Part 3: Adult Basic Life Support

Major Guidelines Changes
Following are the major guidelines changes related to adult basic life support, with the rationale for the change.

BLS Role in Stroke and ACS Management
1. Rescuers should “phone first” for unresponsive adults. Exceptions: “phone fast” (provide CPR first) for adult victims of submersion, trauma, and drug intoxication (Class Indeterminate).
2. Prehospital BLS providers should identify possible stroke victims (through use of stroke scales or screens) and provide rapid transport and prearrival notification to the receiving hospital to increase the likelihood of their eligibility for intravenous fibrinolytic therapy (Class I).
3. Patients with suspected stroke merit the same priorities for dispatch as patients with acute myocardial infarction (AMI) or major trauma (Class IIb).
4. Victims of suspected ischemic stroke (with prearrival notification) should be transported to a facility capable of initiating fibrinolytic therapy within 1 hour of arrival unless that facility is >30 minutes away by ground ambulance (Class IIb).

BLS Sequence
Rescue Breathing and Bag-Mask Ventilation
5. Change ventilation volumes and inspiratory times for mouth-to-mask or bag-mask ventilation as follows:
   a. Without oxygen supplement: tidal volume approximately 10 mL/kg (700 to 1000 mL) over 2 seconds (Class IIa).
   b. With oxygen supplement (<40%): a smaller tidal volume of 6 to 7 mL/kg (approximately 400 to 600 mL) may be delivered over 1 to 2 seconds (Class IIb).
6. Alternative airway devices (ie, laryngeal mask airway and the esophageal-tracheal Combitube) may be acceptable when rescuers are trained in their use (Class IIb).

Pulse Check
7. Lay rescuers will no longer be taught or expected to perform a pulse check. The signal for lay rescuers to begin chest compressions (and attach an AED) is the absence of signs of circulation (normal breathing, coughing, or movement). Healthcare providers should continue to perform a pulse check with assessment of signs of circulation (breathing, coughing, or movement).

Chest Compressions
8. The compression rate for adult CPR is approximately 100 per minute (Class IIb).
9. The compression-ventilation ratio for 1- and 2-rescuer CPR is 15 compressions to 2 ventilations when the victim’s airway is unprotected (not intubated) (Class IIb).
10. Chest compression-only CPR is recommended for use in dispatch-assisted CPR or when the rescuer is unwilling or unable to perform mouth-to-mouth rescue breathing (Class IIa).
11. Audio prompts that guide action sequences and the timing of chest compressions and ventilations increase learning and retention of CPR skills and improve CPR performance (Class IIb).

Relief of Foreign-Body Airway Obstruction
12. Lay rescuers will no longer be taught the sequence for management of foreign-body airway obstruction (FBAO) for unresponsive adults (Class IIb). If FBAO is suspected in the victim who has become unresponsive or who is found unresponsive, lay rescuers should perform the sequence of CPR. When rescue breathing is performed, the lay rescuer should look for a foreign body in the mouth and if one is seen, remove it. Healthcare providers should still perform the sequence for relief of FBAO in the unresponsive victim.

Introduction
The actions taken during the first few minutes of an emergency are critical to victim survival. BLS defines this sequence of actions and saves lives. BLS includes

- Prompt recognition and action for myocardial infarction and stroke to prevent respiratory and cardiac arrest
- Rescue breathing for victims of respiratory arrest
- Chest compressions and rescue breathing for victims of cardiopulmonary arrest
- Attempted defibrillation of patients with ventricular fibrillation (VF) or ventricular tachycardia (VT) with an automated external defibrillator (AED)
- Recognition and relief of FBAO

With the inclusion of AED use in BLS skills, BLS is now defined by the first 3 links in the Chain of Survival: early access, early CPR, and early defibrillation (Figure 1). Each link must be strong throughout the community; this approach is consistent with the concept that the community is the “ultimate coronary care unit.”

