year certification with reinforcement provided as needed. The optimal timing and method for this reassessment and reinforcement are not known.

Why: The quality of rescuer education and frequency of retraining are critical factors in improving the effectiveness of resuscitation. Ideally, retraining should not be limited to 2-year intervals. More frequent renewal of skills is needed, with a commitment to maintenance of certification similar to that embraced by many healthcare-credentialing organizations. Instructors and participants should be aware that successful completion of any AHA ECC course is only the first step toward attaining and maintaining competence. American Heart Association ECC courses should be part of a larger continuing education and continuous quality improvement process that reflects the needs and practices of individuals and systems. The best method to help rescuers maintain required resuscitation skills is currently unknown.

Learning to Mastery

2010 (New): 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 cardiac arrests and resuscitations. Training for the complex combination of skills required to perform adequate chest compressions should focus on demonstrating mastery.

Why: Maintaining focus during CPR on the 3 characteristics of rate, depth, and chest recoil while minimizing interruptions is a complex challenge even for highly trained professionals and accordingly must receive appropriate attention in training. The 2010 AHA Guidelines for CPR and ECC have placed renewed emphasis on ensuring that chest compressions are performed correctly. Training simply to "push hard and push fast" may not be adequate to ensure excellent chest compressions. Use of CPR prompt and feedback devices during training can improve learning and retention.

Overcoming Barriers to Performance

2010 (New): Training should address barriers that interfere with bystander willingness to attempt CPR.

Why: Many fears of potential rescuers can be alleviated by education about actual risks to the resuscitation provider and to the arrest victim. Education may help people previously trained in BLS to be more likely to attempt resuscitation. Frequent responses identified in studies of actual bystanders are fear and panic, and training programs must identify methods to reduce these responses. Emergency medical services dispatcher instructions should identify and use methods that have proven effective in educating and motivating potential providers to act.

Learning Teamwork Skills in ACLS and PALS

2010 (New): Advanced life support training should include training in teamwork.

Why: Resuscitation skills are often performed simultaneously, and healthcare providers must be able to work collaboratively to minimize interruptions in chest compressions. Teamwork and leadership skills continue to be important, particularly for advanced courses that include ACLS and PALS providers.

AED Training Not Required for Use

2010 (New): Use of an AED does not require training, although training does improve performance.

Why: Manikin-based studies have demonstrated that AEDs can be operated correctly without prior training. Allowing the use of AEDs by untrained bystanders can be beneficial and may be lifesaving. Because even minimal training has been shown to improve performance in simulated cardiac arrests, training opportunities should be made available and promoted for the lay rescuer.

Continuous Quality Improvement for Resuscitation Programs

2010 (New): Resuscitation systems should establish ongoing systems of care assessment and improvement.

Why: There is evidence of considerable regional variation in the reported incidence and outcome of cardiac arrest in the United States. This variation is further evidence of the need for communities and systems to accurately identify each instance of treated cardiac arrest and measure outcomes. It also suggests additional opportunities for improving survival rates in many communities.

Community and hospital-based resuscitation programs should systematically monitor cardiac arrests, the level of resuscitation care provided, and outcome. Continuous quality improvement includes systematic evaluation and feedback, measurement or benchmarking and interpretation, and efforts to optimize resuscitation care and help to narrow the gaps between ideal and actual resuscitation performance.

FIRST AID

The 2010 First Aid Guidelines were once again codeveloped by the AHA and the American Red Cross (ARC). The 2010 AHA/ARC Guidelines for First Aid are based on worksheets (topical literature reviews) on selected topics, under the auspices of an International First Aid Science Advisory Board made up of representatives from 30 first aid organizations; this process is different from that used for the ILCOR International Consensus on CPR and ECC Science With Treatment Recommendations and was not part of the ILCOR process.

For the purposes of the 2010 AHA/ARC Guidelines for First Aid, the International First Aid Science Advisory Board defined first aid as the assessments and interventions that can be performed by a bystander (or by the victim) with minimal or no medical equipment. A first aid provider is defined as someone with formal training in first aid, emergency care, or medicine who provides first aid.

Summary of Key Issues and Major Changes

Key topics in the 2010 AHA/ARC Guidelines for First Aid include

- Supplementary oxygen administration
- Epinephrine and anaphylaxis
- Aspirin administration for chest discomfort (new)
- Tourniquets and bleeding control
- Hemostatic agents (new)
- Snakebites
- Jellyfish stings (new)
- Heat emergencies

Topics covered in the 2010 Guidelines but with no new recommendations since 2005 are the use of inhalers for breathing difficulties, seizures, wounds and abrasions, burns and burn blisters, spine stabilization, musculoskeletal injuries, dental injuries, cold emergencies, and poison emergencies.

Supplementary Oxygen

2010 (No Change From 2005): Routine administration of supplementary oxygen is not recommended as a first aid measure for shortness of breath or chest discomfort.

2010 (New): Supplementary oxygen administration should be considered as part of first aid for divers with a decompression injury.

Why: As in 2005, no evidence was found that showed a benefit of supplementary oxygen administration as a first aid measure to victims with shortness of breath or chest discomfort. Evidence was found (new for 2010) of a possible benefit of supplementary oxygen for divers with a decompression injury.

Epinephrine and Anaphylaxis

2010 (New): New in 2010 is the recommendation that if symptoms of anaphylaxis persist despite epinephrine administration, first aid providers should seek medical assistance before administering a second dose of epinephrine.

