Part 4: Adult Basic Life Support

Basic life support (BLS) includes recognition of signs of sudden cardiac arrest (SCA), heart attack, stroke, and foreign-body airway obstruction (FBAO); cardiopulmonary resuscitation (CPR); and defibrillation with an automated external defibrillator (AED). This section summarizes BLS guidelines for lay rescuers and healthcare providers.

Introduction

As noted in Part 3: "Overview of CPR," SCA is a leading cause of death in the United States and Canada.[1–3] At the first analysis of heart rhythm, about 40% of victims of out-of-hospital SCA demonstrate ventricular fibrillation (VF).[3–5] VF is characterized by chaotic rapid depolarizations and repolarizations that cause the heart to quiver so that it is unable to pump blood effectively.[6] It is likely that an even larger number of SCA victims have VF or rapid ventricular tachycardia (VT) at the time of collapse, but by the time of first rhythm analysis the rhythm has deteriorated to asystole.[7]

Many SCA victims can survive if bystanders act immediately while VF is still present, but successful resuscitation is unlikely once the rhythm deteriorates to asystole.[8] Treatment for VF SCA is immediate bystander CPR plus delivery of a shock with a defibrillator. The mechanism of cardiac arrest in victims of trauma, drug overdose, drowning, and in many children is asphyxia. CPR with both compressions and rescue breaths is critical for resuscitation of these victims.

The American Heart Association uses 4 links in a chain (the "Chain of Survival") to illustrate the important time-sensitive actions for victims of VF SCA (Figure 1). Three and possibly all 4 of these links are also relevant for victims of asphyxial arrest.[9] These links are

- Early recognition of the emergency and activation of the emergency medical services (EMS) or local emergency response system: "phone 911."[10,11]
- Early bystander CPR: immediate CPR can double or triple the victim's chance of survival from VF SCA.[8,12–14]
- Early delivery of a shock with a defibrillator: CPR plus defibrillation within 3 to 5 minutes of collapse can produce survival rates as high as 49% to 75%.[15–23]
- Early advanced life support followed by postresuscitation care delivered by healthcare providers.

Bystanders can perform 3 of the 4 links in the Chain of Survival. When bystanders recognize the emergency and activate the EMS system, they ensure that basic and advanced life support providers are dispatched to the site of the emergency. In many communities the time interval from EMS call to EMS arrival is 7 to 8 minutes or longer.[24] This means that in the first minutes after collapse the victim's chance of survival is in the hands of bystanders.

Shortening the EMS response interval increases survival from SCA, but the effect is minimal once the EMS response interval (from the time of EMS call until arrival) exceeds 5 to 6 minutes (LOE 3).[25–31] EMS systems should evaluate their protocols for cardiac arrest patients and try to shorten response intervals when improvements are feasible and resources are available (Class I). Each EMS system should measure the rate of survival to hospital discharge for victims of VF SCA and use these measurements to document the impact of changes in procedures (Class IIa).[32–35]

Victims of cardiac arrest need immediate CPR. CPR provides a small but critical amount of blood flow to the heart and brain. CPR prolongs the time VF is present and increases the likelihood that a shock will terminate VF (defibrillate the heart) and allow the heart to resume an effective rhythm and effective systemic perfusion. CPR is especially important if a shock is not delivered for 4 (LOE 4),[36] 5 (LOE 2),[37] or more minutes after collapse. Defibrillation does not "restart" the heart; defibrillation "stuns" the heart, briefly stopping VF and other cardiac electrical activity. If the heart is still viable, its normal pacemakers may then resume firing and produce an effective ECG rhythm that may ultimately produce adequate blood flow.

In the first few minutes after successful defibrillation, asystole or bradycardia may be present and the heart may pump ineffectively. In one recent study of VF SCA, only 25% to 40% of victims demonstrated an organized rhythm 60 seconds after shock delivery; it is likely that even fewer had effective perfusion at that point.[38] Therefore, CPR may be needed for several minutes following defibrillation until adequate perfusion is present.[39]

Lay rescuers can be trained to use a computerized device called an AED to analyze the victim's rhythm and deliver a shock if the victim has VF or rapid VT. The AED uses audio and visual prompts to guide the rescuer. It analyzes the victim's rhythm and informs the rescuer if a shock is needed. AEDs are extremely accurate and will deliver a shock only when VF (or its precursor, rapid VT) is present.[40] AED function and operation are discussed in Part 5: "Electrical Therapies: Automated External Defibrillators, Defibrillation, Cardioversion, and Pacing."

Successful rescuer actions at the scene of an SCA are time critical. Several studies have shown the beneficial effects of immediate CPR and the detrimental impact of delays in defibrillation on survival from SCA. For every minute without CPR, survival from witnessed VF SCA decreases 7% to 10%.[8] When bystander CPR is provided, the decrease in survival is more gradual and averages 3% to 4% per minute from collapse to defibrillation.[8,12] CPR has been shown to double[8,12] or triple[41] survival from witnessed SCA at many intervals to defibrillation.[42]

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Public access defibrillation and first-responder AED programs may increase the number of SCA victims who receive bystander CPR and early defibrillation, improving survival from out-of-hospital SCA.[43] These programs require an organized and practiced response with rescuers trained and equipped to recognize emergencies, activate the EMS system, provide CPR, and use the AED.[43] Lay rescuer AED programs in airports,[19] on airplanes,[20,21] in casinos,[22] and in first-responder programs with police officers[23,44–46] have achieved survival rates as high as 49% to 75%[19–23] from out-of-hospital witnessed VF SCA with provision of immediate bystander CPR and defibrillation within 3 to 5 minutes of collapse. These high survival rates, however, may not be attained in programs that fail to reduce time to defibrillation.[47–49]

Cardiopulmonary Emergencies

Emergency Medical Dispatch

Emergency medical dispatch is an integral component of the EMS response.[50–53] Dispatchers should receive appropriate training in providing prearrival telephone CPR instructions to callers (Class IIa).[10,54–57] Observational studies (LOE 4)[51,58] and a randomized trial (LOE 2)[57] documented that dispatcher CPR instructions increased the likelihood of bystander CPR being performed. It is not clear if prearrival instructions increase the rate of survival from SCA.[58,59]

Dispatchers who provide telephone CPR instructions to bystanders treating children and adult victims with a high likelihood of an asphyxial cause of arrest (eg, drowning) should give directions for rescue breathing followed by chest compressions. In other cases (eg, likely SCA) telephone instruction in chest compressions alone may be preferable (Class IIb). The EMS system's quality improvement program should include periodic review of the dispatcher CPR instructions provided to specific callers (Class IIa).

