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Part 5: Adult Basic Life Support

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

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Basic life support (BLS) is the foundation for saving lives following cardiac arrest. Fundamental aspects of BLS include immediate **recognition** of sudden cardiac arrest (SCA) and **activation** of the emergency response system, early **cardiopulmonary resuscitation** (*CPR*), and rapid **defibrillation** with an automated external defibrillator (*AED).* Initial recognition and response to heart attack and stroke are also considered part of BLS. This section presents the 2010 adult BLS guidelines for lay rescuers and healthcare providers. Key changes and continued points of emphasis from the 2005 BLS Guidelines include the following:

- Immediate recognition of SCA based on assessing unresponsiveness and absence of normal breathing (ie, the victim is not breathing or only gasping)
- "Look, Listen, and Feel" removed from the BLS algorithm
- Encouraging Hands-Only (chest compression only) CPR (ie, continuous chest compression over the middle of the chest) for the untrained lay-rescuer
- Sequence change to chest compressions before rescue breaths (CAB rather than ABC)
- Health care providers continue effective chest compressions/CPR until return of spontaneous circulation (ROSC) or termination of resuscitative efforts
- Increased focus on methods to ensure that high-quality CPR (compressions of adequate rate and depth, allowing full chest recoil between compressions, minimizing interruptions in chest compressions and avoiding excessive ventilation) is performed
- Continued de-emphasis on pulse check for health care providers
- A simplified adult BLS algorithm is introduced with the revised traditional algorithm
- Recommendation of a simultaneous, choreographed approach for chest compressions, airway management, rescue breathing, rhythm detection, and shocks (if appropriate) by an integrated team of highly-trained rescuers in appropriate settings

Despite important advances in prevention, SCA continues to be a leading cause of death in many parts of the world.[1] SCA has many etiologies (ie, cardiac or noncardiac causes), circumstances (eg, witnessed or unwitnessed), and settings (eg, out-of-hospital or in-hospital). This heterogeneity suggests that a single approach to resuscitation is not practical, but a core set of actions provides a universal strategy for achieving successful resuscitation. These actions are termed the links in the "Chain of Survival." For adults they include

- Immediate recognition of cardiac arrest and activation of the emergency response system
- Early CPR that emphasizes chest compressions
- Rapid defibrillation if indicated
- Effective advanced life support
- Integrated post–cardiac arrest care

When these links are implemented in an effective way, survival rates can approach 50% following witnessed out-of-hospital ventricular fibrillation (VF) arrest.[2] Unfortunately survival rates in many out-of-hospital and in-hospital settings fall far short of this figure. For example, survival rates following cardiac arrest due to VF vary from approximately 5% to 50% in both out-of-hospital and in-hospital settings.[3,4] This variation in outcome underscores the opportunity for improvement in many settings.

Recognition of cardiac arrest is not always straightforward, especially for laypersons. Any confusion on the part of a rescuer can result in a delay or failure to activate the emergency response system or to start CPR. Precious time is lost if bystanders are too confused to act. Therefore, these adult BLS Guidelines focus on recognition of cardiac arrest with an appropriate set of rescuer actions. Once the lay bystander recognizes that the victim is unresponsive, that bystander must immediately activate (or send someone to activate) the emergency response system. Once the healthcare provider recognizes that the victim is unresponsive with no breathing or no normal breathing (ie, only gasping) the healthcare provider will activate the emergency response system. After activation, rescuers should immediately begin CPR.

Early CPR can improve the likelihood of survival, and yet CPR is often not provided until the arrival of professional emergency responders.[5] Chest compressions are an especially critical component of CPR because perfusion during CPR

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depends on these compressions. Therefore, chest compressions should be the highest priority and the initial action when starting CPR in the adult victim of sudden cardiac arrest. The phrase "push hard and push fast" emphasizes some of these critical components of chest compression. High-quality CPR is important not only at the onset but throughout the course of resuscitation. Defibrillation and advanced care should be interfaced in a way that minimizes any interruption in CPR.[6]

Rapid defibrillation is a powerful predictor of successful resuscitation following VF SCA.[7,8] Efforts to reduce the interval from collapse to defibrillation can potentially improve survival in both out-of-hospital and in-hospital settings.[8,9] Depending on the setting and circumstances, earlier defibrillation may be achieved by a variety of strategies that include rescuers who are laypersons, nontraditional first responders, police, emergency medical services (EMS) professionals, and hospital professionals.[9–12] One of these strategies is the use of an AED. The AED correctly assesses heart rhythm, enabling a rescuer who is not trained in heart rhythm interpretation to accurately provide a potentially lifesaving shock to a victim of SCA.[13]

Immediate **recognition and activation**, early **CPR**, and rapid **defibrillation** (when appropriate) are the first three BLS links in the adult Chain of Survival. BLS care in the out-of-hospital setting is often provided by laypersons who may be involved in a resuscitation attempt only once in their lives. Thus, creating an effective strategy to translate BLS skills to real-world circumstances presents a challenge. This section updates the adult BLS guidelines with the goal of incorporating new scientific information while acknowledging the challenges of real-world application. Everyone, regardless of training or experience, can potentially be a lifesaving rescuer.

The rest of this chapter is organized in sections that address the emergency response system, adult BLS sequence, adult BLS skills, use of an AED, special resuscitation situations, and the quality of BLS. The "Adult BLS Sequence" section provides an overview and an abridged version of the BLS sequence. The "Adult BLS Skills" section provides greater detail regarding individual CPR skills and more information about Hands-Only (compression-only) CPR. The "Special Resuscitation Situations" section addresses acute coronary syndromes, stroke, hypothermia, and foreign body airway obstruction. Because of increasing interest in monitoring and ensuring the quality of CPR, the last section focuses on the quality of BLS.

Activating the Emergency Response System

Emergency medical dispatch is an integral component of the EMS response.[14] Bystanders (lay responders) should immediately call their local emergency number to initiate a response anytime they find an unresponsive victim. Because dispatcher CPR instructions substantially increase the likelihood of bystander CPR performance and improve survival from cardiac arrest, all dispatchers should be appropriately trained to provide telephone CPR instructions (Class I, LOE B).[15–21]

When dispatchers ask bystanders to determine if breathing is present, bystanders often misinterpret agonal gasps or abnormal breathing as normal breathing. This erroneous information can result in failure by 911 dispatchers to instruct bystanders to initiate CPR for a victim of cardiac arrest.[19,22–26] To help bystanders recognize cardiac arrest, dispatchers should inquire about a victim's absence of consciousness and quality of breathing (normal versus not normal). Dispatchers should be specifically educated in recognition of abnormal breathing in order to improve recognition of gasping and cardiac arrest (Class I, LOE B). Notably, dispatchers should be aware that brief generalized seizures may be the first manifestation of cardiac arrest.[26,27] Dispatchers should recommend CPR for unresponsive victims who are not breathing normally because most are in cardiac arrest and the frequency of serious injury from chest compressions in the nonarrest group is very low (Class I, LOE B).[28] In summary, in addition to activating professional emergency responders, the dispatcher should ask straightforward questions about whether the patient is conscious and breathing normally in order to identify patients with possible cardiac arrest. The dispatcher should also provide CPR instructions to help bystanders initiate CPR when cardiac arrest is suspected.

