CHANGING GUIDELINES FOR CPR

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Abstract

The guidelines for cardio-pulmonary resuscitation are updated every five years. Basic life support is the foundation for saving lives after cardiac arrest. BLS encompasses three major aspects: airway control, artificial respiration and cardiac massage.

The 5 links in the adult Chain of Survival are

- ***Immediate recognition of cardiac arrest and activation of the emergency response system***
- ***Early cardiopulmonary resuscitation (CPR) with an emphasis on chest compressions***
- ***Rapid defibrillation***
- ***Effective advanced life support***
- ***Integrated post-cardiac arrest care***

A strong Chain of Survival can improve chances of survival and recovery for victims of heart attack, stroke and other emergencies. In this article, we reviewed the recent advances in the updated CPR guidelines.

INTRODUCTION

The history and practice of cardiopulmonary resuscitation (CPR) evolved with the development of understanding of the cardio-pulmonary physiology. The different aspects of CPR evolved over many centuries with the initial accounts dating back to biblical times. However, consistently recorded medical success of CPR methods only appeared in the early nineteenth century. Advances in this area have progressed rapidly from the middle of the twentieth century up to the modern era.

Basic life support encompasses the development of three major practices: airway control, artificial respiration and cardiac massage. Vesalius is credited with the earliest account of artificial respiration and airway control in 1555 when he used a reed placed in the trachea of animals to keep them alive while studying their anatomy [1]. In 1732, Tossach performed the first documented resuscitation of a coal miner using mouth-to-mouth respiration [2]. Later, the Paris Academy of Sciences recommended mouth-to-mouth resuscitation for the newly drowned but the technique could not gain popularity for hygienic reasons and the belief that the carbon dioxide in exhaled air was harmful for the victim. The first successful use of closed chest cardiac massage in living cats is attributed to Bohem of Germany and his associates [1, 3]. In 1880 Niehaus performed the first unsuccessful attempt at closed chest cardiac massage in a man [1]. Five years later, Koenig reported eight successful cases of human closed chest cardiac massage. Although experimental and in-hospital trials of closed cardiac massage continued, it was soon replaced by the assumedly superior and more invasive method of open chest cardiac massage. In 1947, Claude Beck performed the first successful internal defibrillation of a human heart in the operating room, and in 1956 Zoll et al. performed the first human external defibrillation [4, 5]. Eventually, closed chest compressions and artificial ventilatory techniques were combined to produce the method of cardiopulmonary resuscitation most commonly used today.

Guidelines:

BLS is the foundation for saving lives after cardiac arrest. Fundamental aspects of adult BLS include immediate recognition of sudden cardiac arrest and activation of the emergency response system, early CPR and rapid defibrillation with an automated external defibrillator (AED).

The crucial links in the adult out-of-hospital Chain of Survival are unchanged from 2010. However, there is increased emphasis on the rapid identification of potential cardiac arrest by dispatchers with immediate provision of CPR instructions to the caller in the 2015 update. It takes into consideration the ubiquitous usage of mobile phones that can allow the rescuer to activate the emergency response system without leaving the victim's side. For healthcare providers, these recommendations allow flexibility for activation of the

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emergency response to better match the provider's clinical setting.

More data is available showing that high-quality CPR improves survival from cardiac arrest by:

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

The updated guidelines recommend a simultaneous and choreographed approach to the performance of chest compressions, airway management, rescue breathing, rhythm detection and shocks (if indicated) by an integrated team of highly trained rescuers in applicable settings. When the links in the Chain of Survival are implemented in an effective way, survival can approach 50% in EMS-treated patients after witnessed out-of-hospital ventricular fibrillation (VF) arrest [6]. Unfortunately, survival rates in many out-of-hospital and in-hospital settings fall far short of this figure 1.

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

The steps of BLS consist of a series of sequential assessments and actions, which are illustrated in a simplified BLS algorithm that is unchanged from 2010 [7]. The intent of the algorithm is to present the steps of BLS in a logical and concise manner that is easy for all types of rescuers to learn, remember, and perform. Integrated teams of highly trained rescuers may use a choreographed approach that accomplishes multiple steps and assessments simultaneously rather than in the sequential manner used by individual rescuers (eg, one rescuer activates the emergency response system while another begins chest compressions, a third either provides ventilation or retrieves the bag-mask device for rescue breaths, and a fourth retrieves and sets up a defibrillator). Moreover, trained rescuers are encouraged to simultaneously perform some steps (ie, checking for breathing and pulse at the same time) in an effort to reduce the time to first compressions.