Early access requires prompt recognition of emergencies that require time-critical BLS interventions, such as heart attack, stroke, FBAO, and respiratory and cardiac arrest. Early access of the EMS system quickly alerts EMS providers, who can respond with a defibrillator. Emergency Medical Dispatchers (EMDs) can lead callers through the steps of CPR until EMS personnel arrive.
Early CPR is the best treatment for cardiac arrest until the arrival of an AED and advanced cardiovascular life support (ACLS) care.12,13 Early CPR prevents VF from deteriorating to asystole, may increase the chance of defibrillation, contributes to preservation of heart and brain function, and significantly improves survival.13–15 Early defibrillation is the single greatest determinant of survival for adult victims of cardiac arrest.1,12,16–23 Public access defibrillation (PAD) is a healthcare initiative to make AEDs available throughout the community for use by trained laypersons. PAD holds promise to be the single greatest advance in the treatment of VF arrest since the development of CPR.1,12,16–23 PAD programs, including trained flight attendants and police officers, have achieved resuscitation success rates as high as 49%.21,24–28 This nearly doubles the resuscitation rates previously achieved by the most successful EMS programs.29,30

Three BLS actions—early access, early CPR, and early defibrillation—serve as the foundation for emergency cardiovascular care throughout the community. Each community should identify weaknesses in its Chain of Survival and strengthen the Chain through CPR training programs, effective PAD initiatives, and an optimized EMS.31–37

**BLS Response to Cardiopulmonary Emergencies**

**Epidemiology of Adult Cardiopulmonary Arrest:**

**“Phone First” (Adult)/“Phone Fast” (Infants and Children)**

When the initial ECG is obtained, most adults with sudden (witnessed), nontraumatic cardiac arrest are found to be in VF.38 For these victims, the time from collapse to defibrillation is the single greatest determinant of survival.1,3,27,38–46 The window of opportunity is small. Survival from cardiac arrest caused by VF declines by approximately 7% to 10% for each minute without defibrillation.47 More than 12 minutes after collapse, the cardiac arrest survival rate is only 2% to 5%.1,3,27,28,38–47 Structured EMS systems that can be quickly accessed by telephoning an emergency telephone number (such as 911 in the United States, 112 in Europe, or 119 in Japan) have been shown to improve survival from sudden cardiac death by providing early defibrillation (see “Part 12: From Science to Survival: Strengthening the Chain of Survival in Every Community,” for international emergency EMS contact numbers).1,3,28,39,43,47 Because of this compelling data in adult victims, both trained and untrained bystanders should be instructed to activate the EMS system as soon as they have determined that an adult victim requires emergency care.

In sharp contrast to cardiac arrest in adults, most causes of cardiopulmonary arrest in infants (aged <1 year) or children (aged 1 to 8 years) are related to airway or ventilation problems rather than sudden cardiac arrest.48 In these victims, rescue support (especially rescue breathing) is essential and should be attempted first—before activation of the EMS system—if the rescuer is trained.49 This respiratory etiology of cardiopulmonary arrest in children provides the rationale for the “phone fast” approach to resuscitation in children: the rescuer provides approximately 1 minute of CPR and then activates the EMS system.

There are exceptions to the “phone first/phone fast” recommendation for unresponsive adults and children. Some studies suggest that VT/VF may be more common in pediatric and adolescent victims of cardiac arrest (up to 15% of cases) than previously believed, and in some pediatric studies, VF represents the most treatable terminal arrhythmia.50–52 Conversely, noncardiac causes of cardiac arrest can occur in adults and can have favorable outcomes.53 Ideally the lay rescuer should learn a rescue sequence that is tailored to the cause of the victim’s arrest. However, a rescuer may become confused attempting to learn and remember a variety of rescue sequences, and this confusion could create barriers to action during a real emergency. Consequently, these guidelines continue to recommend a “phone first” approach for adult victims and children ≥8 years old and a “phone fast” approach for unresponsive victims <8 years old. However, training materials for BLS laypersons will identify exceptions to the “phone first/phone fast” recommendation (Class Indeterminate). Healthcare providers should be familiar with these exceptions. Exceptions to the “phone first/phone fast” rule include:

1. Submersion/near-drowning (“phone fast,” all ages)
2. Arrest associated with trauma (“phone fast,” all ages)
3. Drug overdoses (“phone fast,” all ages)
4. Cardiac arrest in children known to be at high risk for arrhythmias (“phone first,” all ages)

If an FBAO is present in a responsive adult victim, the trained rescuer should attempt to clear the airway (the Heimlich maneuver is recommended by most resuscitation...
councils) before activating the EMS system.49 The untrained rescuer should activate the EMS system immediately in an emergency; trained dispatchers can then instruct the rescuer to perform CPR or provide other assistance until EMS personnel arrive.