When dispatchers ask bystanders to determine if breathing is present, bystanders often misinterpret occasional gasps as indicating that the victim is breathing. This erroneous information can result in failure to initiate CPR for a victim of cardiac arrest (LOE 5).[60] Dispatcher CPR instruction programs should develop strategies to help bystanders identify patients with occasional gasps as likely victims of cardiac arrest and thus increase the likelihood of provision of bystander CPR for such victims (Class IIb).

Acute Coronary Syndromes

Coronary heart disease continues to be the nation's single leading cause of death, with >500 000 deaths and 1.2 million patients with an acute myocardial infarction (AMI) annually.[61] Approximately 52% of deaths from AMI occur out of the hospital, most within the first 4 hours after onset of symptoms.[62,63]

Early recognition, diagnosis, and treatment of AMI can improve outcome by limiting damage to the heart,[64,65] but treatment is most effective if provided within a few hours of the onset of symptoms.[66,67] Patients at risk for acute coronary syndromes (ACS) and their families should be taught to recognize the signs of ACS and immediately activate the EMS system rather than contact the family physician or drive to the hospital. The classic symptom associated with ACS is chest discomfort, but symptoms may also include 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 are more common in the elderly, women, and diabetic patients.[68–71]

To improve ACS outcome, all dispatchers and EMS providers must be trained to recognize ACS symptoms. EMS providers should be trained to determine onset of ACS symptoms, stabilize the patient, and provide prearrival notification and transport to an appropriate medical care facility.

EMS providers can support the airway, administer oxygen (Class IIb), and administer aspirin and nitroglycerin. If the patient has not taken aspirin and has no history of aspirin allergy, EMS providers should give the patient 160 to 325 mg of aspirin to chew (Class I) and notify the receiving hospital before arrival.[72–75] Paramedics should be trained and equipped to obtain a 12-lead electrocardiogram (ECG) and transmit the ECG or their interpretation of it to the receiving hospital (Class IIa). More specifics on these topics are covered in Part 8: "Stabilization of the Patient With Acute Coronary Syndromes."

Stroke

Stroke is the nation's No. 3 killer and a leading cause of severe, long-term disability.[61] Fibrinolytic therapy administered within the first hours of the onset of symptoms limits neurologic injury and improves outcome in selected patients with acute ischemic stroke.[76–78] The window of opportunity is extremely limited, however. Effective therapy requires early

Figure 1. Adult Chain of Survival.

detection of the signs of stroke, prompt activation of the EMS system, prompt dispatch of EMS personnel, rapid delivery to a hospital capable of providing acute stroke care, prearrival notification, immediate and organized hospital care, appropriate evaluation and testing, and rapid delivery of fibrinolytic agents to eligible patients.[79,80]

Patients at high risk for a stroke and their family members must learn to recognize the signs and symptoms of stroke and to call EMS as soon as they detect any of them. 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.[81,82]

EMS dispatchers should be trained to suspect stroke and rapidly dispatch responders[83] who should be able to perform an out-of-hospital stroke assessment (LOE 3 to 5; Class IIa),[84–87] establish the time the patient was last known to be "normal," support the ABCs, notify the receiving hospital that a patient with possible stroke is being transported there, and consider triaging the patient to a facility with a stroke unit (LOE 5 to 8; Class IIb).[88–91] It may be helpful for a family member to accompany the patient during transport to verify the time of symptom onset. If authorized by medical control, EMS providers should check the patient's glucose level during transport to rule out hypoglycemia as the cause of altered neurologic function and to give glucose if blood sugar is low.

When the stroke victim arrives at the emergency department (ED), the goal of care is to streamline evaluation so that initial assessment is performed within 10 minutes, a computed tomography (CT) scan is performed and interpreted within 25 minutes, and fibrinolytics are administered to selected patients within 60 minutes of arrival at the ED and within 3 hours of the onset of symptoms. Additional information about the assessment of stroke using stroke scales and the management of stroke is included in Part 9: "Adult Stroke."

Adult BLS Sequence

The steps of BLS consist of a series of sequential assessments and actions, which are illustrated in the BLS algorithm (Figure 2). The intent of the algorithm is to present the steps in a logical and concise manner that will be easy to learn, remember, and perform. The box numbers in the following section refer to the corresponding boxes in the Adult BLS Healthcare Provider Algorithm.

Safety during CPR training and performance, including the use of barrier devices, is discussed in Part 3. Before approaching the victim, the rescuer must ensure that the scene is safe. Lay rescuers should move trauma victims only if absolutely necessary (eg, the victim is in a dangerous location, such as a burning building).

Check for Response (Box 1)

Once the rescuer has ensured that the scene is safe, the rescuer should check for response. To check for response, tap the victim on the shoulder and ask, "Are you all right?" If the victim responds but is injured or needs medical assistance, leave the victim to phone 911. Then return as quickly as possible and recheck the victim's condition frequently.

Activate the EMS System (Box 2)

If a lone rescuer finds an unresponsive adult (ie, no movement or response to stimulation), the rescuer should activate the EMS system (phone 911), get an AED (if available), and return to the victim to provide CPR and defibrillation if needed. When 2 or more rescuers are present, one rescuer should begin the steps of CPR while a second rescuer activates the EMS system and gets the AED. If the emergency occurs in a facility with an established medical response system, notify that system instead of the EMS system.