Because it is easier for rescuers receiving telephone CPR instructions to perform Hands-Only (compression-only) CPR than conventional CPR (compressions plus rescue breathing), dispatchers should instruct untrained lay rescuers to provide Hands-Only CPR for adults with SCA (Class I, LOE B).[29] While Hands-Only CPR instructions have broad applicability, instances remain when rescue breaths are critically important. Dispatchers should include rescue breathing in their telephone CPR instructions to bystanders treating adult and pediatric victims with a high likelihood of an asphyxial cause of arrest (eg, drowning).[30]

The EMS system quality improvement process, including review of the quality of dispatcher CPR instructions provided to specific callers, is considered an important component of a high-quality lifesaving program (Class IIa, LOE B).[31–33]

Adult BLS Sequence

The steps of BLS consist of a series of sequential assessments and actions, which are illustrated in the new simplified BLS algorithm (Figure 1). The intent of the algorithm is to present the steps of BLS in a logical and concise manner that is easy for all types of rescuers to learn, remember and perform. These actions have traditionally been presented as a sequence of distinct steps to help a single rescuer prioritize actions. However, many workplaces and most EMS and in-hospital resuscitations involve teams of providers who should perform several actions simultaneously (eg, one rescuer activates the emergency response system while another begins chest compressions, and a third either provides ventilations or retrieves the bag-mask for rescue breathing, and a fourth retrieves and sets up a defibrillator).

Immediate Recognition and Activation of the Emergency Response System

If a lone rescuer finds an unresponsive adult (ie, no movement or response to stimulation) or witnesses an adult who suddenly collapses, after ensuring that the scene is safe, the rescuer should check for a response by tapping the victim on the shoulder and shouting at the victim. The trained or

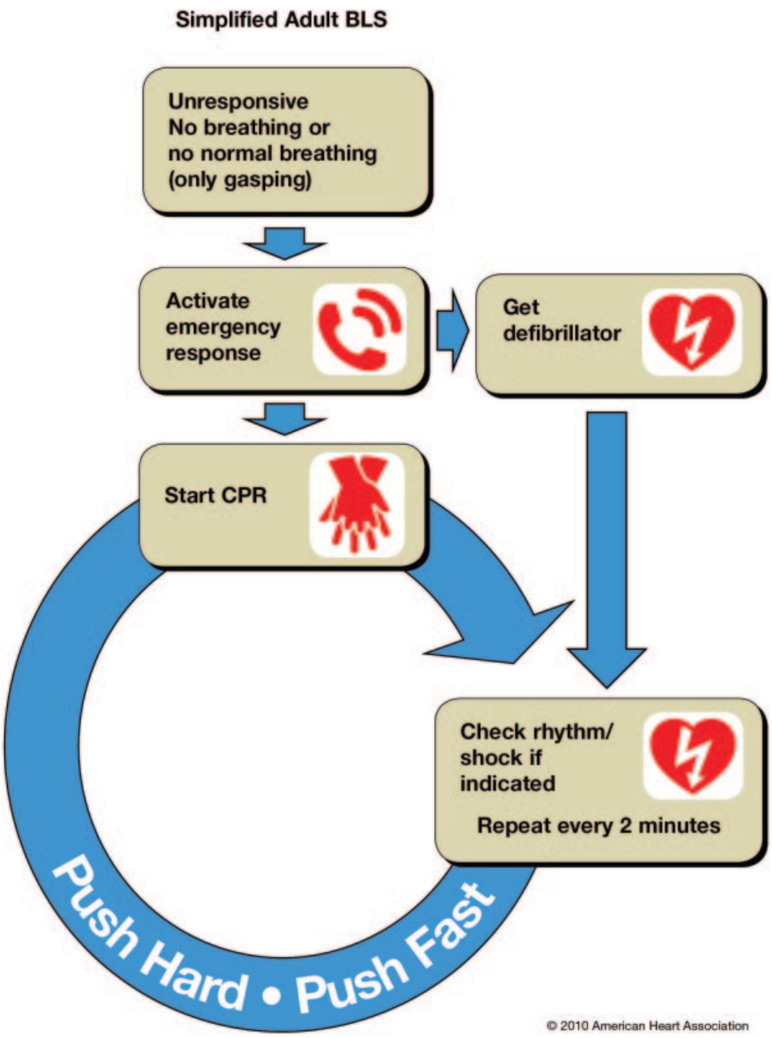

Figure 1. Simplified adult BLS algorithm.

untrained bystander should—at a minimum—activate the community emergency response system (eg, call 911, or if in an institution with an emergency response system, call that facility's emergency response number). If the victim also has absent or abnormal breathing (ie, only gasping), the rescuer should assume the victim is in cardiac arrest (Class I, LOE C).[19,24,34] The lay rescuer should phone the emergency response system once the rescuer finds that the victim is unresponsive—the dispatcher should be able to guide the lay rescuer through the check for breathing and the steps of CPR, if needed. The healthcare provider can check for response and look for no breathing or no normal breathing (ie, only gasping) almost simultaneously before activating the emergency response system. After activation of the emergency response system, all rescuers should immediately begin CPR (see steps below) for adult victims who are unresponsive with no breathing or no normal breathing (only gasping).

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

Pulse Check

Studies have shown that both lay rescuers and healthcare providers have difficulty detecting a pulse.[35–44] Healthcare providers also may take too long to check for a pulse.[38,41]

- The lay rescuer should not check for a pulse and should assume that cardiac arrest is present if an adult suddenly collapses or an unresponsive victim is not breathing normally.
- The healthcare provider should take no more than 10 seconds to check for a pulse and, if the rescuer does not definitely feel a pulse within that time period, the rescuer should start chest compressions (Class IIa, LOE C).[45,46]

Early CPR

Chest Compressions

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

- Effective chest compressions are essential for providing blood flow during CPR. For this reason all patients in cardiac arrest should receive chest compressions (Class I, LOE B).[47–51]

- To provide effective chest compressions, push hard and push fast. It is reasonable for laypersons and healthcare providers to compress the adult chest at a rate of at least 100 compressions per minute (Class IIa, LOE B) with a compression depth of at least 2 inches/5 cm (Class IIa, LOE B). Rescuers should allow complete recoil of the chest after each compression, to allow the heart to fill completely before the next compression (Class IIa, LOE B).
- Rescuers should attempt to minimize the frequency and duration of interruptions in compressions to maximize the number of compressions delivered per minute (Class IIa, LOE B). A compression-ventilation ratio of 30:2 is recommended (Class IIa, LOE B).

Rescue Breaths

A change in the *2010 AHA Guidelines for CPR and ECC* is to recommend the initiation of compressions before ventilations. While no published human or animal evidence demonstrates that starting CPR with 30 compressions rather than 2 ventilations leads to improved outcomes, it is clear that blood flow depends on chest compressions. Therefore, delays in, and interruptions of, chest compressions should be minimized throughout the entire resuscitation. Moreover, chest compressions can be started almost immediately, while positioning the head, achieving a seal for mouth-to-mouth rescue breathing, and getting a bag-mask apparatus for rescue breathing all take time. Beginning CPR with 30 compressions rather than 2 ventilations leads to a shorter delay to first compression (Class IIb, LOE C).[52–54]

Once chest compressions have been started, a trained rescuer should deliver rescue breaths by mouth-to-mouth or bag-mask to provide oxygenation and ventilation, as follows:

- Deliver each rescue breath over 1 second (Class IIa, LOE C).
- Give a sufficient tidal volume to produce *visible chest rise* (Class IIa, LOE C).[55]
- Use a compression to ventilation ratio of 30 chest compressions to 2 ventilations.

Early Defibrillation With an AED

After activating the emergency response system the lone rescuer should next retrieve an AED (if nearby and easily accessible) and then return to the victim to attach and use the AED. The rescuer should then provide high-quality CPR. When 2 or more rescuers are present, one rescuer should begin chest compressions while a second rescuer activates the emergency response system and gets the AED (or a manual defibrillator in most hospitals) (Class IIa, LOE C). The AED should be used as rapidly as possible and both rescuers should provide CPR with chest compressions and ventilations.

Defibrillation Sequence

- Turn the AED on.
- Follow the AED prompts.
- Resume chest compressions immediately after the shock (minimize interruptions).