If a second rescuer is available when a victim of cardiac or respiratory arrest of any age is discovered, the first rescuer should begin CPR (open airway, rescue breathing, chest compressions as needed) while the second rescuer activates the EMS system and retrieves the AED if appropriate.

Throughout “Part 3: Adult Basic Life Support,” an “adult” is defined as anyone ≥8 years of age.

Out-of-Hospital EMS Care, Including Emergency Medical Dispatch

Emergency medical dispatch has evolved over the past 25 years to become a sophisticated and integral component of a comprehensive EMS response.6–9,54,55 EMDs provide the first link between the victim and bystanders and EMS personnel.6–9,54,55 Trained medical dispatchers may provide prearrival instructions to bystanders using standard, medically approved telephone instructions.56 Dispatchers should receive formal training in emergency medical dispatch,10,57 and they should use medical dispatch protocols, including prearrival telephone instructions for airway control, CPR, relief of FBAO, and use of an AED.6–9,11,54,55,58

Dispatchers play an important role in early triage and dispatch for patients with AMI.59 Dispatchers are able to accurately identify victims of cardiac arrest.55 However, they may need specialized training to improve their ability to correctly identify and prioritize victims of stroke.54,60 In one recent study, only 41% of ambulances responding to calls for victims of stroke were dispatched with a high priority.60 If emergency facilities are available for administration of fibrinolytic therapy, EMS policies should set the same high dispatch, treatment, and transport priorities for patients with signs and symptoms of an acute ischemic stroke as those for patients with signs and symptoms of an AMI or major trauma. Patients with suspected stroke with airway compromise or altered level of consciousness should be given the same high priority for dispatch, treatment, and transport as similar patients without stroke symptoms (Class Iib).

Using a script based on written protocols for cardiac arrest, dispatchers can question callers, rapidly assess the condition of the victim, and activate the necessary emergency service.8–11,55 To dispatch appropriate rescue personnel to the scene of a cardiac arrest, the dispatcher needs to know whether the victim is unresponsive, whether CPR is in progress, or whether an AED is in use. If a bystander does not know how to perform CPR or does not remember what steps to take, an EMD can instruct the rescuer in appropriate emergency interventions.8–11,55

Dispatch protocols are evolving as new resuscitation science emerges.61 For example, when providing dispatcher-assisted CPR, some centers have simplified the technique for untrained bystanders to reduce time to bystander intervention.52,60 Dispatchers instruct rescuers to locate the lower half of the victim’s sternum by placing their hands in the center of the chest at the nipple line.62,63 In a single study of dispatcher-assisted CPR, chest compression–only bystander CPR was associated with survival equivalent to chest compressions plus ventilations for victims of witnessed arrest.83 Several studies have demonstrated that chest compression–only CPR is better than no CPR for adult cardiac arrest.64–68 For these reasons of simplicity and elimination of barriers to action, we recommend chest compression–only CPR for use in dispatcher-assisted CPR instructions to untrained bystanders (Class Iia). Continued evaluation of simplified protocols and methods to encourage bystander CPR is needed.

Dispatcher-assisted CPR is practical and effective and can increase the percentage of cardiac arrests in which bystander CPR is performed.10,11,55,58 Because dispatch instructions can be lifesaving, EMD assistance has rapidly become the standard of care in EMS systems.6–11,54,55,57–60,62,69

Some evidence suggests that priority dispatch triage systems that tier the EMS response to send BLS ambulance responders to less urgent calls and reserve paramedics (ACLS responders) for more critical incidents may significantly improve use of paramedic skills.11,70 Although studies of patient outcome are only inferential, traditional systems with high survival rates have used such an approach.6,11,70,71 Research into this concept should continue.