Healthcare providers may tailor the sequence of rescue actions to the most likely cause of arrest.[92] If a lone healthcare provider sees an adult or child suddenly collapse, the collapse is likely to be cardiac in origin, and the provider should phone 911, get an AED, and return to the victim to provide CPR and use the AED. If a lone healthcare provider aids a drowning victim or other victim of likely asphyxial (primary respiratory) arrest of any age, the healthcare provider should give 5 cycles (about 2 minutes) of CPR before leaving the victim to activate the EMS system.

When phoning 911 for help, the rescuer should be prepared to answer the dispatcher's questions about location, what happened, number and condition of victims, and type of aid provided. The caller should hang up only when instructed to do so by the dispatcher and should then return to the victim to provide CPR and defibrillation if needed.

Open the Airway and Check Breathing (Box 3)

To prepare for CPR, place the victim on a hard surface in a face up (supine) position. If an unresponsive victim is face down (prone), roll the victim to a supine (face up) position. If a hospitalized patient with an advanced airway (eg, endotracheal tube, laryngeal mask airway [LMA], or esophageal-tracheal combitube [Combitube]) cannot be placed in the supine position (eg, during spinal surgery), the healthcare provider may attempt CPR with the patient in a prone position (Class IIb). See below.

Open the Airway: Lay Rescuer

The lay rescuer should open the airway using a head tilt–chin lift maneuver for both injured and noninjured victims (Class IIa). The jaw thrust is no longer recommended for lay rescuers because it is difficult for lay rescuers to learn and perform, is often not an effective way to open the airway, and may cause spinal movement (Class IIb).

Open the Airway: Healthcare Provider

A healthcare provider should use the head tilt–chin lift maneuver to open the airway of a victim without 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[93] and radiographic (LOE 3) evidence[94,95] and a case series (LOE 5)[96] have shown it to be effective.

Approximately 2% of victims with blunt trauma have a spinal injury, and this risk is tripled if the victim has a

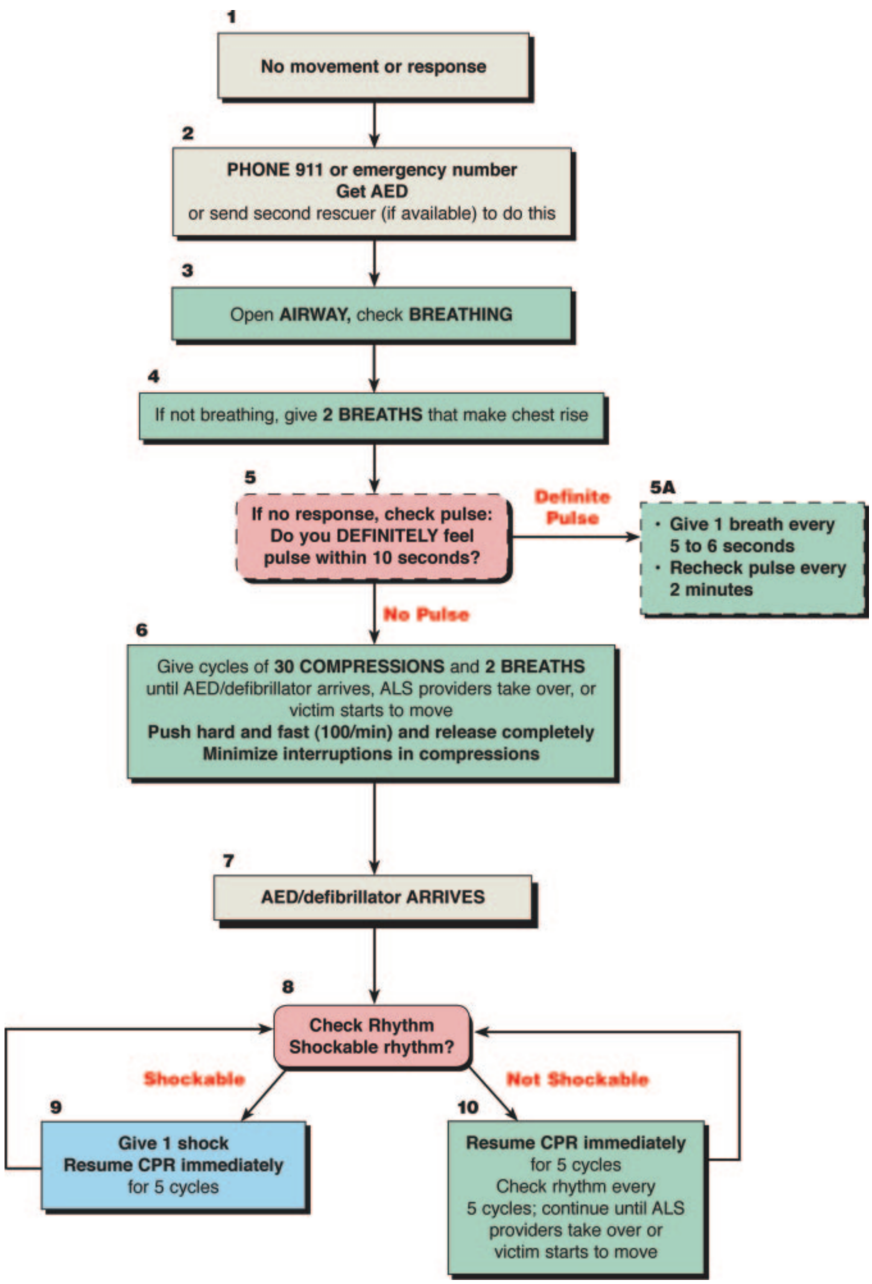

Figure 2. Adult BLS Healthcare Provider Algorithm. Boxes bordered with dotted lines indicate actions or steps performed by the healthcare provider but not the lay rescuer.

craniofacial injury,[97] a Glasgow Coma Scale score of <8,[98] or both.[97,99] If a healthcare provider suspects a cervical spine injury, open the airway using a jaw thrust without head extension (Class IIb).[96] Because maintaining a patent airway and providing adequate ventilation is a priority in CPR (Class I), use a head tilt–chin lift maneuver if the jaw thrust does not open the airway.