Rescuer Specific CPR Strategies: Putting It All Together

This section summarizes the sequence of CPR interventions that should be performed by 3 prototypical rescuers after they activate the emergency response system. The specific steps that rescuers should take (Hands-Only CPR, conventional CPR with rescue breathing, CPR and AED use) are determined by the rescuer's level of training.

Untrained Lay Rescuer

If a bystander is not trained in CPR, then the bystander should provide Hands-Only (chest compression only) CPR, with an emphasis on "push hard and fast," 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 healthcare providers take over care of the victim (Class IIa, LOE B).

Trained Lay Rescuer

All lay rescuers should, at a minimum, provide chest compressions for victims of cardiac arrest. In addition, if the trained lay rescuer is able to perform rescue breaths, he or she should add rescue breaths in a ratio of 30 compressions to 2 breaths. The rescuer should continue CPR until an AED arrives and is ready for use or EMS providers take over care of the victim (Class I, LOE B).

Healthcare Provider

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 (Class IIa, LOE B). This should be performed in cycles of 30 compressions to 2 ventilations until an advanced airway is placed; then continuous chest compressions with ventilations at a rate of 1 breath every 6 to 8 seconds (8 to 10 ventilations per minute) should be performed. Care should be taken to minimize interruptions in chest compressions when placing, or ventilating with, an advanced airway. In addition, excessive ventilation should be avoided.

It is reasonable for healthcare providers to tailor the sequence of rescue actions to the most likely cause of arrest. For example, if a lone healthcare provider sees an adolescent suddenly collapse, the provider may assume that the victim has suffered a sudden cardiac arrest and call for help (phone 911 or the emergency response number), get an AED (if nearby), and return to the victim to attach and use the AED and then provide CPR. If a lone healthcare provider aids an adult drowning victim or a victim of foreign body airway obstruction who becomes unconscious, the healthcare provider may give about 5 cycles (approximately 2 minutes) of CPR before activating the emergency response system (Class IIa, LOE C).

Adult BLS Skills

The sequence of BLS skills for the healthcare provider is depicted in the BLS Healthcare Provider Algorithm (see Figure 2).

Recognition of Arrest (Box 1)

The necessary first step in the treatment of cardiac arrest is immediate recognition. Bystanders may witness the sudden

Figure 2. BLS healthcare provider algorithm.

collapse of a victim or find someone who appears lifeless. At that time several steps should be initiated. Before approaching a victim, the rescuer must ensure that the scene is safe and then check for response. To do this, tap the victim on the shoulder and shout, "Are you all right?" If the victim is responsive he or she will answer, move, or moan. If the victim remains unresponsive, the **lay rescuer** should activate the emergency response system. The **health care provider** should also check for no breathing or no normal breathing (ie, only gasping) while checking for responsiveness; if the healthcare provider finds the victim is unresponsive with no breathing or no normal breathing (ie, only gasping), the rescuer should assume the victim is in cardiac arrest and immediately activate the emergency response system (Class I, LOE C[19,24,34]).

These *2010 AHA Guidelines for CPR and ECC* deemphasize checking for breathing. Professional as well as lay rescuers may be unable to accurately determine the presence or absence of adequate or normal breathing in unresponsive victims[35,56] because the airway is not open[57] or because the victim has occasional gasps, which can occur in the first minutes after SCA and may be confused with adequate breathing. Occasional gasps do not necessarily result in adequate ventilation. The rescuer should treat the victim who has occasional gasps as if he or she is not breathing (Class I, LOE C). CPR training, both formal classroom training and "just in time" training such as that given through a dispatch center, should emphasize how to recognize occasional gasps and should instruct rescuers to provide CPR even when the unresponsive victim demonstrates occasional gasps (Class I, LOE B).

These *2010 AHA Guidelines for CPR and ECC* also deemphasize the pulse check as a mechanism to identify cardiac arrest. Studies have shown that both laypersons and healthcare providers have difficulty detecting a pulse.[35–44] For this reason pulse check was deleted from training for lay rescuers several years ago, and is deemphasized in training for healthcare providers. The lay rescuer should assume that cardiac arrest is present and should begin CPR if an adult suddenly collapses or an unresponsive victim is not breathing or not breathing normally (ie, only gasping).

Healthcare providers may take too long to check for a pulse[38,41] and have difficulty determining if a pulse is present or absent.[38,41,45] There is no evidence, however, that checking for breathing, coughing, or movement is superior for detection of circulation.[58] Because delays in chest compressions should be minimized, the healthcare provider should take no more than 10 seconds to check for a pulse; and if the rescuer does not definitely feel a pulse within that time period the rescuer should start chest compressions (Class IIa, LOE C[45,46]).

Technique: Chest Compressions (Box 4)

To maximize the effectiveness of chest compressions, place the victim on a firm surface when possible, in a supine position with the rescuer kneeling beside the victim's chest (eg, out-of-hospital) or standing beside the bed (eg, in-hospital).[59] Because hospital beds are typically not firm and some of the force intended to compress the chest results in mattress displacement rather than chest compression, we have traditionally recommended the use of a backboard despite insufficient evidence for or against the use of backboards during CPR.[60–63] If a backboard is used, care should be taken to avoid delays in initiation of CPR, to minimize interruptions in CPR, and to avoid line/tube displacement.[61] Air-filled mattresses should be deflated when performing CPR.[64,65]

The rescuer should place the heel of one hand on the center (middle) of the victim's chest (which is the lower half of the sternum) and the heel of the other hand on top of the first so that the hands are overlapped and parallel (Class IIa, LOE B[66–69]).

Correct performance of chest compressions requires several essential skills. The adult sternum should be depressed at least 2 inches (5 cm) (Class IIa, LOE B[70–73]), with chest compression and chest recoil/relaxation times approximately equal (Class IIb, LOE C[74,75]). Allow the chest to completely recoil after each compression (Class IIa, LOE B[76–80]). In human studies of CPR in out-of-hospital[81] and in-hospital settings,[78–80] incomplete chest wall recoil was common, particularly when rescuers were fatigued.[78,81] Incomplete recoil during BLS CPR is associated with higher intrathoracic pressures and significantly decreased hemodynamics, including decreased coronary perfusion, cardiac index, myocardial blood flow, and cerebral perfusion.[76,82] Importantly, the incidence of incomplete chest wall recoil can be reduced during CPR by using electronic recording devices that provide real-time feedback.[80] Manikin studies suggest that lifting the heel of the hand slightly, but completely, off the chest can improve chest recoil.[77,81]

The total number of chest compressions delivered to the victim is a function of the chest compression rate and the proportion of time that chest compressions are delivered without interruption. The compression rate refers to the speed of compressions, not the actual number of compressions delivered per minute. The actual number of chest compressions delivered per minute is determined by the rate of chest compressions and the number and duration of interruptions to open the airway, deliver rescue breaths, and allow AED analysis.[83,84] The number of chest compressions delivered per minute is an important determinant of return of spontaneous circulation (ROSC) and neurologically intact survival.[6,85] One study of in-hospital cardiac arrest patients[85] showed that delivery of $>$80 compressions/min was associated with ROSC. Extrapolation of data from an out-of-hospital observational study[6] showed improved survival to hospital discharge when at least 68 to 89 chest compressions per minute were delivered; the study also demonstrated that improved survival occurred with chest compression rates as high as 120/min. It is therefore reasonable for lay rescuers and healthcare providers to perform chest compressions for adults at a rate of at least 100 compressions per minute (Class IIa, LOE B).