No scientific studies have documented improved survival with use of computerized systems that automatically provide the EMD with the caller’s location and telephone number (called “enhanced 911” in the United States). Such systems, however, expedite the EMD process, and their use should be strongly encouraged.6

Recognition and Actions for Acute Coronary Syndromes

Each year millions of patients around the world are evaluated for chest pain in Emergency Departments (EDs).72 Of these, approximately half will be diagnosed as having an acute coronary syndrome (ACS), including unstable angina, non–Q-wave myocardial infarction (MI), and ST-elevation MI.72,73 Of all patients with ACS, approximately half will die before reaching the hospital. Of patients who reach the hospital, an additional 25% will die within the first year.74 In 17% of patients, ischemic pain is the first, last, and only symptom.75

Current management of ACS contrasts dramatically with the approach used 2 decades ago. Fibrinolytic agents and percutaneous coronary interventions (including angioplasty/stent) may reopen the blocked coronary vessels that cause myocardial ischemia. These treatments save lives and improve quality of life.76–83 Early diagnosis and treatment of AMI significantly reduces mortality.76,77,79–81 decreases infarct size,77,79–81 improves regional78 and global79–81 left ventricular function, and decreases the incidence of resultant heart failure.82,83 To be most effective, these interventions must be administered within the first few hours of symptom onset.76–83

The time-limited treatments now available for ACS have highlighted the important role of lay rescuers, first responders, and EMS personnel. Early recognition, early intervention, and early transport of victims with suspected ACS from the scene to the hospital can substantially reduce morbidity and mortality.
Presentation of ACS

Early access to the EMS system is often delayed because both victim and bystanders fail to recognize the signs and symptoms of ACS.84–88 Public education is needed to increase recognition of the signs and symptoms of ACS and encourage the public to access the EMS system quickly.

The classic symptom associated with ACS is a dull, substernal discomfort described as a pressure or tightness, often radiating to the left arm, neck, or jaw. It may be associated with shortness of breath, palpitations, nausea, vomiting, or sweating. Symptoms of angina pectoris typically last <15 minutes. In contrast, the symptoms of AMI are characteristically more intense and last >15 minutes.

Some victims of ACS have atypical or vague chest discomfort. The victim may feel light-headed, short of breath, nauseous, or faint, or have a cold sweat. The discomfort may be more diffuse than classic chest pain and may radiate to the back or may be concentrated between the shoulder blades. The elderly, women,90–92 and persons with diabetes and ACS are more likely to present with vague complaints rather than classic descriptions of chest pain.

The patient with new onset of chest discomfort should rest quietly. Both angina pectoris and AMI are caused by a lack of adequate blood supply to the heart, so activity should be kept to a minimum. If chest discomfort lasts more than a few minutes, initiate emergency action. The action steps for lay rescuers include (1) recognize the signs and symptoms of ACS, (2) have the victim sit or lie down, and (3) if discomfort persists for ≥5 minutes, activate the EMS system.

After activating the EMS system, give the victim supportive care, including rest, reassurance, and use of a recovery position. If the victim becomes unresponsive, be prepared to provide rescue breathing, chest compressions, and (when possible and appropriate) attempted defibrillation with an AED.

Denial is a common reaction to emergencies such as AMI. The victim’s first tendency may be to deny the possibility of a heart attack. This response is not limited to the victim; the lay rescuer may also deny such a possibility. In an emergency, those involved, whether victims or bystanders, are inclined to deny or downplay the seriousness of the problem. This response, while natural, must be overcome to give victims the greatest chance of survival. Denial of the serious nature of symptoms delays treatment and increases risk of death.93,94

The elderly, women, and persons with diabetes, hypertension, or known coronary artery disease are most likely to delay calling the EMS system.92 Because the victim may deny the possibility of a heart attack, lay rescuers must be prepared to activate the EMS system themselves and provide additional BLS as needed. Public education campaigns have been effective in increasing public awareness of this important issue.95,96

Out-of-Hospital Care for ACS

There are many benefits to early access of the EMS system as soon as you recognize the signs and symptoms of ACS. EMDs can send the appropriate emergency team and provide instructions for patient care before EMS personnel arrive.8 BLS ambulance providers can provide CPR; use an AED; support airway, oxygenation, and ventilation; and administer nitroglycerin and aspirin out of the hospital.97,98 The EMS provider should also obtain a significant medical history and inquire about risk factors for ACS.