Use manual spinal motion restriction rather than immobilization devices for victims with suspected spinal injury (Class IIb).[100,101] Manual spinal motion restriction is safer, and immobilization devices may interfere with a patent airway (LOE 3 to 4).[102–104] Cervical collars may complicate airway management during CPR (LOE 4),[102] and they can cause increased intracranial pressure in a victim with a head injury (LOE 4 to 5; Class IIb).[105–108] Spine immobilization devices, however, are necessary during transport.

Check Breathing

While maintaining an open airway, look, listen, and feel for breathing. If you are a lay rescuer and do not confidently detect *normal* breathing or if you are a healthcare provider and do not detect *adequate* breathing within 10 seconds, give 2 breaths (see below). If you are a lay rescuer and you are unwilling or unable to give rescue breaths, begin chest compressions (Class IIa).

Professional as well as lay rescuers may be unable to accurately determine the presence or absence of adequate or normal breathing in unresponsive victims (LOE 7)[109–111] because the airway is not open[112] or the victim has occasional gasps, which can occur in the first minutes after SCA and may be confused with adequate breathing. Occasional gasps are not effective breaths. Treat the victim who has occasional gasps as if he or she is not breathing (Class I) and give rescue breaths. CPR training should emphasize how to recognize occasional gasps and should instruct rescuers to give rescue breaths and proceed with the steps of CPR when the unresponsive victim demonstrates occasional gasps (Class IIa).

Give Rescue Breaths (Boxes 4 and 5A)

Give 2 rescue breaths, each over 1 second, with enough volume to produce visible chest rise. This recommended 1-second duration to make the chest rise applies to all forms of ventilation during CPR, including mouth-to-mouth and bag-mask ventilation and ventilation through an advanced airway, with and without supplementary oxygen (Class IIa).

During CPR the purpose of ventilation is to maintain adequate oxygenation, but the optimal tidal volume, respiratory rate, and inspired oxygen concentration to achieve this are not known. The following general recommendations can be made:

1. During the first minutes of VF SCA, rescue breaths are probably not as important as chest compressions[113] because the oxygen level in the blood remains high for the first several minutes after cardiac arrest. In early cardiac arrest, myocardial and cerebral oxygen delivery is limited more by the diminished blood flow (cardiac output) than a lack of oxygen in the blood. During CPR blood flow is provided by chest compressions. Rescuers must be sure to provide effective chest compressions (see below) and minimize any interruption of chest compressions.
2. Both ventilations and compressions are important for victims of prolonged VF SCA, when oxygen in the blood is utilized. Ventilations and compressions are also important for victims of asphyxial arrest, such as children and drowning victims who are hypoxemic at the time of cardiac arrest.
3. During CPR blood flow to the lungs is substantially reduced, so an adequate ventilation-perfusion ratio can be maintained with lower tidal volumes and respiratory rates than normal.[114] Rescuers should not provide hyperventilation (too many breaths or too large a volume). Excessive ventilation is unnecessary and is harmful because it increases intrathoracic pressure, decreases venous return to the heart, and diminishes cardiac output and survival.[115]
4. Avoid delivering breaths that are too large or too forceful. Such breaths are not needed and may cause gastric inflation and its resultant complications.[116]

The *ECC Guidelines 2000*[117] recommended a variety of tidal volumes, respiratory rates, and breath delivery intervals. But it is unrealistic to expect the rescuer to distinguish half-second differences in inspiratory times or to judge tidal volumes delivered by mouth-to-mouth or bag-mask ventilation. So these guidelines provide simple recommendations for delivery of rescue breaths during cardiac arrest as follows:

- Deliver each rescue breath over 1 second (Class IIa).
- Give a sufficient tidal volume (by mouth-to-mouth/mask or bag mask with or without supplementary oxygen) to produce *visible chest rise* (Class IIa).
- Avoid rapid or forceful breaths.
- When an advanced airway (ie, endotracheal tube, Combitube, or LMA) is in place during 2-person CPR, ventilate at a rate of 8 to 10 breaths per minute without attempting to synchronize breaths between compressions. There should be no pause in chest compressions for delivery of ventilations (Class IIa).

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,[118] so oxygen uptake from the lungs and CO_2 delivery to the lungs are also reduced.[119] As a result, low minute ventilation (lower than normal tidal volume and respiratory rate) can maintain effective oxygenation and ventilation during CPR.[120–123] During adult CPR tidal volumes of approximately 500 to 600 mL (6 to 7 mL/kg) should suffice (Class IIa). Although a rescuer cannot estimate tidal volume, this guide may be useful for setting automatic transport ventilators and as a reference for manikin manufacturers.

If you are delivering ventilation with a bag and mask, use an adult ventilating bag (volume of 1 to 2 L); a pediatric bag delivers inadequate tidal volume for an adult.[124,125]

When giving rescue breaths, give sufficient volume to cause visible chest rise (LOE 6, 7; Class IIa). In 1 observational study trained BLS providers were able to detect "adequate" chest rise in anesthetized, intubated, and paralyzed adult patients when a tidal volume of approximately 400 mL was delivered.[114] It is likely, however, that a larger volume is required to produce chest rise in a victim with no advanced airway (eg, endotracheal tube, Combitube, LMA) in place. We therefore recommend a tidal volume of 500 to 600 mL but emphasize that *the volume delivered should produce visible chest rise* (Class IIa). It is reasonable to use the same tidal volume in patients with asphyxial and arrhythmic cardiac arrest (Class IIb).

Currently manikins show visible chest rise when tidal volumes reach about 700 to 1000 mL. To provide a realistic practice experience, manikins should be designed to achieve a visible chest rise at a tidal volume of 500 to 600 mL.[114] Automated and mechanical ventilators are discussed briefly at the end of this chapter and in Part 6: "CPR Techniques and Devices."

Gastric inflation often develops when ventilation is provided without an advanced airway. It can cause regurgitation and aspiration, and by elevating the diaphragm, it can restrict lung movement and decrease respiratory compliance.[117] Air delivered with each rescue breath can enter the stomach when pressure in the esophagus exceeds the lower esophageal sphincter opening pressure. Risk of gastric inflation is increased by high proximal airway pressure[114] and the reduced opening pressure of the lower esophageal sphincter.[126] High pressure can be created by a short inspiratory time, large tidal volume, high peak inspiratory pressure, incomplete airway opening, and decreased lung compliance.[127] To minimize the potential for gastric inflation and its complications, deliver each breath to patients with or without an advanced airway over 1 second and deliver a tidal volume that is sufficient to produce a visible chest rise (Class IIa). But do not deliver more volume or use more force than is needed to produce visible chest rise.