The term "duty cycle" refers to the time spent compressing the chest as a proportion of the time between the start of 1 cycle of compression and the start of the next. Coronary blood flow is determined partly by the duty cycle (reduced coronary perfusion is associated with a duty cycle of $>$50%) and partly by how fully the chest is relaxed at the end of each compression.[86] Although duty cycles ranging between 20% and 50% can result in adequate coronary and cerebral perfusion,[87–90] a duty cycle of 50% is recommended because it is easy to achieve with practice (Class IIb, LOE C[75]).

In 2005 3 human observational studies[91–93] showed that interruptions of chest compressions were common, averaging 24% to 57%[85,91–93] of the total arrest time.

The preponderance of *efficacy* data[94,95] suggests that limiting the frequency and duration of interruptions in chest compressions may improve clinically meaningful outcomes in cardiac arrest patients. Data are now accumulating regarding the *effectiveness* of these interventions in "the real world."[2,96–102] Therefore, despite some data to the contrary,[103] it is reasonable for rescuers to minimize interruption of chest compressions for checking the pulse, analyzing rhythm, or performing other activities throughout the entire resuscitation, particularly in the period immediately before and after a shock is delivered (Class IIa, LOE B[94–98]).

Additional evidence of the importance of minimizing interruptions in chest compressions comes from nonrandomized studies suggesting that survival from out-of-hospital cardiac arrest may be improved by the initial EMS provider delivery of continuous chest compressions without initial assisted ventilations,[97,98] or by EMS providers using a higher compression-to-ventilation ratio (50:2).[96] Notably, in each of these studies, the airway was opened, oxygen insufflations were provided, and assisted ventilation was recommended at some point during the EMS resuscitation. Other EMS systems have noted significant improvement in survival from out-of-hospital arrest with use of compressions-plus-ventilations with emphases on improved quality of compressions and minimization of hands-off time.[2,99] At this time there is insufficient evidence to support the removal of ventilations from CPR provided by EMS professionals.

Rescuer fatigue may lead to inadequate compression rates or depth.[104–106] Significant fatigue and shallow compressions are common after 1 minute of CPR, although rescuers may not recognize that fatigue is present for $\geq$5 minutes.[105] When 2 or more rescuers are available it is reasonable to switch chest compressors approximately every 2 minutes (or after about 5 cycles of compressions and ventilations at a ratio of 30:2) to prevent decreases in the quality of compressions (Class IIa, LOE B). Consider switching compressors during any intervention associated with appropriate interruptions in chest compressions (eg, when an AED is delivering a shock). Every effort should be made to accomplish this switch in $<$5 seconds. If the 2 rescuers are positioned on either side of the patient, 1 rescuer will be ready and waiting to relieve the "working compressor" every 2 minutes.

Interruptions of chest compressions to palpate for a spontaneous pulse or to otherwise check for return of spontaneous circulation (ROSC) can compromise vital organ perfusion.[2,94–99] Accordingly lay rescuers should not interrupt chest compressions to palpate pulses or check for ROSC (Class IIa, LOE C). In addition lay rescuers should continue

CPR until an AED arrives, the victim wakes up, or EMS personnel take over CPR (Class IIa, LOE B).

Healthcare providers should interrupt chest compressions as infrequently as possible and try to limit interruptions to no longer than 10 seconds, except for specific interventions such as insertion of an advanced airway or use of a defibrillator (Class IIa, LOE C). Because of difficulties with pulse assessments, interruptions in chest compressions for a pulse check should be minimized during the resuscitation, even to determine if ROSC has occurred.

Because of the difficulty in providing effective chest compressions while moving the patient during CPR, the resuscitation should generally be conducted where the patient is found (Class IIa, LOE C). This may not be possible if the environment is dangerous.

Compression-Ventilation Ratio (Box 4)

A compression-ventilation ratio of 30:2 is reasonable in adults, but further validation of this guideline is needed (Class IIb, LOE B[83,107–111]). This 30:2 ratio in adults is based on a consensus among experts and on published case series.[2,99–102] Further studies are needed to define the best method for coordinating chest compressions and ventilations during CPR and to define the best compression-ventilation ratio in terms of survival and neurologic outcome in patients with or without an advanced airway in place.

Once an advanced airway is in place, 2 rescuers no longer need to pause chest compressions for ventilations. Instead, the compressing rescuer should give continuous chest compressions at a rate of at least 100 per minute without pauses for ventilation (Class IIa, LOE B). The rescuer delivering ventilation can provide a breath every 6 to 8 seconds (which yields 8 to 10 breaths per minute).

Hands-Only CPR

Only about 20% to 30% of adults with out-of-hospital cardiac arrests receive any bystander CPR.[29,48–51,112,113] Hands-Only (compression-only) bystander CPR substantially improves survival following adult out-of-hospital cardiac arrests compared with no bystander CPR.[29,48–51] Observational studies of adults with cardiac arrest treated by lay rescuers showed similar survival rates among victims receiving Hands-Only CPR versus conventional CPR with rescue breaths.[29,48–51] Of note, some healthcare providers[114–116] and laypersons[116,117] indicate that reluctance to perform mouth-to-mouth ventilation for victims of cardiac arrest is a theoretical and potential barrier to performing bystander CPR. When actual bystanders were interviewed, however, such reluctance was not expressed; panic was cited as the major obstacle to laypersons performance of bystander CPR.[118] The simpler Hands-Only technique may help overcome panic and hesitation to act.

How can bystander CPR be effective without rescue breathing? Initially during SCA with VF, rescue breaths are not as important as chest compressions because the oxygen level in the blood remains adequate for the first several minutes after cardiac arrest. In addition, many cardiac arrest victims exhibit gasping or agonal gasps, and gas exchange allows for some oxygenation and carbon dioxide (CO_2) elimination.[110,111,119] If the airway is open, passive chest recoil during the relaxation phase of chest compressions can also provide some air exchange.[19,110,111,119–122] However, at some time during prolonged CPR, supplementary oxygen with assisted ventilation is necessary. The precise interval for which the performance of Hands-Only CPR is acceptable is not known at this time.[110,111,119,123–126]

Laypersons should be encouraged to provide chest compressions (either Hands-Only or conventional CPR, including rescue breaths) for anyone with a presumed cardiac arrest (Class I, LOE B). No prospective study of adult cardiac arrest has demonstrated that layperson conventional CPR provides better outcomes than Hands-Only CPR when provided before EMS arrival. A recent large study of out-of-hospital pediatric cardiac arrests showed that survival was better when conventional CPR (including rescue breaths) as opposed to Hands-Only CPR was provided for children in cardiac arrest due to noncardiac causes.[30] Because rescue breathing is an important component for successful resuscitation from pediatric arrests (other than sudden, witnessed collapse of adolescents), from asphyxial cardiac arrests in both adults and children (eg, drowning, drug overdose) and from prolonged cardiac arrests, conventional CPR with rescue breathing is recommended for all trained rescuers (both in hospital and out of hospital) for those specific situations (Class IIa, LOE C[109,123,127–129]).

Managing the Airway

As previously stated, a significant change in these Guidelines is to recommend the initiation of chest compressions before ventilations (CAB rather than ABC). This change reflects the growing evidence of the importance of chest compressions and the reality that setting up airway equipment takes time. The ABC mindset may reinforce the idea that compressions should wait until ventilations have begun. This mindset can occur even when more than 1 rescuer is present because "airway and breathing before ventilations" is so ingrained in many rescuers. This new emphasis on CAB helps clarify that airway maneuvers should be performed quickly and efficiently so that interruptions in chest compressions are minimized and chest compressions should take priority in the resuscitation of an adult.

Open the Airway: Lay Rescuer

The trained lay rescuer who feels confident that he or she can perform both compressions and ventilations should open the airway using a head tilt–chin lift maneuver (Class IIa, LOE B). For the rescuer providing Hands-Only CPR, there is insufficient evidence to recommend the use of any specific passive airway (such as hyperextending the neck to allow passive ventilation).

