INTRODUCTION — Cardiopulmonary resuscitation (CPR) as we recognize it today was developed in the late 1950s and 1960s. Elam and Safar described the technique and benefits of mouth-to-mouth ventilation in 1958 [1]. Kouwenhoven, Knickerbocker, and Jude subsequently described the benefits of external chest compressions [2], which in combination with mouth-to-mouth ventilation form the basis of modern CPR. External defibrillation, first described in 1957 by Kouwenhoven [3], has since been incorporated into resuscitation guidelines.

Basic life support consists of cardiopulmonary resuscitation and, when available, defibrillation using automated external defibrillators (AED). The keys to survival from sudden cardiac arrest (SCA) are early recognition and treatment, specifically, immediate initiation of excellent CPR and early defibrillation.

This topic review will discuss the critical facets of basic life support in adults as presented in the American Heart Association's 2010 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care [4]. Advanced cardiac life support and other related topics, such as airway management and basic life support for infants and children, are presented separately. (See "Advanced cardiac life support (ACLS) in adults" and "Basic airway management in adults" and "Basic life support in infants and children".)

EPIDEMIOLOGY AND SURVIVAL — Sudden cardiac arrest (SCA) is a leading cause of death in both the United States and Canada [5-7], outnumbered only by cancer. Approximately 400,000 people in the United States [8,9] and 700,000 people in Europe [10,11], suffer SCA each year. The most common etiology of SCA is ischemic cardiovascular disease resulting in the development of lethal arrhythmias. Resuscitation is attempted in up to two-thirds of people who sustain SCA.

Despite the development of cardiopulmonary resuscitation (CPR), electrical defibrillation, and other advanced resuscitative techniques over the past 50 years, survival rates for SCA remain low. The epidemiology and etiology of SCA are discussed in greater detail separately. (See "Overview of sudden cardiac arrest and sudden cardiac death" and "Pathophysiology and etiology of sudden cardiac arrest".)

Assessments of survival from SCA have reached widely disparate conclusions. In the out-of-
hospital setting, studies have reported survival rates of 1 to 6 percent [12-14]. Three systematic reviews of survival-to-hospital discharge from out-of-hospital SCA reported 5 to 10 percent survival among those treated by emergency medical services (EMS) and 15 percent survival when the underlying rhythm disturbance was ventricular fibrillation (VF) [14-16]. An analysis of a national registry of in-hospital SCA reported a 17 percent survival to discharge [14].

Not performing CPR or low quality performance are important factors contributing to poor outcomes [17]. Multiple studies assessing both in-hospital and prehospital performance of CPR have shown that trained healthcare providers consistently fail to meet basic life support guidelines [18,19].

THE 2010 RESUSCITATION GUIDELINES — The American Heart Association (AHA) 2010 Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (AHA 2010 Guidelines) are based upon an extensive review of the clinical and laboratory evidence performed by the International Liaison Committee on Resuscitation (ILCOR) [4]. The Guidelines and algorithms are designed to be simple, practical, and effective (algorithm 1).

Important changes in the content or emphasis of the 2010 Guidelines for basic life support (BLS) include:

- Emphasizing early recognition of sudden cardiac arrest (SCA) by noting unresponsiveness or absent/gasping breathing
- Emphasizing the importance of the immediate initiation of excellent CPR – “push hard, push fast” – with continuous attention to the quality of chest compressions, and to the frequency of ventilations
- Minimizing interruptions in CPR
- For health care professional rescuers, taking no more than 10 seconds to check for a pulse
- For single untrained rescuers, encouraging performance of excellent chest compression-only CPR
- Using automated external defibrillators as soon as available
- Activating emergency medical services as soon as possible

Patient survival depends primarily upon immediate initiation of excellent CPR and early defibrillation [5,20,21].

Phases of resuscitation — Many researchers in resuscitation consider there to be three distinct phases of cardiac arrest: the electrical phase, the hemodynamic phase, and the metabolic phase [20]. The emphasis of treatment varies according to the phase.