2005 (Old): As in 2005, the 2010 AHA/ARC Guidelines for First Aid recommend that first aid providers learn the signs and symptoms of anaphylaxis and the proper use of an epinephrine autoinjector so they can aid the victim.

Why: Epinephrine can be lifesaving for a victim of anaphylaxis, but approximately 18% to 35% of victims who have the signs and symptoms of anaphylaxis may require a second dose of epinephrine. The diagnosis of anaphylaxis can be a challenge, even for professionals, and excessive epinephrine administration may produce complications (eg, worsening of myocardial ischemia or arrhythmias) if given to patients who do not have anaphylaxis (eg, if administered to a patient with ACS). Therefore, the first aid provider is encouraged to activate the EMS system before administering a second dose of epinephrine.

Aspirin Administration for Chest Discomfort

2010 (New): First aid providers are encouraged to activate the EMS system for anyone with chest discomfort. While waiting for EMS to arrive, first aid providers should advise the patient to chew 1 adult (non–enteric-coated) or 2 low-dose “baby” aspirins if the patient has no history of allergy to aspirin and no recent gastrointestinal bleeding.

Why: Aspirin is beneficial if the chest discomfort is due to an ACS. It can be very difficult even for professionals to determine whether chest discomfort is of cardiac origin. The administration of aspirin must therefore never delay EMS activation.

Tourniquets and Bleeding Control

2010 (No Change From 2005): Because of the potential adverse effects of tourniquets and difficulty in their proper application, use of a tourniquet to control bleeding of the extremities is indicated only if direct pressure is not effective or possible and if the first aid provider has proper training in tourniquet use.

Why: There has been a great deal of experience with using tourniquets to control bleeding on the battlefield, and there is no question that they work under proper circumstances and with proper training. However, there are no data on tourniquet use by first aid providers. The adverse effects of tourniquets, which can include ischemia and gangrene of the extremity, as well as shock and even death, appear to be related to the amount of time tourniquets remain in place, and their effectiveness is partially dependent on tourniquet type. In general, specially designed tourniquets are better than improvised ones.

Hemostatic Agents

2010 (New): The routine use of hemostatic agents to control bleeding as a first aid measure is not recommended at this time.

Why: Despite the fact that a number of hemostatic agents have been effective in controlling bleeding, their use is not recommended as a first aid method of bleeding control because of significant variability in effectiveness and the potential for adverse effects, including tissue destruction with induction of a proembolic state and potential thermal injury.

Snakebites

2010 (New): Applying a pressure immobilization bandage with a pressure between 40 and 70 mm Hg in the upper extremity and between 55 and 70 mm Hg in the lower extremity around the entire length of the bitten extremity is an effective and safe way to slow lymph flow and therefore the dissemination of venom.

2005 (Old): In 2005, use of pressure immobilization bandages to slow the spread of the toxin was recommended only for victims of bites by snakes with neurotoxic venom.

Why: Effectiveness of pressure immobilization has now also been demonstrated for bites by other venomous American snakes.

Jellyfish Stings

2010 (New): To inactivate venom load and prevent further envenomation, jellyfish stings should be liberally washed with vinegar (4% to 6% acetic acid solution) as soon as possible and for at least 30 seconds. After the nematocysts are removed or deactivated, the pain from jellyfish stings should be treated with hot-water immersion when possible.

Why: There are 2 actions necessary for treatment of jellyfish stings: preventing further nematocyst discharge and pain relief. A number of topical treatments have been used, but a critical evaluation of the literature shows that vinegar is most effective for inactivation of the nematocysts. Immersion with water, as hot as tolerated for about 20 minutes, is most effective for treating the pain.

Heat Emergencies

2010 (No Change From 2005): First aid for heat cramps includes rest, cooling off, and drinking an electrolyte-carbohydrate mixture that can include juice, milk, or a commercial electrolyte-carbohydrate drink. Stretching, icing, and massaging the painful muscles may be helpful. Heat exhaustion must be vigorously treated by having the victim lie down in a cool place, removing as many of the victim's clothes as possible, cooling, preferably by immersing the victim in cold water, and activating EMS. Heat stroke requires emergency treatment by EMS providers and will require treatment with IV fluids. The first aid provider should not try to force the victim of heat stroke to drink fluids.

Why: The 2010 AHA/ARC Guidelines for First Aid have divided heat emergencies into 3 categories of increasing severity: heat cramps, heat exhaustion, and, the most severe, heat stroke. Signs of heat stroke include those of heat exhaustion plus signs of central nervous system involvement. As a result, heat stroke requires emergency care including IV fluid therapy.

SUMMARY

In the years since the publication of the 2005 AHA Guidelines for CPR and ECC, many resuscitation systems and communities have documented improved survival for victims of cardiac arrest. However, too few victims of cardiac arrest receive bystander CPR. We know that CPR quality must be high and that victims require excellent post–cardiac arrest care by organized teams with members who function well together. Education and frequent refresher training are likely the keys to improving resuscitation performance. In this 50th year since the publication of the landmark Kouwenhoven, Jude, and Knickerbocker description of successful closed chest compression,[4] we must all rededicate ourselves to improving the frequency of bystander CPR and the quality of all CPR and post–cardiac arrest care.

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HIGHLIGHTS

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