Open the Airway: Healthcare Provider

A healthcare provider should use the head tilt–chin lift maneuver to open the airway of a victim with no evidence of head or neck trauma. Although the head tilt–chin lift technique was developed using unconscious, paralyzed adult volunteers and has not been studied in victims with cardiac arrest, clinical[130] and radiographic evidence[131,132] and a case series[133] have shown it to be effective (Class IIa, LOE B).

Between 0.12 and 3.7% of victims with blunt trauma have a spinal injury,[134–136] and the risk of spinal injury is increased if the victim has a craniofacial injury,[137,138] a Glasgow Coma

Scale score of <8,[139,140] or both.[138,139] For victims with suspected spinal injury, rescuers should initially use manual spinal motion restriction (eg, placing 1 hand on either side of the patient's head to hold it still) rather than immobilization devices (Class IIb, LOE C[141,142]). Spinal immobilization devices may interfere with maintaining a patent airway,[143,144] but ultimately the use of such a device may be necessary to maintain spinal alignment during transport.

If healthcare providers suspect a cervical spine injury, they should open the airway using a jaw thrust without head extension (Class IIb, LOE C[133]). Because maintaining a patent airway and providing adequate ventilation are priorities in CPR (Class I, LOE C), use the head tilt–chin lift maneuver if the jaw thrust does not adequately open the airway.

Rescue Breathing (Box 3A, 4)

The *2010 AHA Guidelines for CPR and ECC* make many of the same recommendations regarding rescue breathing as in 2005:

- Deliver each rescue breath over 1 second (Class IIa, LOE C).
- Give a sufficient tidal volume to produce *visible chest rise* (Class IIa, LOE C).[55]
- Use a compression to ventilation ratio of 30 chest compressions to 2 ventilations.
- When an advanced airway (ie, endotracheal tube, Combitube, or laryngeal mask airway [LMA]) is in place during 2-person CPR, give 1 breath every 6 to 8 seconds without attempting to synchronize breaths between compressions (this will result in delivery of 8 to 10 breaths/minute). There should be no pause in chest compressions for delivery of ventilations (Class IIb, LOE C).

Studies in anesthetized adults (with normal perfusion) suggest that a tidal volume of 8 to 10 mL/kg maintains normal oxygenation and elimination of CO_2. During CPR, cardiac output is ≈25% to 33% of normal, so oxygen uptake from the lungs and CO_2 delivery to the lungs are also reduced. As a result, a low minute ventilation (lower than normal tidal volume and respiratory rate) can maintain effective oxygenation and ventilation.[55,110,111,119] For that reason during adult CPR tidal volumes of approximately 500 to 600 mL (6 to 7 mL/kg) should suffice (Class IIa, LOE B).[145–147] This is consistent with a tidal volume that produces visible chest rise.

Patients with airway obstruction or poor lung compliance may require high pressures to be properly ventilated (to make the chest visibly rise). A pressure-relief valve on a resuscitation bag-mask may prevent the delivery of a sufficient tidal volume in these patients.[148] Ensure that the bag-mask device allows you to bypass the pressure-relief valve and use high pressures, if necessary, to achieve visible chest expansion.[149]

Excessive ventilation is unnecessary and can cause gastric inflation and its resultant complications, such as regurgitation and aspiration (Class III, LOE B[150–152]). More important, excessive ventilation can be harmful because it increases intrathoracic pressure, decreases venous return to the heart, and diminishes cardiac output and survival.[152] In summary, rescuers should avoid excessive ventilation (too many breaths or too large a volume) during CPR (Class III, LOE B).

During CPR the primary purpose of assisted ventilation is to maintain adequate oxygenation; the secondary purpose is to eliminate CO_2. However, the optimal inspired oxygen concentration, tidal volume and respiratory rate to achieve those purposes are not known. As noted above, during the first minutes of sudden VF cardiac arrest, rescue breaths are not as important as chest compressions[29,108,153] because the oxygen content in the noncirculating arterial blood remains unchanged until CPR is started; the blood oxygen content then continues to be adequate during the first several minutes of CPR. In addition, attempts to open the airway and give rescue breaths (or to access and set up airway equipment) may delay the initiation of chest compressions.[154] These issues support the CAB approach of the *2010 AHA Guidelines for CPR and ECC* (ie, starting with **C**hest Compressions prior to **A**irway and **B**reathing).

For victims of prolonged cardiac arrest both ventilations and compressions are important because over time oxygen in the blood is consumed and oxygen in the lungs is depleted (although the precise time course is unknown). Ventilations and compressions are also important for victims of asphyxial arrest, such as children and drowning victims, because they are hypoxemic at the time of cardiac arrest.[30,109]

Mouth-to-Mouth Rescue Breathing

Mouth-to-mouth rescue breathing provides oxygen and ventilation to the victim.[155] To provide mouth-to-mouth rescue breaths, open the victim's airway, pinch the victim's nose, and create an airtight mouth-to-mouth seal. Give 1 breath over 1 second, take a "regular" (not a deep) breath, and give a second rescue breath over 1 second (Class IIb, LOE C). Taking a regular rather than a deep breath prevents the rescuer from getting dizzy or lightheaded and prevents overinflation of the victim's lungs. The most common cause of ventilation difficulty is an improperly opened airway,[57] so if the victim's chest does not rise with the first rescue breath, reposition the head by performing the head tilt–chin lift again and then give the second rescue breath.

If an adult victim with spontaneous circulation (ie, strong and easily palpable pulses) requires support of ventilation, the healthcare provider should give rescue breaths at a rate of about 1 breath every 5 to 6 seconds, or about 10 to 12 breaths per minute (Class IIb, LOE C). Each breath should be given over 1 second regardless of whether an advanced airway is in place. Each breath should cause visible chest rise.

Mouth-to–Barrier Device Breathing

Some healthcare providers[114–116] and lay rescuers state that they may hesitate to give mouth-to-mouth rescue breathing and prefer to use a barrier device. The risk of disease transmission through mouth to mouth ventilation is very low, and it is reasonable to initiate rescue breathing with or without a barrier device. When using a barrier device the rescuer should not delay chest compressions while setting up the device.

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

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

(Class IIa, LOE C). A case series suggests that mouth-to-nose ventilation in adults is feasible, safe, and effective.[156]

Give mouth-to-stoma rescue breaths to a victim with a tracheal stoma who requires rescue breathing. A reasonable alternative is to create a tight seal over the stoma with a round, pediatric face mask (Class IIb, LOE C). There is no published evidence on the safety, effectiveness, or feasibility of mouth-to-stoma ventilation. One study of patients with laryngectomies showed that a pediatric face mask created a better peristomal seal than a standard ventilation mask.[157]

Ventilation With Bag and Mask

Rescuers can provide bag-mask ventilation with room air or oxygen. A bag-mask device provides positive-pressure ventilation without an advanced airway; therefore a bag-mask device may produce gastric inflation and its complications.

The Bag-Mask Device

A bag-mask device should have the following[158]: a nonjam inlet valve; either no pressure relief valve or a pressure relief valve that can be bypassed; standard 15-mm/22-mm fittings; an oxygen reservoir to allow delivery of high oxygen concentrations; a nonrebreathing outlet valve that cannot be obstructed by foreign material and will not jam with an oxygen flow of 30 L/min; and the capability to function satisfactorily under common environmental conditions and extremes of temperature.

Masks should be made of transparent material to allow detection of regurgitation. They should be capable of creating a tight seal on the face, covering both mouth and nose. Masks should be fitted with an oxygen (insufflation) inlet and have a standard 15-mm/22-mm connector.[159] They should be available in one adult and several pediatric sizes.