Mouth-to-Mouth Rescue Breathing

Mouth-to-mouth rescue breathing provides oxygen and ventilation to the victim.[128] 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). Taking a regular rather than a deep breath prevents you from getting dizzy or lightheaded. The most common cause of ventilation difficulty is an improperly opened airway,[112] so if the victim's chest does not rise with the first rescue breath, perform the head tilt–chin lift and give the second rescue breath.[120,121]

Mouth-to–Barrier Device Breathing

Despite its safety,[129] some healthcare providers[130–132] and lay rescuers may hesitate to give mouth-to-mouth rescue breathing and prefer to use a barrier device. Barrier devices may not reduce the risk of infection transmission,[129] and some may increase resistance to air flow.[133,134] If you use a barrier device, do not delay rescue breathing.

Barrier devices are available in 2 types: face shields and face masks. Face shields are clear plastic or silicone sheets that reduce direct contact between the victim and rescuer but do not prevent contamination of the rescuer's side of the shield.[135–137]

A rescuer with a duty to respond should use a face shield only as a substitute for mouth-to-mouth breathing. These responders should switch to face mask or bag-mask ventilation as soon as possible.[137] Masks used for mouth-to-mask breathing should contain a 1-way valve that directs the rescuer's breath into the patient while diverting the patient's exhaled air away from the rescuer.[137]

Some masks include an oxygen inlet for administration of supplementary oxygen. When oxygen is available, healthcare providers should provide it at a minimum flow rate of 10 to 12 L/min.

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

Mouth-to-nose ventilation is recommended if it is impossible to ventilate through the victim's mouth (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). A case series suggests that mouth-to-nose ventilation in adults is feasible, safe, and effective (LOE 5).[138]

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). 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 bag (LOE 4).[139]

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 and therefore may produce gastric inflation and its complications (see above). When using a bag-mask device, deliver each breath over a period of 1 second and provide sufficient tidal volume to cause visible chest rise.

The Bag-Mask Device

A bag-mask device should have the following[140]: 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, have a standard 15-mm/22-mm connector,[141] and 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.[142,143] The lone rescuer using a bag-mask device should be able to simultaneously open the airway with a jaw lift, hold the mask tightly against the patient's face, and squeeze the bag. The rescuer must also watch to be sure the chest rises with each breath.

Bag-mask ventilation 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.[142–144]

The rescuer should use an adult (1 to 2 L) bag to deliver a tidal volume sufficient to achieve visible chest rise (Class IIa). If the airway is open and there are no leaks (ie, there is a good seal between face and mask), this volume can be delivered by squeezing a 1-L adult bag about one half to two thirds of its volume or a 2-L adult bag about one-third its volume. As long as the patient does not have an advanced airway in place, the rescuer(s) should deliver cycles of 30 compressions and 2 breaths. The rescuer delivers the breaths during pauses in compressions and delivers each breath over 1 second (Class IIa).

The healthcare provider should use supplementary oxygen (O_2 >40%, a minimum flow rate of 10 to 12 L/min) when available. Ideally the bag should be attached to an oxygen reservoir to enable delivery of 100% oxygen.

Advanced airway devices such as the LMA[145,146] and the esophageal-tracheal combitube[147–149] are currently within the scope of BLS practice in a number of regions (with specific authorization from medical control). These devices may provide acceptable alternatives to bag-mask devices for healthcare providers who are well trained and have sufficient experience to use them (Class IIb). 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.

Ventilation With an Advanced Airway

When the victim has an advanced airway in place during CPR, 2 rescuers no longer deliver cycles of CPR (ie, compressions interrupted by pauses for ventilation). Instead, the compressing rescuer should give continuous chest compressions at a rate of 100 per minute without pauses for ventilation. The rescuer delivering ventilation provides 8 to 10 breaths per minute. The 2 rescuers should change compressor and ventilator roles approximately every 2 minutes to prevent compressor fatigue and deterioration in quality and rate of chest compressions. When multiple rescuers are present, they should rotate the compressor role about every 2 minutes.

Rescuers should avoid excessive ventilation by giving the recommended breaths per minute and limiting tidal volume to achieve chest rise (Class IIa).[115] A translational research study showed that delivery of >12 breaths per minute during CPR leads to increased intrathoracic pressure, impeding venous return to the heart during chest compressions.[115] Reduced venous return leads to diminished cardiac output during chest compressions and decreased coronary and cerebral perfusion.[150,151] It is critically important that rescuers maintain a ventilation rate of 8 to 10 breaths per minute during CPR and avoid excessive ventilation.[115,150]

Automatic Transport Ventilators and Manually Triggered, Flow-Limited Resuscitators

Automatic transport ventilators (ATVs) are useful for ventilation of adult patients with a pulse who have an advanced airway in place, both in and out of the hospital (Class IIa). For the adult cardiac arrest patient who does not have an advanced airway in place, the ATV may be useful if tidal volumes are delivered by a flow-controlled, time-cycled ventilator without positive end-expiratory pressure (PEEP).

Manually triggered, oxygen-powered, flow-limited resuscitators may be considered for mask ventilation of the patient who does not have an advanced airway in place during CPR. For further information about these devices see Part 6.

Cricoid Pressure

Pressure applied to the victim's cricoid cartilage pushes the trachea posteriorly, compresses the esophagus against the cervical vertebrae, and can prevent gastric inflation and reduce the risk of regurgitation and aspiration.[152,153] Application of cricoid pressure usually requires a third rescuer, one who is not responsible for chest compressions or ventilations. Cricoid pressure should be used only if the victim is deeply unconscious (ie, has no cough or gag reflex).