Emergency medical dispatch is an integral component of the EMS response. Bystanders (lay responders) should immediately call their local emergency number to initiate a response any time they find an unresponsive victim. Begin chest compressions as quickly as possible after recognition of cardiac arrest. The 2010 Guidelines included a major change for trained rescuers, who were instructed to begin the CPR sequence with chest compressions rather than breaths (C-A-B versus A-B-C) to minimize the time to initiation of chest compressions. The 2015 ILCOR BLS Task Force reviewed the most recent evidence evaluating the impact of this change in sequence on resuscitation. After activating the emergency response system, the lone rescuer retrieves an AED (if nearby and easily accessible) and then returns to the victim to attach and use the AED and provide CPR. When 2 or more trained rescuers are present, first rescuer begins CPR starting with chest compressions, while a second rescuer activates the emergency response system and gets the AED (or a manual defibrillator in most hospitals) and other emergency equipment. The AED or manual defibrillator is used as rapidly as possible, and both rescuers are expected to provide CPR with chest compressions and ventilation. The sequence for using an AED has not been updated from the 2010 Guidelines.

Rescuer specific CPR strategies

CPR is performed by 3 types of prototypical rescuers after they activate the emergency response system. The specific steps for rescuers and healthcare providers (compression-only CPR, conventional CPR with rescue breaths, and CPR with AED use) are determined by the rescuer's level of training.

1. Untrained Lay rescuer

Bystander CPR may prevent VF from deteriorating to asystole, and it also increases the chance of defibrillation, contributes to preservation of heart and brain function, and improves survival from OHCA [8].

Bystander CPR rates remain unacceptably low in many communities. Because compression-only CPR is easier to teach, remember, and perform, it is preferred for "just-in-time" teaching for untrained lay rescuers.

2. Trained Lay rescuer

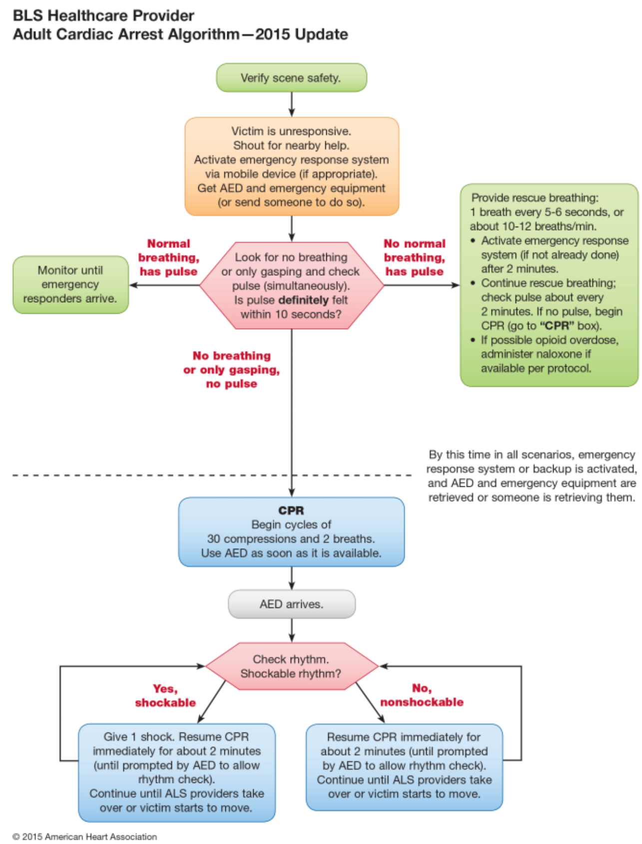
The 2010 Guidelines recommended that trained rescuers should provide rescue breaths in addition to chest compressions because they may encounter victims with asphyxial causes of cardiac arrest or they may be providing CPR for prolonged periods of time before additional help arrives.

3. Health care provider

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

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

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



The 2010 Guidelines are as follows:

Bystanders may witness the sudden collapse of a victim or find someone who appears lifeless. At that time several steps should be initiated. Before approaching a victim, the rescuer must ensure that the scene is safe and then check for a response. To do this, tap the victim on the shoulder and shout, "Are you all right?" If the victim is responsive he or she will answer, move, or moan. If the victim remains unresponsive, the lay rescuer should activate the emergency response system.
When calling for help, the rescuer should be prepared to answer the dispatcher's questions about the location of the incident, the events of the incident, the number and condition of the victim(s), and the type of aid provided. If rescuers never learned or have forgotten how to do CPR, they should also be prepared to follow the dispatcher's instructions. Finally, the rescuer making the phone call should hang up only when instructed to do so by the dispatcher.
After activation of the emergency response system, all rescuers should immediately begin CPR (see steps below) for adult victims who are unresponsive with no breathing or no normal breathing (only gasping).