Electrical phase — The electrical phase is defined as the first four to five minutes of arrest due to ventricular fibrillation (VF). Immediate DC cardioversion is needed to optimize survival of these patients. Performing excellent chest compressions while the defibrillator is readied also improves survival [21].
Hemodynamic phase — The hemodynamic or circulatory phase, which follows the electrical phase, consists of the period from 4 to 10 minutes after SCA, during which the patient may remain inVF. Early defibrillation remains critical for survival in patients found in VF. Excellent chest compressions should be started immediately upon recognizing SCA and continued until just before cardioversion is performed (ie, charge the defibrillator during active compressions, stopping only briefly to confirm the rhythm and deliver the shock). Resume CPR immediately after the shock is delivered.

Whether it is beneficial during the hemodynamic phase to delay cardioversion in order to perform a full two to three minutes of CPR remains unclear. Randomized trials have reached inconsistent conclusions:

- In one trial, investigators randomly assigned 200 patients with out-of-hospital VF arrest to receive immediate defibrillation or three minutes of CPR prior to defibrillation [15]. Among cases with ambulance response times over five minutes, patients treated with CPR prior to defibrillation had higher rates of survival to hospital discharge than those immediately defibrillated (22 versus 4 percent, OR 7.4, 95% CI 1.6-34.3). In contrast, among cases with a rapid ambulance response, patient outcomes did not differ.

- A similar trial of 202 patients found a nonsignificant increase in survival to hospital discharge with three minutes of CPR prior to defibrillation, regardless of ambulance response time (17 versus 10 percent, p = 0.16) [22].

- A third trial treated 256 patients with out-of-hospital cardiac arrest using immediate defibrillation or 90 seconds (rather than three minutes) of CPR followed immediately by defibrillation [23]. There was no significant difference in survival to hospital discharge (4.2 versus 5.1 percent, OR 0.81, 95% CI 0.25 to 2.6). Although subgroup analysis was not planned for this study, no differences in survival were noted in the two treatment groups based upon ambulance response time.

The AHA 2010 BLS Guidelines state that there is insufficient evidence to determine whether a period of CPR prior to defibrillation is beneficial in all cases of SCA, while a meta-analysis of the randomized trials described above concluded that either approach is reasonable [24]. Providers should consider both patient downtime and their own response time when deciding whether to postpone defibrillation to provide CPR. We feel that it is reasonable to perform two minutes of excellent CPR prior to defibrillation for patients with an unwitnessed cardiac arrest and fine ventricular fibrillation whose down time is thought to exceed three to five minutes.

Metabolic phase — Treatment of the metabolic phase, defined as greater than 10 minutes of pulselessness, is primarily based upon post-resuscitative measures, including hypothermia therapy. If not quickly converted into a perfusing rhythm, patients in this phase generally do not survive.

Recognition of cardiac arrest — Rapid recognition of cardiac arrest is the essential first step of successful resuscitation. According to the AHA 2010 Guidelines, the lay rescuer who witnesses a person collapse or comes across an apparently unresponsive person should check to be sure the area is safe before approaching the victim and then confirm
unresponsiveness by tapping the person on the shoulder and shouting: “are you all right?” [21]. If the person does not respond, the rescuer calls for help, activates the emergency response system, and initiates excellent chest compressions. Lay rescuers should not attempt to assess the victim’s pulse and, unless the patient has what appear to be normal respirations, should assume the patient is apneic.

The AHA 2010 Guidelines emphasize that even well-trained professionals can have difficulty determining if breathing is adequate or pulses are present in unresponsive adults. After assessing responsiveness, health care providers should quickly check the patient’s pulse. While doing so, it is reasonable for the healthcare provider to visually assess the patient’s respirations. It is appropriate to assume the patient is in cardiac arrest if there is no breathing or abnormal breathing (eg, gasping) or if a pulse cannot be readily palpated within 10 seconds. The key point is not to delay CPR.

Chest compressions

**Performance of excellent chest compressions** — Chest compressions are the most important element of cardiopulmonary resuscitation (CPR) [25-28]. Coronary perfusion pressure and return of spontaneous circulation (ROSC) are maximized when excellent chest compressions are performed [29,30]. The mantra of the AHA 2010 BLS Guidelines is: "push hard and push fast on the center of the chest" (algorithm 1) [21].