Nitroglycerin is effective for relief of symptoms, and it dilates coronary arteries and reduces ventricular preload and oxygen requirements.99 If the patient with chest pain has nitroglycerin and his systolic blood pressure is >90 mm Hg, the BLS ambulance provider can help the patient take the nitroglycerin. The patient can take up to 3 nitroglycerin tablets at intervals of 3 to 5 minutes. After administration of each nitroglycerin tablet, monitor blood pressure closely for signs of hypotension.

If local protocol permits, the BLS ambulance provider should administer aspirin (160 to 325 mg) en route. Aspirin inhibits coronary reocclusion and recurrent events after fibrinolytic therapy and reduces mortality in ACS.100 Routine out-of-hospital administration of nitroglycerin and aspirin by BLS ambulance providers is expected to reduce morbidity and mortality from AMI.101

Some ACLS ambulance providers are authorized to administer morphine to reduce pain and decrease myocardial oxygen requirements and left ventricular preload and afterload. ACLS providers also monitor the heart rhythm and can immediately detect potentially lethal cardiac arrhythmias. ACLS ambulance providers may administer medications to manage arrhythmias, shock, and pulmonary congestion; they may initiate transcutaneous pacing as well. The mnemonic “MONA” (morphine, oxygen, nitroglycerin, and aspirin) is a reminder of the core out-of-hospital therapies for ACS.

In many systems, ACLS ambulance providers can attach a 12-lead ECG to the victim and transmit the findings to the receiving facility. This allows diagnosis of a heart attack in progress and significantly reduces time to treatment, which may include fibrinolytic therapy, in the hospital.102–110 This prearrival ECG and notification has been shown to improve outcome.111 In the event of a complication (either at the scene or en route to the hospital), ACLS ambulance providers can administer lifesaving therapies, including CPR, rapid defibrillation, airway management, and intravenous medications.

The BLS algorithm for EMS out-of-hospital management of patients with ACS is shown in Figure 2. (For further information about the management of ACS, see “Part 7, Section 1: Acute Coronary Syndromes.”)

Recognition of Stroke and Actions for Patients With Suspected Stroke

Stoke is a leading cause of death and brain injury in adults. Each year millions of adults suffer a new or recurrent stroke, and nearly a quarter of them die.112 Until recently, care of the stroke patient was largely supportive, with therapy focused on treatment of complications.113 Because no treatment was directed toward altering the course of the stroke itself, little emphasis was placed on rapid identification, transport, or intervention.113

Now fibrinolytic therapy offers the opportunity to limit neurological insult and improve outcome in ischemic stroke patients.114–121 Fibrinolytic therapy reduces disability and
death from stroke in eligible patients. Furthermore, patients treated with fibrinolytics are more likely to be discharged home and less likely to be discharged to a rehabilitative or chronic care facility. Fibrinolytic therapy is cost-effective and results in sustained improvement in quality of life. For these reasons, intravenous fibrinolytic therapy should be considered for all patients presenting to the hospital within 3 hours of the onset of signs and symptoms consistent with acute ischemic stroke (Class I). Use of intra-arterial fibrinolytic agents within 3 to 6 hours of symptom onset may also be beneficial for patients with stroke caused by middle cerebral artery occlusion (Class IIb).

The window of opportunity to provide this beneficial therapy is small. For most stroke victims, definitive hospital-based intervention must occur within 3 hours of symptom onset. The time-limited treatments now available for stroke have emphasized the important role of lay rescuers, first responders, and emergency rescue service personnel. Early recognition, early intervention, and early transport of victims with suspected stroke from the scene to the hospital can substantially reduce morbidity and mortality from stroke.

**Presentation of Stroke**

A transient ischemic attack (TIA) is a reversible episode of focal neurological dysfunction that typically lasts a few minutes to a few hours. It is impossible to distinguish between a TIA and a stroke at the time of onset. If the neurological symptoms completely resolve within 24 hours, the event is classified as a TIA. Most TIAs, however, last...
TIAs are a significant indicator of stroke risk. Approximately one fourth of patients presenting with stroke have had a previous TIA. In addition, approximately 5% of patients with a TIA will develop a stroke within 1 month if untreated.