Professional as well as lay rescuers may be unable to accurately determine the presence or absence of adequate or normal breathing in unresponsive victim because the airway may not be open or because the victim has occasional gasps. Occasional gasps do not necessarily result in adequate ventilation.

Studies have shown that both laypersons and healthcare providers have difficulty detecting a pulse [9]. 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.

Chest compressions

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

Characteristics of chest compressions include their depth, rate, and degree of recoil. The quality of CPR can also be characterized by the frequency and duration of interruptions in chest compressions—when such interruptions are minimized, the chest compression fraction (percent of total resuscitation time that compressions are performed) is higher. Finally, with high-quality CPR, the rescuer avoids excessive ventilation. These CPR performance elements affect intrathoracic pressure, coronary perfusion pressure, cardiac output, and, in turn, clinical outcomes. In the 2010 Guidelines, the recommended compression rate was at least 100 compressions per minute. The 2015 Guidelines Update incorporates new evidence about the potential for an upper threshold of rate beyond which outcome may be adversely affected. In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100/min to 120/min.

Compression depth

The 2015 ILCOR systematic review addressed whether a chest compression depth different from 2 inches (5 cm) influences physiologic or clinical outcomes. The depth of chest compression can affect the relative increase in intrathoracic pressure and, in turn, influence forward blood flow from the heart and great vessels to the systemic circulation. During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches or 5 cm for an average adult, while avoiding excessive chest compression depths (greater than 2.4 inches or 6 cm).

Chest wall recoil

The 2015 ILCOR systematic reviews addressed whether full chest wall recoil compared with incomplete recoil influenced physiologic or clinical outcomes. Full chest wall recoil occurs when the sternum returns to its natural or neutral position during the decompression phase of CPR. Chest wall recoil creates a relative negative intrathoracic pressure that promotes venous return and cardiopulmonary blood flow. Leaning on the chest wall between compressions precludes full chest wall recoil [10]. Incomplete recoil could increase intrathoracic pressure and reduce venous return, coronary perfusion pressure, and myocardial blood flow and could potentially influence resuscitation outcomes.

Minimizing chest compression interruptions

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

Chest compression fraction is a measurement of the proportion of time that compressions are performed during a cardiac arrest. An increase in chest compression fraction can be achieved by minimizing pauses in chest compressions. For adults in cardiac arrest receiving CPR without an advanced airway, it is reasonable to pause compressions for less than 10 seconds to deliver 2 breaths.

Compression to ventilation ratio

In 2005, the recommended compression-to-ventilation ratio for adults in cardiac arrest was changed from 15:2 to 30:2. The 2015 ILCOR systematic review addressed whether compression-to-ventilation ratios different from 30:2 influenced physiologic or clinical outcomes. The guidelines still recommends to provide a compression-to-ventilation ratio of 30:2 for adults in cardiac arrest.

Managing the airway

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

Opening the airway

The recommendation for trained and untrained lay rescuers remains the same as in 2010. For victims with suspected spinal injury, rescuers should initially use manual spinal motion restriction (eg, placing 1 hand on either side of the patient's head to hold it still) rather than immobilization devices, because use of immobilization devices by lay rescuers may be harmful. Spinal immobilization devices may interfere with maintaining a patent airway but ultimately the use of such a device may be necessary to maintain spinal alignment during transport [11, 12].

A healthcare provider uses the head tilt–chin lift manoeuvre to open the airway of a victim with no evidence of head or neck trauma. The evidence for this was last reviewed in 2010. For victims with suspected spinal cord injury, this evidence was last reviewed in 2010 and there is no change in treatment recommendation. If healthcare providers suspect a cervical spine injury, they should open the airway using a jaw thrust without head extension [13].

Rescue breathing

The 2015 Guidelines Update makes many of the same recommendations regarding rescue breathing as were made in 2005 and 2010. Effective performance of rescue breathing or bag-mask or bag-tube ventilation is an essential skill and requires training and practice. During CPR without an advanced airway, a compression-to-ventilation ratio of 30:2 is used. 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 [14, 15]. Excessive ventilation is unnecessary and can cause gastric inflation and its resultant complications, such as regurgitation and aspiration [16].

Mouth to mouth rescue breath

The technique for mouth-to-mouth rescue breathing was last reviewed in 2010 [17]. Mouth-to-mouth rescue breathing provides oxygen and ventilation to the victim. 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. 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 breath

Some healthcare providers and lay rescuers 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.