The following goals are essential for performing excellent chest compressions:

- Maintain a rate of at least 100 compressions per minute
- Compress the chest at least 5 cm (2 inches) with each down-stroke
- Allow the chest to recoil completely after each down-stroke (eg, it should be easy to pull a piece of paper from between the rescuer’s hand and the patient’s chest just before the next down-stroke)
- Minimize the frequency and duration of any interruptions

To perform excellent chest compressions, the rescuer and patient must be in optimal position. This may require movement of the patient or bed, adjustment of the bed’s height, or the use of a step-stool so the rescuer performing chest compressions is appropriately positioned. The patient must lie on a firm surface. This may require a backboard if chest compressions are performed on a bed [31-33]. If a backboard cannot be used, the patient should be placed on the floor.

The rescuer places the heel of one hand in the center of the chest over the lower (caudad) portion of the sternum and the heel of their other hand atop the first. The rescuer’s own chest should be directly above their hands. This enables the rescuer to use their body weight to compress the patient’s chest, rather than just the muscles of their arms, which fatigue quickly.

It is imperative that each facet of performing excellent chest compressions be continually reassessed and corrections made throughout the resuscitation. Resuscitation teams often believe that compressions are being performed appropriately when in fact they are inadequate and cerebral perfusion is compromised, thereby reducing the chance for neurologically intact survival.
An inadequate rate of chest compression reduces the likelihood of ROSC and neurologically intact survival following sudden cardiac arrest (SCA) \[29,34,35\]. Rates as high as 120 compressions per minute may be beneficial. The AHA 2010 Guidelines recommend a rate of at least 100 compressions per minute. Audiovisual tools that provide immediate feedback may help rescuers maintain adequate rates \[36\].

Animal studies suggest that chest compressions of proper depth (at least 5 cm) play an important role in successful resuscitation \[37\]. In addition, full chest recoil between downstrokes promotes lower intrathoracic pressures, resulting in enhanced cardiac preload and higher coronary perfusion pressures \[38\]. According to the AHA 2010 Guidelines, rescuers are better at allowing full recoil when they receive immediate automated feedback on CPR performance and if they remove their hands slightly but completely from the chest wall at the end of each compression \[36\].

Inadequate compression and incomplete recoil are more common when rescuers fatigue, which can begin as soon as one minute after beginning CPR \[21\]. The AHA 2010 Guidelines suggest that the rescuer performing chest compressions be changed every two minutes whenever more than one rescuer is present. Interruptions in chest compressions are reduced by changing the rescuer performing compressions at the time defibrillation is performed.

**Minimizing interruptions** — Interruptions in chest compressions during CPR, no matter how brief, result in unacceptable declines in coronary and cerebral perfusion pressure and worse patient outcomes \[27,34,39-43\]. Once compressions stop, up to one minute of continuous, excellent compressions may be required to reattain steady perfusion pressures at desirable levels \[44\]. Two minutes of CPR should be performed following any interruption \[45\]. (See ‘Pulse checks and rhythm analysis’ below.)

Rescuers must ensure that excellent chest compressions are provided with minimal interruption; pulse checks and rhythm analysis without compressions should only be performed at preplanned intervals (every two minutes). Such interruptions should not exceed 10 seconds, except for specific interventions, such as defibrillation.

When preparing for defibrillation, rescuers should continue performing excellent chest compressions while charging the defibrillator until just before the single shock is delivered, and resume immediately after shock delivery without taking time to assess pulse or breathing. No more than 3 to 5 seconds should elapse between stopping chest compressions and shock delivery. If a single lay rescuer is providing CPR, excellent chest compressions should be performed continuously without ventilations. (See ‘Compression-only CPR (CO-CPR)’ below.)

Multiple studies of trained rescuers support the importance of uninterrupted chest compressions:

- One prospective study reported improved survival among out-of-hospital cardiac arrest patients treated with minimally interrupted cardiac resuscitation \[46\]. This study was performed as urban and rural EMS and Fire personnel in Arizona were being trained in the approach advocated by the AHA 2005 BLS Guidelines, which were the first to emphasize continuous chest compressions with minimal interruption. Survival among patients rescued by personnel trained according to the 2005
Guidelines was 5.4 percent (36/668) compared to 1.8 percent (4/218) among those treated according to earlier BLS guidelines (OR 3.0; 95% CI 1.1 to 8.9).