Bag-Mask Ventilation

Bag-mask ventilation is a challenging skill that requires considerable practice for competency.[160,161] Bag-mask ventilation is not the recommended method of ventilation for a lone rescuer during CPR. It is most effective when provided by 2 trained and experienced rescuers. One rescuer opens the airway and seals the mask to the face while the other squeezes the bag. Both rescuers watch for visible chest rise.[160,162]

The rescuer should use an adult (1 to 2 L) bag to deliver approximately 600 mL tidal volume[163–165] for adult victims. This amount is usually sufficient to produce visible chest rise and maintain oxygenation and normocarbia in apneic patients (Class IIa, LOE C[145–147]). If the airway is open and a good, tight seal is established between face and mask, this volume can be delivered by squeezing a 1-L adult bag about two thirds of its volume or a 2-L adult bag about one third of its volume. As long as the patient does not have an advanced airway in place, the rescuers should deliver cycles of 30 compressions and 2 breaths during CPR. The rescuer delivers ventilations during pauses in compressions and delivers each breath over 1 second (Class IIa, LOE C). The healthcare provider should use supplementary oxygen (O_2 concentration >40%, at a minimum flow rate of 10 to 12 L/min) when available.

Ventilation With a Supraglottic Airway

Supraglottic airway devices such as the LMA, the esophageal-tracheal combitube and the King airway device, are currently within the scope of BLS practice in a number of regions (with specific authorization from medical control). Ventilation with a bag through these devices provides an acceptable alternative to bag-mask ventilation for well-trained healthcare providers who have sufficient experience to use the devices for airway management during cardiac arrest (Class IIa, LOE B[166–171]). It is not clear that these devices are any more or less complicated to use than a bag and mask; training is needed for safe and effective use of both the bag-mask device and each of the advanced airways. These devices are discussed in greater detail in Part 8.1 of these Guidelines.

Ventilation With an Advanced Airway

When the victim has an advanced airway in place during CPR, rescuers no longer deliver cycles of 30 compressions and 2 breaths (ie, they no longer interrupt compressions to deliver 2 breaths). Instead, continuous chest compressions are performed at a rate of at least 100 per minute without pauses for ventilation, and ventilations are delivered at the rate of 1 breath about every 6 to 8 seconds (which will deliver approximately 8 to 10 breaths per minute).

Passive Oxygen Versus Positive-Pressure Oxygen During CPR

Although many studies describe outcomes after compression-only CPR, these studies infrequently address additional techniques to improve ventilation or oxygenation. Two comparative studies[97,172] and 2 post hoc analysis studies[98,173] of passive ventilation airway techniques during cardiac arrest used the same protocol. The protocol included insertion of an oral airway and administration of oxygen with a nonrebreather mask, with interposed ventilations versus passive insufflation of oxygen during minimally interrupted chest compressions. These studies did not demonstrate a significant overall improvement in outcome measures. However, subgroup analysis showed better survival with passive oxygen insufflation among patients with witnessed VF cardiac arrest. For layperson Hands-Only CPR, evidence is insufficient to support recommending the use of any specific passive airway or ventilation technique.

Cricoid Pressure

Cricoid pressure is a technique of applying pressure to the victim's cricoid cartilage to push the trachea posteriorly and compress the esophagus against the cervical vertebrae. Cricoid pressure can prevent gastric inflation and reduce the risk of regurgitation and aspiration during bag-mask ventilation, but it may also impede ventilation. Seven randomized, controlled studies demonstrated that cricoid pressure can delay or prevent the placement of an advanced airway and that aspiration can occur despite application of pressure.[174–180] Additional manikin studies[181–194] found training in the maneuver to be difficult for both expert and nonexpert rescuers. Neither expert nor nonexpert rescuers demonstrated mastery of the technique, and the applied pressure was frequently inconsistent and outside of effective limits. Cricoid pressure might be used in a few special circumstances (eg, to aid in viewing the vocal cords during tracheal intubation). However, the routine use of cricoid pressure in adult cardiac arrest is not recommended (Class III, LOE B).

AED Defibrillation (Box 5, 6)

All BLS providers should be trained to provide defibrillation because VF is a common and treatable initial rhythm in adults with witnessed cardiac arrest.[195] For victims with VF, survival rates are highest when immediate bystander CPR is provided and defibrillation occurs within 3 to 5 minutes of collapse.[4,5,10,11,196,197] Rapid defibrillation is the treatment of choice for VF of short duration, such as for victims of witnessed out-of-hospital cardiac arrest or for hospitalized patients whose heart rhythm is monitored (Class I, LOE A).

In swine, microvascular blood flow is markedly reduced within 30 seconds of the onset of VF; chest compressions restore some of the diminished microvascular blood flow within 1 minute.[198] Performing chest compressions while another rescuer retrieves and charges a defibrillator improves the probability of survival.[6] After about 3 to 5 minutes of untreated VF, some animal models suggest that a period of chest compressions before defibrillation may be beneficial.[199] In 2 randomized controlled trials in adults with out-of-hospital VF/pulseless ventricular tachycardia (VT), a period of 1 ½ to 3 minutes of CPR by EMS before defibrillation did not improve ROSC or survival rates regardless of EMS response interval.[200,201] A third randomized controlled trial[202] and a cohort clinical trial with historic controls[203] also found no overall differences in outcomes. However, in two of these studies subgroups of patients with the EMS response interval intervals longer than 4 to 5 minutes showed increased survival to hospital discharge with a period of CPR prior to defibrillation.[202, 203]

There is insufficient evidence to recommend for or against delaying defibrillation to provide a period of CPR for patients in VF/pulseless VT out-of-hospital cardiac arrest. In settings with lay rescuer AED programs (AED onsite and available) and for in-hospital environments, or if the EMS rescuer witnesses the collapse, the rescuer should use the defibrillator as soon as it is available (Class IIa, LOE C). When more than one rescuer is available, one rescuer should provide chest compressions while another activates the emergency response system and retrieves the defibrillator. Defibrillation is discussed in further detail in Part 6: "Electrical Therapies."

Recovery Position

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

There are several variations of the recovery position, each with its own advantages. No single position is perfect for all victims.[204,205] The position should be stable, near a true lateral position, with the head dependent and with no pressure on the chest to impair breathing (Class IIa, LOE C). Studies in normal volunteers[206] show that extending the lower arm above the head and rolling the head onto the arm, while bending both legs, may be feasible for victims with known or suspected spinal injury.[207]

Special Resuscitation Situations

Acute Coronary Syndromes

In the United States coronary heart disease was responsible for 1 of every 6 hospital admissions in 2005 and 1 in every 6 deaths in 2006.[208] The American Heart Association estimates that in 2010, 785 000 Americans will have a new coronary attack and 470 000 will have a recurrent attack.[208] Approximately 70% of deaths from acute myocardial infarction (AMI) occur outside of the hospital, most within the first 4 hours after the onset of symptoms.[208,209]

Early recognition, diagnosis, and treatment of AMI can improve outcome by limiting damage to the heart,[210] but treatment is most effective if provided within a few hours of the onset of symptoms.[211] Patients at risk for acute coronary syndromes (ACS) and their families should be taught to recognize the symptoms of ACS and to immediately activate the EMS system when symptoms appear, rather than delaying care by contacting family, calling a physician, or driving themselves to the hospital.