Ventilation with bag mask device

When using a self-inflating bag, rescuers can provide bag-mask ventilation with room air or oxygen. A bag-mask device can provide positive-pressure ventilation without an advanced airway and may result in gastric inflation and its potential complications. Bag-mask ventilation is a challenging skill that requires considerable practice for competency. 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 [18]. The rescuer should use an adult (1 to 2 L) bag to deliver approximately 600 ml tidal volume for adult victims [19]. This amount is usually sufficient to produce visible chest rise and maintain oxygenation and normocarbia in apneic patients.

Ventilation with 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. 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.

Ventilation with advanced airway

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

Defibrillation

VF and pVT are treatable cardiac arrest rhythms with outcomes closely related to the rapidity of recognition and treatment [20]. Survival in victims of VF/pVT is highest when bystanders deliver CPR and defibrillation is attempted within 3 to 5 minutes of collapse [21]. 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.

CPR before defibrillation

The 2015 ILCOR systematic review addressed whether a specified period (typically 1.5 to 3 minutes) of chest compressions before shock delivery affected resuscitation outcomes. When cardiac arrest is unwitnessed, experts have debated whether a period of CPR might be beneficial before attempting defibrillation, especially in the out-of-hospital setting when access to defibrillation may be delayed until the arrival of professional rescuers. Observational clinical studies and mechanistic studies in animal models suggest that CPR under conditions of prolonged untreated VF might help restore metabolic conditions of the heart favorable to defibrillation. Others have suggested that prolonged VF is energetically detrimental to the ischemic heart, justifying rapid defibrillation attempts regardless of the duration of arrest. For witnessed adult cardiac arrest when an AED is immediately available, it is reasonable that the defibrillator be used as soon as possible. For adults with unmonitored cardiac arrest or for whom an AED is not immediately available, it is reasonable that CPR be initiated while the defibrillator equipment is being retrieved.

Rhythm analysis

In 2010, the Guidelines emphasized the importance of avoiding pauses in cardiac compressions during CPR. Assessment of rhythm after shock delivery lengthens the period of time that chest compressions are not delivered. It may be reasonable to immediately resume chest compressions after shock delivery for adults in cardiac arrest in any setting.

Team based resuscitation

Resuscitation from cardiac arrest most often involves a team of caregivers, with team composition and level of experience varying depending on location (in-versus out-of-hospital), setting (field, emergency department, hospital ward), and circumstances. Despite the varied environments and team members, a designated team leader is needed to direct and coordinate all components of the resuscitation with a central focus on delivering high-quality CPR. The team leader choreographs team activities with an aim to minimize interruptions in CPR and, through the use of real-time feedback, ensures delivery of adequate compression rate and depth, minimization of leaning, and interruptions in chest compressions and avoidance of excessive ventilation [22].

Duration of resuscitation

Two observational cohort studies of patients with in-hospital arrests were recently published suggesting that extending the duration of resuscitation efforts may result in improved cardiac arrest survival. For adult patients, hospitals that systematically practiced longer durations of resuscitation had improved outcomes of ROSC and survival to discharge, with no apparent detriment in neurologic outcomes [23]. Another report of paediatric patients demonstrated an intact survival of 16.2% after more than 35 minutes of CPR in certain patient population. Extending the duration of resuscitation may be a means of improving survival in selected hospitalized patients.

Drugs in cardiac arrest

The 2015 ILCOR systematic review did not specifically address the selection or use of second-line antiarrhythmic medications in patients who are unresponsive to a maximum therapeutic dose of the first administered drug. Amiodarone may be considered for VF/pVT that is unresponsive to CPR, defibrillation, and a vasopressor therapy. Lidocaine may be considered as an alternative to amiodarone for VF/pVT that is unresponsive to CPR, defibrillation, and vasopressor therapy. Epinephrine produces beneficial effects in patients during cardiac arrest, primarily because of its α-adrenergic (ie, vasoconstrictor) effects. These α-adrenergic effects of epinephrine can increase coronary perfusion pressure and cerebral perfusion pressure during CPR. The value and safety of the β-adrenergic effects of epinephrine are controversial because they may increase myocardial work and reduce subendocardial perfusion. Standard-dose epinephrine (1 mg every 3 to 5 minutes) may be reasonable for patients in cardiac arrest. Vasopressin offers no advantage as a substitute for epinephrine in cardiac arrest [24].

CONCLUSION

The art of cardiopulmonary resuscitation portrays the advances in resuscitative medicine through the application of scientific methods. Although the field of CPR has seen much growth already, as health care providers we can only expect that the road ahead will lead to numerous discoveries and changes that will further shape resuscitative practice.

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