- A retrospective observational study compared survival rates and neurologic outcomes in two groups of rural patients who sustained out-of-hospital cardiac arrest [28]. The first group was treated between 2001 and 2003 according to the 2000 AHA Guidelines (standard compressions and ventilations), while the second group was treated between 2004 and 2007 according to the 2005 AHA Guidelines (compression-only CPR without ventilations). Among 92 patients in the first group, 18 survived of whom 14 (15 percent) were neurologically intact. Of the 89 patients in the second group, 42 survived of whom 35 (39 percent) were neurologically intact. Similar subsequent studies have replicated these results [42,47].

**Compression-only CPR (CO-CPR)** — When multiple trained personnel are present, the simultaneous performance of continuous excellent chest compressions, airway protection, and proper ventilation is recommended by the AHA for the management of sudden cardiac arrest (SCA). The importance of ventilation increases with the duration of the arrest. (See 'Ventilations' below and 'Phases of resuscitation' above.)

However, if a sole lay rescuer is present or multiple lay rescuers are reluctant to perform mouth-to-mouth ventilation, the AHA 2010 Guidelines encourage the performance of CPR using excellent chest compressions alone. The Guidelines further state that lay rescuers should **not** interrupt excellent chest compressions to palpate for pulses or check for the return of spontaneous circulation, and should continue CPR until an AED is ready to defibrillate, EMS personnel assume care, or the patient wakes up. Note that CO-CPR is **not** recommended for children or arrest of noncardiac origin (eg, near drowning). (See "Basic life support in infants and children".)

For many would-be rescuers, the requirement to perform mouth-to-mouth ventilation is a significant barrier to the performance of CPR [19]. This reluctance may stem from anxiety about performing CPR correctly or fear of contracting a communicable disease, despite scant reports of infection contracted from the performance of mouth-to-mouth ventilation, none of which involve HIV [19]. CO-CPR circumvents these problems, potentially increasing the willingness of bystanders to perform CPR.

A meta-analysis of studies comparing treatment with CO-CPR and standard CPR, including ventilation (S-CPR) for patients with out-of-hospital cardiac arrest, concluded that the former is preferred for untrained rescuers [48]. The primary meta-analysis evaluated three high quality randomized trials and found that CO-CPR improved survival to hospital discharge compared to S-CPR (14 percent (211/1500) versus 12 percent (178/1531); RR 1.22; 95% CI 1.01 to 1.46). The secondary meta-analysis of seven observational studies found no significant difference between the two approaches.

**Ventilations** — During the initial phase of SCA, when the pulmonary vessels and heart likely contain sufficient oxygenated blood to meet markedly reduced demands, the importance of compressions supersedes ventilations [49-51]. Consequently, the initiation of excellent chest compressions is the first step to improving oxygen delivery to the tissues (algorithm 1). This is the rationale behind the compressions-airway-breathing (C-A-B) approach to SCA advocated in the 2010 AHA Guidelines [21].
In some circumstances, continuing excellent compression-only CPR may be preferable to adding ventilations, especially when lay rescuers are performing the resuscitation. However, in patients whose cardiac arrest is associated with hypoxia, it is likely that oxygen reserves have been depleted, necessitating the performance of excellent standard CPR with ventilations. (See 'Chest compressions' above and 'Compression-only CPR (CO-CPR)' above.)

Properly performed ventilations become increasingly important as pulselessness persists. In this, the metabolic phase of resuscitation, clinicians must continue to ensure that ventilations do not interfere with the cadence and continuity of chest compressions. The techniques used in basic airway management are discussed separately. (See 'Phases of resuscitation' above and "Basic airway management in adults".)

Proper ventilation for adults includes the following:

- Give 2 ventilations after every 30 compressions for patients without an advanced airway
- Give each ventilation over no more than one second
- Provide enough tidal volume to see the chest rise
- Avoid excessive ventilation
- Give 1 asynchronous ventilation every 8 to 10 seconds (6 to 8 per minute) to patients with an advanced airway (eg, supraglottic device, endotracheal tube) in place

Although the Guidelines recommend 8 to 10 breaths per minute, we believe 6 to 8 breaths are adequate in the low-flow state of cardiac resuscitation. However, the key point is to avoid excessive ventilation.

Asynchronous implies ventilations need not be coordinated with chest compressions. Ventilations should be delivered in as short a period as possible, not exceeding one second per breath, while avoiding excessive ventilatory force. Only enough tidal volume to confirm initial chest rise should be given. This approach promotes both prompt resumption of compressions and improved cerebral and coronary perfusion.