A stroke is a neurological impairment caused by disruption of blood supply to the brain. Approximately 75% of strokes are ischemic, the result of complete occlusion of a cerebral artery caused by cerebral thrombosis or embolism. Hemorrhagic strokes are caused by cerebral artery rupture with bleeding into the surface of the brain (subarachnoid hemorrhage) or bleeding into the tissue of the brain (intracerebral hemorrhage). The most common cause of a subarachnoid hemorrhage is an aneurysm. Hypertension is the most common cause of intracerebral hemorrhage.

Although both ischemic and hemorrhagic stroke can be life-threatening, ischemic stroke rarely leads to death within the first hour. In comparison, hemorrhagic stroke can be fatal at onset. Patients with ischemic strokes can often be treated with fibrinolytic therapy if they are able to receive the drug within 3 hours of symptom onset. Fibrinolytic therapy cannot be given to patients with hemorrhagic stroke because it would worsen intracerebral bleeding. Some patients with hemorrhagic stroke can benefit from surgical intervention.

In both stroke and heart attack, blood supply is inadequate, often the result of an obstructing blood clot. Rapid intervention with fibrinolytic therapy can improve outcome after an ischemic stroke just as it can after an AMI.

Recognition of the signs and symptoms of stroke is critical to early intervention and treatment. The presentation of stroke may be subtle. Signs and symptoms of stroke may include only mild facial paralysis or difficulty speaking that may go unnoticed or be denied by the patient or family members.

Other signs and symptoms of stroke include alteration in consciousness (confusion, stupor, or coma); sudden weakness or numbness of the face, arm, or leg on one side of the body; slurred or incoherent speech; unexplained dizziness; unsteadiness; sudden falls; or dimness or loss of vision, particularly in one eye. The lay rescuer should immediately activate the EMS system as soon as signs or symptoms of stroke are suspected.

Stroke victims may either be unable to understand that they are having a stroke or, like AMI victims, deny their symptoms by rationalization. Most stroke victims delay access to care for hours after symptom onset. Tragically, this delay often eliminates the possibility of fibrinolytic therapy. Because the victim may deny having symptoms of a stroke or be unable to understand, lay rescuers must take the initiative and rapidly activate the EMS system, providing additional BLS as necessary.

The 7 “D’s” of Stroke Management

Management of the stroke patient can be remembered by use of the mnemonic of the 7 “D’s”: Detection, Dispatch, Delivery, Door, Data, Decision, and Drug. Delay may occur at any of these points of management, so response to and management of the stroke victim must be skilled and efficient at each point. The first 3 D’s (detection, dispatch, and delivery) are the responsibility of BLS providers in the community, including the lay public and EMS responders. A patient, family member, or bystander recognizes (detects) the signs and symptoms of a stroke or TIA and activates the EMS system. EMDs then prioritize the call for a patient with suspected stroke just as they would for a victim of AMI or serious trauma, and they dispatch the appropriate EMS team with high transport priority. EMS providers must respond rapidly, confirm signs and symptoms of a suspected stroke, and provide transport (delivery) of the patient to a stroke center (a hospital that can provide fibrinolytic therapy within 1 hour after arrival at the ED door). The remaining 4 D’s are initiated in the hospital, including rapid triage at the door (in the ED), neurological examination, and performance and interpretation of a CT scan to diagnose type of stroke (data), identifying candidates eligible for fibrinolytic therapy (decision), and treating with fibrinolytic therapy (drug).
acute ischemic stroke as those for patients with signs and symptoms of an AMI or major trauma. Patients with suspected stroke with airway compromise or altered level of consciousness should be given the same high dispatch, treatment, and transport priorities as other nonstroke patients with similar problems (Class IIb). Airway compromise after stroke is relatively common. Cardiac arrest is relatively uncommon, although many stroke victims demonstrate arrhythmias, including ventricular tachyarrhythmias and atrial fibrillation, in the first hours and days after a stroke.165–167

The goals of out-of-hospital management by BLS ambulance providers of patients with suspected stroke include (1) priority dispatch and response; (2) initial assessment and management, including support of airway, oxygenation, ventilation, and circulation; (3) rapid identification of stroke (by use of a standardized stroke scale); (4) rapid transport of the victim to a stroke center capable of delivering fibrinolytics within 1 hour of arrival; and (5) prearrival notification of the hospital.