Pulse Check (for Healthcare Providers) (Box 5)

Lay rescuers fail to recognize the absence of a pulse in 10% of pulseless victims (poor sensitivity for cardiac arrest) and fail to detect a pulse in 40% of victims with a pulse (poor specificity). In the *ECC Guidelines 2000*[117] the pulse check was deleted from training for lay rescuers and deemphasized in training for healthcare providers. There is no evidence, however, that checking for breathing, coughing, or movement is superior for detection of circulation.[154] For ease of training, the lay rescuer will be taught to assume that cardiac arrest is present if the unresponsive victim is not breathing.

Healthcare providers also may take too long to check for a pulse[109,155] and have difficulty determining if a pulse is present or absent. The healthcare provider should take no more than 10 seconds to check for a pulse (Class IIa). If a pulse is not definitely felt within 10 seconds, proceed with chest compressions (see below).

Rescue Breathing Without Chest Compressions (for Healthcare Providers Only—Box 5A)

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

During delivery of rescue breaths, reassess the pulse approximately every 2 minutes (Class IIa), but spend no more than 10 seconds doing so.

Chest Compressions (Box 6)

Chest compressions consist of 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. Although properly performed chest compressions can produce systolic arterial pressure peaks of 60 to 80 mm Hg, diastolic pressure is low[118] and mean arterial pressure in the carotid artery seldom exceeds 40 mm Hg.[118]

Blood flow generated by chest compressions delivers a small but critical amount of oxygen and substrate to the brain and myocardium. In victims of VF SCA, chest compressions increase the likelihood that a shock (ie, attempted defibrillation) will be successful. Chest compressions are especially important if the first shock is delivered ≥4 minutes after collapse.[36,37,156]

Much of the information about the physiology of chest compressions and the effect of varying compression rates, compression-ventilation ratios, and duty cycles (percent of time the chest is compressed versus time allowed for chest recoil) is derived from animal models. Researchers at the 2005 Consensus Conference,[157] however, reached several conclusions about chest compressions:

1. "Effective" chest compressions are essential for providing blood flow during CPR (Class I).
2. To give "effective" chest compressions, "push hard and push fast." Compress the adult chest at a rate of about 100 compressions per minute, with a compression depth of 1½ to 2 inches (approximately 4 to 5 cm). Allow the chest to recoil *completely* after each compression, and allow approximately equal compression and relaxation times.
3. Minimize interruptions in chest compressions.
4. Further studies are needed to define the best method for coordinating ventilations and chest compressions and to identify the best compression-ventilation ratio in terms of survival and neurologic outcome.

Technique

To maximize the effectiveness of compressions, the victim should lie supine on a hard surface (eg, backboard or floor),[158] with the rescuer kneeling beside the victim's thorax.[159] The safety and efficacy of over-the-head CPR (OTH-CPR) for lone rescuers and 2-person straddle CPR are unknown, but these techniques may be advantageous in confined spaces (LOE 6).[159,160] "CPR-friendly" deflatable mattresses have been studied, and they do not provide an adequate surface on which to perform chest compressions (LOE 6).[161,162]

The rescuer should compress the lower half of the victim's sternum in the center (middle) of the chest, between the nipples.[163] The rescuer should place the heel of the hand on the sternum in the center (middle) of the chest between the nipples and then place the heel of the second hand on top of the first so that the hands are overlapped and parallel (LOE 6; Class IIa).[163–165]

Depress the sternum approximately 1½ to 2 inches (approximately 4 to 5 cm) and then allow the chest to return to its normal position. Complete chest recoil allows venous return to the heart, is necessary for effective CPR, and should be emphasized in training (Class IIb).[166,167] Compression and chest recoil/relaxation times should be approximately equal (Class IIb).[168–171] In studies of chest compression in out-of-hospital[172] and in-hospital settings,[173] 40% of chest compressions were of insufficient depth. Rescuers should practice to ensure good chest compressions and should relieve one another every few minutes to reduce the contribution of fatigue to inadequate chest compression depth and rate (see below).

There is insufficient evidence from human studies to identify a single optimal chest compression rate. Animal[174] and human[175,176] studies support a chest compression rate of >80 compressions per minute to achieve optimal forward blood flow during CPR. We recommend a compression rate of about 100 compressions per minute (Class IIa).

Two human observational studies[172,173] showed that interruptions of chest compressions were common. In these studies of healthcare provider CPR, no chest compressions were provided for 24% to 49%[172,173,177] of total arrest time.

Interruption of chest compressions in animal models is associated with reduced coronary artery perfusion pressure, and the more frequent or prolonged the interruption, the lower the mean coronary perfusion pressure. In 3 animal studies frequent or prolonged interruptions in chest compressions were associated with reduced return of spontaneous circulation (ROSC), reduced survival rates, and reduced postresuscitation myocardial function (LOE 6).[113,174,178,179] Some animal studies suggest that continuous chest compressions with minimal or no interruptions produce higher survival rates than standard CPR (LOE 6).[151,179–181] These guidelines recommend that all rescuers minimize interruption of chest compressions for checking the pulse, analyzing rhythm, or performing other activities (Class IIa).

Lay rescuers should continue CPR until an AED arrives, the victim begins to move, or EMS personnel take over CPR (Class IIa). Lay rescuers should no longer interrupt chest compressions to check for signs of circulation or response. 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).

We strongly recommend that patients not be moved while CPR is in progress unless the patient is in a dangerous environment or is a trauma patient in need of surgical intervention. CPR is better and has fewer interruptions when the resuscitation is conducted where the patient is found.