The classic symptoms associated with ACS are chest discomfort, discomfort in other areas of the upper body, shortness of breath, sweating, nausea, and lightheadedness. The symptoms of AMI characteristically last more than 15 minutes. Atypical symptoms of ACS may be more common in the elderly, women, and diabetic patients, but any patient may present with atypical signs and symptoms.[212–214] Signs and symptoms cannot be used to confirm or exclude the diagnosis of ACS because reported sensitivity ranges from 35% to 92% and specificity ranges from 28% of 91%. Numerous studies do not support the use of any clinical signs and symptoms independent of electrocardiograph (ECG) tracings, cardiac biomarkers, or other diagnostic tests to rule in or rule out ACS in prehospital or emergency department (ED) settings.[215–228]

To improve ACS outcome, all dispatchers and EMS providers must be trained to recognize ACS symptoms, even if atypical. It is reasonable for dispatchers to advise patients with potential cardiac symptoms to chew an aspirin (160 to 325 mg), providing the patient has no history of aspirin allergy and no signs of active or recent gastrointestinal bleeding (Class IIa, LOE C).[229–233]

EMS providers should obtain a 12-lead ECG, determine onset of ACS symptoms, and provide prearrival notification to the destination hospital.[229,234] Clinical trials have shown improved outcomes in ST-segment elevation myocardial infarction (STEMI) patients transported by EMS directly to a percutaneous coronary intervention (PCI)–capable hospital.[235–237] If the patient has a STEMI on ECG and if PCI is the chosen method of reperfusion, it is reasonable to transport the patient directly to a PCI facility, bypassing closer emergency departments as necessary, in systems where time intervals between first medical contact and balloon times are less than 90 minutes, and transport times are relatively short (ie, less than 30 minutes), or based on regional EMS protocols (Class IIa, LOE B).

Common practice has been for basic EMT's to administer oxygen during the initial assessment of patients with suspected ACS. However, there is insufficient evidence to 'support or refute oxygen use in uncomplicated ACS. If the patient is dyspneic, hypoxemic, has obvious signs of heart failure, or an oxyhemoglobin saturation $<$94%, providers should administer oxygen and titrate therapy to provide the lowest administered oxygen concentration that will maintain the oxyhemoglobin saturation $\geq$94% (Class I, LOE C).[238] If the patient has not taken aspirin and has no history of aspirin allergy and no evidence of recent gastrointestinal bleeding, EMS providers should give the patient nonenteric aspirin (160 to 325 mg) to chew (Class I, LOE C).[229,234,239,240]

EMS providers can administer nitroglycerin for patients with chest discomfort and suspected ACS. Although it is reasonable to consider the early administration of nitroglycerin in select hemodynamically stable patients, insufficient evidence exists to support or refute the routine administration of nitroglycerin in the ED or prehospital setting in patients with a suspected ACS (Class IIb, LOE B).[241–243] Nitrates in all forms are contraindicated in patients with initial systolic blood pressure $<$90 mm Hg or $\geq$30 mm Hg below baseline and in patients with right ventricular infarction (see Part 10). Caution is advised in patients with known inferior wall STEMI, and a right-sided ECG should be performed to evaluate right ventricular infarction. Administer nitrates with extreme caution, if at all, to patients with inferior STEMI and suspected RV involvement because these patients require adequate RV preload. Nitrates are contraindicated when patients have taken a phosphodiesterase-5 (PDE-5) inhibitor within 24 hours (48 hours for tadalafil).

For patients diagnosed with STEMI in the prehospital setting, EMS providers should administer appropriate analgesics, such as intravenous morphine, for persistent chest pain (Class IIa, LOE C). EMS providers may consider administering intravenous morphine for undifferentiated chest pain unresponsive to nitroglycerin (Class IIb, LOE C). However, morphine should be used with caution in unstable angina (UA)/NSTEMI due to an association with increased mortality in a large registry.

Additional information about the assessment and treatment of the patient with ACS and STEMI is included in Part 10: "Acute Coronary Syndromes."

Stroke

Almost 800 000 people suffer stroke each year in the United States, and stroke is a leading cause of severe, long-term disability and death.[245] Fibrinolytic therapy administered within the first hours of the onset of symptoms limits neurological injury and improves outcome in selected patients with acute ischemic stroke.[246–249] The window of opportunity is extremely limited, however. Effective therapy requires early detection of the signs of stroke, prompt activation of the EMS system and dispatch of EMS personnel; appropriate triage to a stroke center; prearrival notification; rapid triage, evaluation, and management in the ED; and rapid delivery of fibrinolytic therapy to eligible patients. For additional information about these steps, see the AHA/American Stroke Association (ASA) Guidelines for the management of acute ischemic stroke and Part 11: "Adult Stroke."[250,251]

Patients at high risk for stroke, their family members, and BLS providers should learn to recognize the signs and symptoms of stroke and to call EMS as soon as any signs of stroke are present (Class I, LOE C). The signs and symptoms of stroke are sudden numbness or weakness of the face, arm, or leg, especially on one side of the body; sudden confusion, trouble speaking or understanding; sudden trouble seeing in one or both eyes; sudden trouble walking, dizziness, loss of balance or coordination; and sudden severe headache with no known cause.[252,253] Community and professional education is essential to improve stroke recognition and early EMS activation.[254–256]

EMS dispatchers should be trained to suspect stroke and rapidly dispatch emergency responders. EMS personnel should be able to perform an out-of-hospital stroke assessment (Class I, LOE B[257–259]), establish the time of symptom onset when possible, provide cardiopulmonary support, and notify the receiving hospital that a patient with possible stroke is being transported.[260–262] EMS systems should have protocols that address triaging the patient when possible directly to a stroke center (Class I, LOE B[261,263,264]). It may be important for a family member to accompany the patient during transport to verify the time of symptom onset and provide consent for interventional therapy.

Patients with acute stroke are at risk for respiratory compromise, and the combination of poor perfusion and hypoxemia will exacerbate and extend ischemic brain injury leading to worse outcomes.[265] Both out-of-hospital and in-hospital medical personnel should administer supplementary oxygen to hypoxemic (ie, oxygen saturation $<$94%) stroke patients (Class 1, LOE C) or those with unknown oxygen saturation. There are no data to support initiation of hypertension intervention in the prehospital environment. Unless the patient is hypotensive (systolic blood pressure $<$90 mm Hg), prehospital intervention for blood pressure is not recommended (Class III, LOE C). Additional information about the assessment of stroke using stroke scales and the management of stroke is included in Part 11: "Adult Stroke."

Drowning

Drowning is a preventable cause of death for more than 3500 Americans annually.[266] Over the last 25 years, the incidence of fatal drowning has declined significantly from 3.8 deaths per 100 000 population in 1970 to 1.2 in 2006.[266] The duration and severity of hypoxia sustained as a result of drowning is the single most important determinant of outcome.[267,268] Rescuers should provide CPR, particularly rescue breathing, as soon as an unresponsive submersion victim is removed from the water (Class I, LOE C). When rescuing a drowning victim of any age, it is reasonable for the lone healthcare provider to give 5 cycles (about 2 minutes) of CPR before leaving the victim to activate the EMS system.

Mouth-to-mouth ventilation in the water may be helpful when administered by a trained rescuer (Class IIb, LOE C[269]). Chest compressions are difficult to perform in water; they may not be effective and they could potentially cause harm to both the rescuer and the victim. There is no evidence that water acts as an obstructive foreign body. Maneuvers to relieve foreign-body airway obstruction (FBAO) are not recommended for drowning victims because such maneuvers are not necessary and they can cause injury, vomiting, aspiration, and delay of CPR.[270]

Rescuers should remove drowning victims from the water by the fastest means available and should begin resuscitation as quickly as possible. Spinal cord injury is rare among fatal drowning victims.[271] Victims with obvious clinical signs of injury, alcohol intoxication, or a history of diving into shallow water are at a higher risk of spinal cord injury, and health care providers may consider stabilization and possible immobilization of the cervical and thoracic spine for these victims.[272]

Hypothermia

In an unresponsive victim with hypothermia, assessments of breathing and pulse are particularly difficult because heart rate and breathing may be very slow, depending on the degree of hypothermia.