The clinical presentations of ischemic and hemorrhagic stroke often overlap, making a diagnosis on the basis of symptoms alone impossible. In general, headaches (often described by the victim as the sudden onset of “the worst headache of my life”), disturbances in consciousness, nausea, and vomiting are more severe in association with intracranial hemorrhages. Loss of consciousness may be transient, with resolution by the time the patient receives medical attention. Patients with subarachnoid hemorrhage may have an intense headache without focal neurological signs.

The patient with an ischemic stroke may be eligible for in-hospital treatment with fibrinolytic therapy. The diagnosis

### TABLE 1. Cincinnati Prehospital Stroke Scale

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Yes</th>
<th>Unknown</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial droop (have patient show teeth or smile)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal—both sides of face move equally</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal—one side of face does not move as well as the other side</td>
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<tr>
<td>Arm drift (patient closes eyes and holds both arms straight out for 10 seconds)</td>
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<tr>
<td>Normal—both arms move the same or both arms do not move at all (other findings, such as pronator grip, may be helpful)</td>
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<tr>
<td>Abnormal—one arm does not move or one arm drifts down compared with the other</td>
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<tr>
<td>Abnormal speech (have the patient say “you can’t teach an old dog new tricks”)</td>
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<tr>
<td>Normal—patient uses correct words with no slurring</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal—patient slurs words, uses the wrong words, or is unable to speak</td>
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</tbody>
</table>

Interpretation: If any of these 3 signs is abnormal, the probability of a stroke is 72%.

From Reference 158.

### TABLE 2. Los Angeles Prehospital Stroke Screen (LAPSS)

*For evaluation of acute, noncomatose, nontraumatic neurological complaint: If items 1 through 6 are ALL checked “yes” (or “unknown”), notify the receiving hospital before arrival of the potential stroke patient. If any are checked “no,” follow appropriate treatment protocol.*

Interpretation: Ninety-three percent of patients with stroke will have positive findings (all items checked “yes” or “unknown”) on the LAPSS (sensitivity=93%), and 97% of those with positive findings will have a stroke (specificity=97%). The patient may still be having a stroke if LAPSS criteria are not met.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Yes</th>
<th>Unknown</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age &gt;45 years</td>
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<tr>
<td>2. History of seizures or epilepsy absent</td>
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<tr>
<td>3. Symptom duration &lt;24 hours</td>
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<tr>
<td>4. At baseline, patient is not wheelchair bound or bedridden</td>
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<td></td>
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<tr>
<td>5. Blood glucose between 60 and 400</td>
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<tr>
<td>6. Obvious asymmetry (right vs left) in any of the following 3 categories (must be unilateral)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Equal R Weak L Weak

| Facial smile/grimace | [ ] [ ] Droop | [ ] Droop |
| Grip | [ ] [ ] Weak grip | [ ] Weak grip |
| Arm strength | [ ] [ ] No grip | [ ] No grip |
| [ ] | [ ] Drifts down | [ ] Drifts down |
| [ ] | [ ] Falls rapidly | [ ] Falls rapidly |

From References 149 and 159.
of ischemic stroke and determination of eligibility, however, require several time-consuming steps once the victim arrives at the hospital: a treatment team is mobilized, the patient is assessed and eligibility determined, a CT scan is obtained and interpreted to rule out intracranial hemorrhage, and therapy is administered. All of these steps must be completed to allow drug delivery within 3 hours after onset of patient symptoms. BLS ambulance providers can maximize the likelihood of patient eligibility for fibrinolytic therapy by rapidly identifying a possible stroke victim, rapidly transporting the victim to a stroke center, and providing prearrival notification to the receiving hospital. Emphasis on the time-critical nature of this management should be included in out-of-hospital assessment and management protocols.

**BLS ambulance providers should establish the time of onset of signs and symptoms of stroke: this timing has important implications for potential therapy.** The onset of symptoms is viewed as the beginning (onset) of the stroke, and eligibility for fibrinolytic therapy ends 3 hours from that time. If the victim is unable to estimate the time of onset of signs and symptoms, question family members or friends at the scene. It may be possible to determine when the victim was last observed, what the victim was doing when symptoms developed (eg, preparing lunch), and any other information that will give the receiving hospital an estimate of the time of symptom onset.