Allow the chest wall to recoil completely after each compression. In studies of CPR in humans[166] and pigs,[167] incomplete chest wall recoil was common, particularly when rescuers were fatigued.[182] Incomplete recoil during BLS CPR is associated with higher intrathoracic pressures, decreased coronary perfusion, and decreased cerebral perfusion (LOE 6).[167] CPR instruction should emphasize the importance of allowing complete chest recoil between compressions.[166]

Manikin[168] and animal studies[170,183] suggest that with duty cycles (the compression part of the cycle) of 20% to 50%, coronary and cerebral perfusion increase as the chest compression rate increases up to 130 to 150 compressions per minute (LOE 6).[170,183] A duty cycle of 50% is recommended because it is easy to achieve with practice.[168]

Rescuer fatigue may lead to inadequate compression rates or depth. Significant fatigue and shallow compressions are seen after 1 minute of CPR, although rescuers may deny that fatigue is present for ≥5 minutes (LOE 6).[182] When 2 or more rescuers are available, it is reasonable to switch the compressor about every 2 minutes (or after 5 cycles of compressions and ventilations at a ratio of 30:2). Every effort should be made to accomplish this switch in <5 seconds (Class IIb). If the 2 rescuers are positioned on either side of the patient, one rescuer will be ready and waiting to relieve the "working compressor" every 2 minutes.

In the past sternal compression force was gauged as adequate if it generated a palpable carotid or femoral pulse. But a venous pulse may be felt during CPR in the absence of effective arterial blood flow.[110,184] The available evidence suggests that blood flow is optimized by using the recommended chest compression force and duration and maintaining a chest compression rate of approximately 100 compressions per minute.[170]

Compression-Ventilation Ratio

A compression-ventilation ratio of 30:2 is recommended and further validation of this guideline is needed (Class IIa).[150,151,180,185–187] In infants and children (see Part 11: "Pediatric Basic Life Support"), 2 rescuers should use a ratio of 15:2 (Class IIb).

This 30:2 ratio is based on a consensus of experts rather than clear evidence. It is designed to increase the number of compressions, reduce the likelihood of hyperventilation, minimize interruptions in chest compressions for ventilation, and simplify instruction for teaching and skills retention. A manikin study suggests that rescuers may find a compression-ventilation ratio of 30:2 more tiring than a ratio of 15:2.[182] 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 deliver cycles of CPR (ie, compressions interrupted by pauses for ventilation). Instead, the compressing rescuer should give continuous chest compressions at a rate of 100 per minute without pauses for ventilation. The rescuer delivering ventilation provides 8 to 10 breaths per minute. The 2 rescuers should change compressor and ventilator roles approximately every 2 minutes to prevent compressor fatigue and deterioration in quality and rate of chest compressions. When multiple rescuers are present, they should rotate the compressor role about every 2 minutes.

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.[185,188] Rescuers must make every effort to minimize these interruptions in chest compressions. In 1 out-of-hospital study rescuers intermittently achieved compression rates of 100 to 121 compressions per minute, but the mean number of compressions delivered per minute was reduced to 64 compressions per minute by frequent interruptions.[172]

CPR Prompts
Evidence from 2 adult studies[172,173] show that the chest compression rate during unprompted CPR is frequently inadequate in both out-of-hospital and in-hospital settings. Human,[176,189] animal,[190,191] and manikin studies[37,192–196] showed consistent improvement in end-tidal CO_2 and/or quality of CPR in both the out-of-hospital and in-hospital settings when CPR prompt devices were used. A CPR prompt device may be useful in both out-of-hospital and in-hospital settings (Class IIb).

Compression-Only CPR
The outcome of chest compressions without ventilations is significantly better than the outcome of no CPR for adult cardiac arrest.[113,197–201] In surveys healthcare providers[130–132] as well as lay rescuers[132,202] were reluctant to perform mouth-to-mouth ventilation for unknown victims of cardiac arrest.

In observational studies of adults with cardiac arrest treated by lay rescuers, survival rates were better with chest compressions only than with no CPR but were best with compressions and ventilation (LOE 3[203]; 4[204]). Some animal studies (LOE 6)[113,197–200,205,206] and extrapolation from clinical evidence[207] suggest that rescue breathing is not essential during the first 5 minutes of adult CPR for VF SCA. If the airway is open, occasional gasps and passive chest recoil may provide some air exchange.[186,187,199] In addition, a low minute ventilation may be all that is necessary to maintain a normal ventilation-perfusion ratio during CPR.[208,209]

Laypersons should be encouraged to do compression-only CPR if they are unable or unwilling to provide rescue breaths (Class IIa), although the best method of CPR is compressions coordinated with ventilations.

Alternative Approaches to Chest Compressions
Additional information about alternative CPR techniques and devices can be found in Part 6.

"Cough" CPR
"Cough" CPR currently has no role when the victim is unresponsive,[210–215] so it has no role in lay rescuer CPR. So-called cough CPR has been reported only in awake monitored patients who develop VF or VT.[216] For more information see Part 6.

Prone CPR
When the patient cannot be placed in the supine position, rescuers may consider providing CPR with the patient in the prone position, particularly in hospitalized patients with an advanced airway in place (LOE 5; Class IIb). One crossover study of 6 patients (LOE 3)[217] and 3 case reports (LOE 5)[218–220] documented higher blood pressure in hospitalized intubated patients during CPR in the prone position when compared with patients who received CPR in the supine position. Six case series that included 22 intubated hospitalized patients documented survival to discharge in 10 patients who received CPR in the prone position (LOE 5).[219,220]

Defibrillation (Boxes 8, 9, 10)
All BLS providers should be trained to provide defibrillation because VF is the most common rhythm found in adults with witnessed, nontraumatic SCA.[7] For these victims survival rates are highest when immediate bystander CPR is provided and defibrillation occurs within 3 to 5 minutes.[8,12–14,19–23]

Immediate defibrillation is the treatment of choice for VF of short duration, such as witnessed SCA (Class I).

The effect of CPR before defibrillation for prolonged VF SCA has largely been positive. When EMS arrived more than 4[36] to 5[37] minutes after dispatch, a brief period of CPR (1½ to 3 minutes) before defibrillation improved ROSC and survival rates for adults with out-of-hospital VF/VT in a before-after study (LOE 3)[36] and a randomized trial (LOE 2).[37] But in another randomized trial in adults with out-of-hospital VF/VT, CPR before defibrillation did not improve ROSC or survival rates (LOE 2).[221]

Thus, for adult out-of-hospital cardiac arrest that is not witnessed by the EMS provider, rescuers may give a period of CPR (eg, about 5 cycles or about 2 minutes) before checking the rhythm and attempting defibrillation (Class IIb). In settings with lay rescuer AED programs (AED on-site 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). Defibrillation is discussed in further detail in Part 5: Electrical Therapies.