Excessive ventilation, whether by high ventilatory rates or increased volumes, must be avoided. Positive pressure ventilation raises intrathoracic pressure which causes a decrease in venous return, pulmonary perfusion, cardiac output, and cerebral and coronary perfusion pressures [52]. Studies in animal models have found that over-ventilation reduces defibrillation success rates and decreases overall survival [27,45,53-55].

Despite the risk of compromised perfusion, rescuers routinely over-ventilate patients. One study of prehospital resuscitation reported that average ventilation rates during CPR were 30 per minute, while a study of in-hospital CPR revealed ventilation rates of more than 20 per minute [18,52]. It is imperative that the rate and volume of ventilations be continually reassessed and corrections made throughout the resuscitation. Resuscitation teams often believe that ventilations are being performed appropriately when in fact they are too fast or too forceful, resulting in inadequate cerebral perfusion and reducing the patient's chance for a neurologically intact survival.
**Defibrillation** — The effectiveness of early defibrillation in patients with ventricular fibrillation (VF) and short "downtimes" is well supported by the resuscitation literature and early defibrillation is a fundamental recommendation of the AHA 2010 BLS Guidelines [20,56]. For BLS, a single shock from an automated external defibrillator (AED) is followed by the immediate resumption of excellent chest compressions. For advanced cardiac life support, a single shock is still recommended regardless of whether a biphasic or monophasic defibrillator is used.

Biphasic defibrillators are preferred because of the lower energy levels needed for effective cardioversion. Biphasic defibrillators measure the impedance between the electrodes placed on the patient and adjust the energy delivered accordingly. Rates of first shock success are reported to be approximately 85 percent [57-59]. (See "Basic principles and technique of cardioversion and defibrillation".)

The AHA 2010 Guidelines recommend using the energy levels suggested by the manufacturer of the device [60]. We recommend that all defibrillations for patients in cardiac arrest be delivered at the highest available energy in adults (generally 360 J for a monophasic defibrillator and 200 J for a biphasic defibrillator). This approach reduces interruptions in CPR and is implicitly supported by a study in which out-of-hospital cardiac arrest patients randomly assigned to treatment with escalating energy using a biphasic device showed higher conversion and termination rates for ventricular fibrillation than those assigned to treatment with fixed lower energy [61]. (See "Advanced cardiac life support (ACLS) in adults", section on 'Sudden cardiac arrest'.)

**Pulse checks and rhythm analysis** — It is essential to minimize delays and interruptions in the performance of excellent chest compressions. Therefore, pulse checks and rhythm analysis should be done sparingly and are best performed during a planned interruption at the two minute interval following a complete cycle of cardiopulmonary resuscitation (CPR). Even short delays in the initiation or brief interruptions in the performance of CPR can compromise cerebral and coronary perfusion pressure and decrease survival. Following any interruption, sustained chest compressions are needed to regain pre-interruption rates of blood flow. (See 'Chest compressions' above.)

Wide variation exists in the ability of both lay rescuers and healthcare providers to determine pulselessness accurately and efficiently [62]. Therefore, the AHA 2010 BLS Guidelines recommend that untrained rescuers begin CPR immediately, without a pulse check, as soon as they determine a patient is unresponsive. Healthcare providers must not spend more than ten seconds checking for a pulse, and should start CPR immediately if no pulse is felt. (See 'Recognition of cardiac arrest' above.)

The AHA 2010 Guidelines recommend that CPR be resumed for two minutes, without a pulse check, after any attempt at defibrillation, regardless of the resulting rhythm. Data suggest that the heart does not immediately generate effective cardiac output after defibrillation, and CPR may enhance post-defibrillation perfusion [15,16,59,63,64].