If the victim is unresponsive with no normal breathing, lay rescuers should begin chest compressions immediately (see Part 12: "Cardiac Arrest in Special Situations"). If the adult victim is unresponsive with no breathing or no normal breathing (ie, only gasping), healthcare providers can check for a pulse, but should start CPR if a pulse is not definitely felt within 10 seconds. Do not wait to check the victim's temperature and do not wait until the victim is rewarmed to start CPR. To prevent further heat loss, remove wet clothes from the victim; insulate or shield the victim from wind, heat, or cold; and if possible, ventilate the victim with warm, humidified oxygen.

Avoid rough movement, and transport the victim to a hospital as soon as possible. If VF is detected, emergency personnel should deliver shocks using the same protocols used for the normothermic cardiac arrest victim (see Part 12: "Cardiac Arrest in Special Situations").

For the hypothermic patient in cardiac arrest, continue resuscitative efforts until the patient is evaluated by advanced care providers. In the out-of-hospital setting, passive warming can be used until active warming is available.

Foreign-Body Airway Obstruction (Choking)

FBAO is an uncommon, but preventable, cause of death.[273] Most reported cases of FBAO occur in adults while they are eating.[274] Most reported episodes of choking in infants and children occur during eating or play when parents or childcare providers are present. The choking event is therefore commonly witnessed, and the rescuer usually intervenes while the victim is still responsive. Treatment is usually successful, and survival rates can exceed 95%.[275]

Recognition of Foreign-Body Airway Obstruction

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

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

Relief of Foreign-Body Airway Obstruction

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

The clinical data about effectiveness of maneuvers to relieve FBAO are largely retrospective and anecdotal. For responsive adults and children >1 year of age with severe FBAO, case reports show the feasibility and effectiveness of back blows or "slaps,"[276–278] abdominal thrusts,[275–277,279,280] and chest thrusts.[276,281] In 1 case series of 513 choking episodes for which EMS was summoned,[275] approximately 50% of the episodes of airway obstruction were relieved prior to arrival of EMS. EMS intervention with abdominal thrusts successfully relieved the obstruction in more than 85% of the remaining cases. The few patients with persistent obstruction usually responded to suction or the use of Magill forceps. Less than 4% died.[275]

Although chest thrusts, back slaps, and abdominal thrusts are feasible and effective for relieving severe FBAO in conscious (responsive) adults and children ≥ 1 year of age, for simplicity in training it is recommended that abdominal thrusts be applied in rapid sequence until the obstruction is relieved (Class IIb, LOE B). If abdominal thrusts are not effective, the rescuer may consider chest thrusts (Class IIb, LOE B). It is important to note that abdominal thrusts are not recommended for infants <1 year of age because thrusts may cause injuries.

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

If the adult victim with FBAO becomes unresponsive, the rescuer should carefully support the patient to the ground, immediately activate (or send someone to activate) EMS, and then begin CPR. The healthcare provider should carefully lower the victim to the ground, send someone to activate the emergency response system and begin CPR (without a pulse check). After 2 minutes, if someone has not already done so, the healthcare provider should activate the emeregency response system. A randomized trial of maneuvers to open the airway in cadavers[282] and 2 prospective studies in anesthetized volunteers[281,283] showed that higher sustained airway pressures can be generated using the chest thrust rather than the abdominal thrust. Each time the airway is opened during CPR, the rescuer should look for an object in the victim's mouth and if found, remove it. Simply looking into the mouth should not significantly increase the time needed to attempt the ventilations and proceed to the 30 chest compressions.

No studies have evaluated the routine use of the finger sweep to clear an airway in the absence of visible airway obstruction. The recommendation to use the finger sweep in past guidelines was based on anecdotal reports that suggested that it was helpful for relieving an airway obstruction.[276,277,284] However, case reports have also documented harm to the victim[236,285,286] or rescuer.

The Quality of BLS

The quality of unprompted CPR in both in-hospital and out-of–hospital cardiac arrest events is often poor, and methods should be developed to improve the quality of CPR delivered to victims of cardiac arrest.[73,91–93,287] Several studies have demonstrated improvement in chest compression rate, depth, chest recoil, ventilation rate, and indicators of blood flow such as end-tidal CO_2 (P_{ETCO_2}) when real-time feedback or prompt devices are used to guide CPR performance.[72,73,80,288–293] However, there are no studies to date that demonstrate a significant improvement in patient survival related to the use of CPR feedback devices during actual cardiac arrest events. Other CPR feedback devices with accelerometers may overestimate compression depth when compressions are performed on a soft surface such as a mattress because the depth of sternal movement may be partly due to movement of the mattress rather than anterior-posterior (AP) compression of the chest.[62,294] Nevertheless, real-time CPR prompting and feedback technology such as visual and auditory prompting devices can improve the quality of CPR (Class IIa, LOE B).

Summary

The critical lifesaving steps of BLS are

- Immediate **Recognition** and **Activation** of the emergency response system
- Early **CPR** and
- Rapid **Defibrillation** for VF

When an adult suddenly collapses, whoever is nearby should activate the emergency system and begin chest compressions (regardless of training). Trained lay rescuers who are able and healthcare providers should provide compressions and ventilations. Contrary to the belief of too many in this situation, *CPR is not harmful. Inaction is harmful and CPR can be lifesaving*. However, the quality of CPR is critical. Chest compressions should be delivered by pushing hard and fast in the center of the chest (ie, chest compressions should be of adequate rate and depth). Rescuers should allow complete chest recoil after each compression and minimize interruptions in chest compressions. They should also avoid excessive ventilation. If and when available, an AED should be applied and used without delaying chest compressions. With prompt and effective provision of these actions, lives are saved every day.

Disclosures

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(*Continued*)

Guidelines Part 5: Adult Basic Life Support: Writing Group Disclosures, *Continued*

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
E. Brooke Lerner	Medical College of Wisconsin– Associate Professor	None	†Title: Circulation Improving Resuscitation Care Trial Source: Zoll Medical Corporation Role: Consultant Principal Investigator: Lars Wik, M.D. Dates: 12/2006–8/2010 Total Funding to MCW: $345,000 (funding is received by my employer to support my time on this trial. My institution receives support for 20% of my time and the remaining funds are used for other members of our staff and supplies. My role is to advise them on human subject protection issues and to assist with data management and report generation for the trial)	None	*Stockholder in Medtronic, Pfizer, and General Electric	None	None
Thomas D. Rea	University of Washington: Physician–Associate Professor of Medicine; Emergency Medical Services Division of Public Health-Seattle & King County–Program Medical Director	*In the past, I have received unrestricted (modest) grant support from Philips Inc and PhysioControl. The topics were related to improving resuscitation generally (changing resuscitation protocols) and not specific to proprietary information or equipment. I am currently an investigator in the ROC. As part of this, I am directly involved in the Feedback Trial to evaluate dynamic fdbk available on the Philips MRX. The ROC is also evaluating the impedance threshold device. These studies are supported by the NIH primarily and I receive no support from Philips or the company that makes the impedance threshold device. I am participating in a trial of chest compression only vs chest compression plus ventilation for dispatch-assisted CPR-supported in part by Laerdal Foundation. I receive less than 5% salary support	*We conducted an AED training study that recently completed where Philips and PhysioControl contributed equipment for the research. I did not receive any of this equipment	None	None	None	*I serve on a DSMB for a trial sponsored by Philips to evaluate quantitative VF waveform algorhithm to guide care. I receive no support for this effort in order to minimize (eliminate) any conflict
Michael R. Sayre	The Ohio State University-Associate Professor	None	None	None	None	None	None
Robert A. Swor	Beaumont Hospital–Director EMS Programs	None	None	None	None	None	None

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

*Modest.

†Significant.

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KEY WORDS: cardiacarrest ■ defibrillation ■ emergency