Special Resuscitation Situations

Drowning
Drowning is a preventable cause of death. The duration and severity of hypoxia sustained as a result of drowning is the single most important determinant of outcome. Rescuers should provide CPR, particularly rescue breathing, as soon as an unresponsive submersion victim is removed from the water (Class IIa). When rescuing a drowning victim of any age, the lone healthcare provider should 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 (LOE 5; Class IIb). Chest compressions are difficult to perform in water, may not be effective, and could potentially cause harm to both the rescuer and the victim.[222,223] There is no evidence that water acts as an obstructive foreign body. Maneuvers to relieve FBAO are not recommended for drowning victims because such maneuvers are not necessary and they can cause injury, vomiting, and aspiration and delay CPR.[224]

Rescuers should remove drowning victims from the water by the fastest means available and should begin resuscitation as quickly as possible (Class IIa). Only victims with obvious clinical signs of injury or alcohol intoxication or a history of diving, waterslide use, or trauma should be treated as a "potential spinal cord injury," with stabilization and possible immobilization of the cervical and thoracic spine.[225–231]

Hypothermia

In an unresponsive victim with hypothermia, a healthcare provider should assess breathing to confirm respiratory arrest and assess the pulse to confirm cardiac arrest or profound bradycardia for 30 to 45 seconds because heart rate and breathing may be very slow, depending on the degree of hypothermia. If the victim is not breathing, initiate rescue breathing immediately.

If the victim does not have a pulse, begin chest compressions immediately. 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 10.4: "Hypothermia").

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 (Class Indeterminate).

Recovery Position

The recovery position is used for unresponsive adult victims who have normal breathing (Class IIb) 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.[232,233] The position should be stable, near a true lateral position, with the head dependent and no pressure on the chest to impair breathing. Although healthy volunteers report compression of vessels and nerves in the dependent limb when the lower arm is placed in front,[234,235] the ease of turning the victim into this position may outweigh the risk. Studies in normal volunteers[236] show that extension of 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 (LOE 7; Class IIb).[236,237]

Foreign-Body Airway Obstruction (Choking)

Death from FBAO is an uncommon but preventable cause of death.[238] Most reported cases of FBAO in adults are caused by impacted food and occur while the victim is eating. 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.

Recognition of Foreign-Body Airway Obstruction

Because recognition of airway obstruction 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 has 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 on choking is 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,"[239–241] abdominal thrusts,[239,240,242–247] and chest thrusts.[239,248] Case reports (LOE 5)[242,249,250] and 1 large case series of 229 choking episodes (LOE 5)[239] report that approximately 50% of the episodes of airway obstruction were not relieved by a single technique. The likelihood of success was increased when combinations of back blows or slaps, abdominal thrusts, and chest thrusts were used.

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 we recommend that the abdominal thrust be applied in rapid sequence until the obstruction is relieved (Class IIb). If abdominal thrusts are not effective, the rescuer may consider chest thrusts (Class IIb). 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 (Class Indeterminate). If the choking victim is in the late stages of pregnancy, the rescuer should use chest thrusts instead of abdominal thrusts (Class Indeterminate). Because abdominal thrusts can cause injury,[251–272] victims of FBAO who are treated with abdominal thrusts should be encouraged to undergo an examination by a physician for injury (Class IIb).

Epidemiologic data[238] does not distinguish between FBAO fatalities in which the victims were responsive when first encountered and those in which the victims were unresponsive when initially encountered. However, the likelihood that a cardiac arrest or unresponsiveness will be caused by an unsuspected FBAO is thought to be low.[238]

If the adult victim with FBAO becomes unresponsive, the rescuer should carefully support the patient to the ground, immediately activate EMS, and then begin CPR. A randomized trial of maneuvers to open the airway in cadavers[273] and 2 prospective studies in anesthetized volunteers[274,275] show that higher sustained airway pressures can be generated using the chest thrust rather than the abdominal thrust (LOE 7). Each time the airway is opened during CPR, the rescuer should look for an object in the victim's mouth and remove it. Simply looking into the mouth should not increase the time it takes to attempt the ventilations and proceed to the 30 chest compressions.

A healthcare provider should use a finger sweep only when the provider can see solid material obstructing the airway of an unresponsive patient (Class Indeterminate). No studies have evaluated the routine use of the finger sweep to clear an airway in the absence of visible airway obstruction.[95,276,277] 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.[240,250,251] But 4 case reports have documented harm to the victim[276,277] or rescuer (LOE 7).[95,96]

Summary: The Quality of BLS

Methods should be developed to improve the quality of CPR delivered at the scene of cardiac arrest by healthcare providers and lay rescuers (Class IIa). These may include education, training, assistance or feedback from biomedical devices, mechanical CPR, and electronic monitoring. Components of CPR known to affect hemodynamics include ventilation rate and duration, compression depth, compression rate and number, complete chest recoil, and hands-off time.

Systems that deliver professional CPR should implement processes of continuous quality improvement that include monitoring the quality of CPR delivered at the scene of cardiac arrest, other process-of-care measures (eg, initial rhythm, bystander CPR, and response intervals), and patient outcome up to hospital discharge. This evidence should be used to maximize the quality of CPR delivered (Class Indeterminate).

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Part 4: Adult Basic Life Support

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Correction

In the 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care section, "Part 4: Adult Basic Life Support," which published ahead of print on November 28, 2005, and appeared in the December 13, 2005, issue of the journal (*Circulation*. 2005;112:IV-19–IV-34), a correction is needed.

On page IV-27, in the first column, the second paragraph under the heading "Compression-Only CPR," the first sentence reads, "In observational studies of adults with cardiac arrest treated by lay rescuers, survival rates were better with chest compressions only than with no CPR but were best with compressions and ventilation (LOE 3[203]; 4[204])." It should read, "In observational studies of adults with cardiac arrest treated by lay rescuers, survival rates were better with chest compressions only than with no CPR (LOE 3[203]), but chest compressions only were not better than compressions and ventilations (LOE 4[204])."

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