One observational study of 481 cases of cardiac arrest found that rhythm reanalysis, repeated shocks, and postshock pulse checks resulted on average in a 29-second delay in restarting chest compressions [65]. Postshock pulse checks were of benefit in only 1 of 50 patients.
SUMMARY AND RECOMMENDATIONS — The American Heart Association (AHA) in collaboration with the International Liaison Committee on Resuscitation published updated guidelines for basic life support (BLS) and advanced cardiac life support (ACLS) in 2010 (AHA 2010 Guidelines) (algorithm 1). We recommend following the practices described in the AHA 2010 BLS Guidelines, the important elements of which are summarized below:

- Chest compressions — Chest compressions are the most important element of cardiopulmonary resuscitation (CPR). Interruptions in chest compressions during CPR, no matter how brief, result in unacceptable declines in coronary and cerebral perfusion pressure. The CPR mantra is: *push hard and push fast on the center of the chest.* The critical performance standards for CPR include:
  
  Maintain a rate of at least 100 compressions per minute  
  Compress the chest at least 5 cm (2 inches) with each down-stroke  
  Allow the chest to recoil completely between each down-stroke  
  Minimize the frequency and duration of any interruptions  

- Compression-only CPR — If a sole lay rescuer is present or multiple lay rescuers are reluctant to perform mouth-to-mouth ventilation, the AHA 2010 Guidelines encourage the performance of CPR using chest compressions alone. Lay rescuers should not interrupt chest compressions to palpate for pulses and should continue CPR until an AED is ready to defibrillate, EMS personnel assume care, or the patient wakes up. Note that CO-CPR is not recommended for children or arrest of noncardiac origin (eg, near drowning). (See 'Chest compressions' above and 'Compression-only CPR (CO-CPR)' above.)

- Ventilations — As pulselessness persists in patients with SCA, the importance of performing ventilations increases. The AHA 2010 Guidelines suggest that each ventilation be delivered over no more than one second. Ventilations must not be delivered with excessive force; only enough tidal volume to confirm chest rise should be given. Avoid excessive ventilation (which can compromise cardiac output) through high rates or increased volumes. (See 'Ventilations' above.)

- Compression-ventilation ratio — In adults, the AHA 2010 Guidelines recommend that CPR be performed at a ratio of 30 excellent compressions to 2 ventilations until an advanced airway has been placed. Following placement of an advanced airway, excellent compressions are continuous, and asynchronous ventilations are delivered approximately eight times per minute. (See 'Ventilations' above.)

- Defibrillation — Early defibrillation is critical to the survival of patients with ventricular fibrillation. The AHA 2010 Guidelines recommend a single defibrillation in all shocking sequences. In adults, we suggest defibrillation using the highest available energy (generally 200 J with a biphasic defibrillator and 360 J with a monophasic defibrillator) (Grade 2C). (See 'Defibrillation' above.)

- Phases of resuscitation — There are three phases of cardiac arrest. The electrical phase comprises the first four to five minutes and requires immediate defibrillation. The hemodynamic phase spans approximately minutes four to ten following sudden
cardiac arrest (SCA). Patients in the hemodynamic phase benefit from excellent chest compressions to generate adequate cerebral and coronary perfusion and immediate defibrillation. The metabolic phase occurs following approximately ten minutes of pulselessness; few patients who reach this phase survive. (See 'Phases of resuscitation' above.)

- Instruction — All healthcare providers should receive standardized training in CPR and be familiar with the operation of automated external defibrillators (AED).

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REFERENCES


Adult BLS algorithm for healthcare providers: 2010 guidelines

1. Unresponsive
   No breathing or no normal breathing
   (i.e., only gasping)

2. Activate emergency response system
   Get AED/defibrillator
   or send second rescuer (if available) to do this

3* Check pulse:
   DEFINITE pulse within 10 seconds?
   No pulse

4. Begin cycles of 30 COMPRESSIONS and 2 BREATHS

5. AED/defibrillator ARRIVES

6. Check rhythm
   Shockable
   Not shockable

7. Give 1 shock
   Resume CPR immediately
   for 2 minutes

8. Resume CPR immediately
   for 2 minutes
   Check rhythm every 2 minutes; continue until
   ALS providers take over or victim starts to move

High-quality CPR
- Rate at least 100/min
- Compression depth at least 2 inches (5 cm)
- Allow complete chest recoil after each compression
- Minimize interruptions in chest compressions
- Avoid excessive ventilation

AED: automated external defibrillator; ALS: advanced life support; BLS: basic life support.
* The boxes bordered with dashed lines are performed by healthcare providers and not by lay rescuers. Reprinted with permission. Adult Basic Life Support: 2010. American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. © 2010 American Heart Association, Inc.