Breviary Neurological Evaluation: Stroke Scale and Stroke Screen
It is impractical to perform an extensive neurological examination out of hospital because it delays the patient’s transport to the ED. The abbreviated out-of-hospital neurological examination should include a validated tool such as the Cincinnati Prehospital Stroke Scale (CPS) (Table 1) or the Los Angeles Prehospital Stroke Screen (LAPSS) (Table 2). Fleming, Fristad, and Anderson149,159 Providers using the Cincinnati Prehospital Stroke Scale attempt to elicit any of 3 major physical findings suggestive of stroke: facial droop (Figure 3), arm drift (Figure 4), and abnormal speech.158 The LAPSS includes several items designed to rule out other causes of altered level of consciousness (history of seizures, severe hyperglycemia or hypoglycemia). The provider using the LAPSS attempts to identify asymmetry in facial weakness/grimace, hand grip, or arm strength; asymmetry (right versus left) in any category indicates that the victim has had a possible stroke (Table 2).149,159 These scales are both sensitive and specific in identifying stroke patients149,158,159 and can be quickly applied.

Assess the patient’s level of consciousness. The Glasgow Coma Scale (GCS) can be used to score the patient’s responsiveness when the level of consciousness is depressed. This scale evaluates eye opening, best motor response, and best verbal response to simple stimuli, such as voice and pain. The highest possible score is 15; a score of 13 to 14 indicates mild neurological impairment; 11 to 13, moderate impairment; and <11, severe impairment. The GCS is well known, reproducible, and reliable when applied to patients with stroke.160 EMS personnel can identify stroke patients with reasonable sensitivity and specificity.150,156,158,159,161–164 Once the diagnosis of stroke is suspected, time in the field should be minimized and the patient prepared for immediate transport to a stroke center. (For further information, please see “Part 7, Section 2: Acute Stroke.”)

EMS physicians should work with neurologists and local hospitals to establish clear destination protocols for patients suspected of having an acute stroke.144–146,154–156 EMS ambulance services should transport a patient with stroke symptoms to an emergency receiving facility with proven capability to initiate fibrinolytic therapy for eligible stroke patients within 1 hour of arrival unless the emergency facility is >30 minutes away by ground ambulance (Class IIb). A Canadian study revealed that the vast majority of residents live within a 30-minute drive of a hospital with 24-hour CT scanning capability.164 Prearrival notification to the receiving hospital shortens the time to definitive hospital-based evaluation and intervention for patients with stroke.1 In addition to standard information, EMS systems should communicate the results of the stroke scale or stroke screen, the GCS, and the estimated time of symptom onset to the receiving hospital before arrival. The receiving facility should have a written plan to initiate therapy as quickly as possible (see Figure 5). Figure 5 summarizes BLS ambulance provider out-of-hospital assessment and management of patients with possible stroke.

Indications for BLS

Respiratory Arrest
Respiratory arrest can result from a number of causes, including submersion/near-drowning, stroke, FBAO, smoke inhalation, epiglottitis, drug overdose, electrocution, suffocation, injuries, myocardial infarction, lightning strike, and coma from any cause. When primary respiratory arrest occurs, the heart and lungs can continue to oxygenate the blood for several minutes, and oxygen will continue to circulate to the brain and other vital organs.168 Such patients initially demonstrate signs of circulation. When respiratory

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*References 7, 114, 134, 136–142, 144–146, 149–155, 164.*
Cardiac Arrest
In cardiac arrest, circulation ceases and vital organs are deprived of oxygen. Ineffective “gasing” breathing efforts (“agonal” respirations) may occur early in cardiac arrest and should not be confused with effective respirations.66,169,170 Because lay rescuers rely on evaluation of breathing to determine cardiac arrest, they should be carefully trained to differentiate between adequate versus inadequate ventilation.

Cardiac arrest can be accompanied by the following cardiac rhythms: VF, VT, asystole, or pulseless electrical activity.

AED Use
The cardiac arrest rhythms of VT and VF are treated most effectively with early defibrillation. AED use is now considered an important and lifesaving addition to BLS and provides the trained lay rescuer or healthcare provider with the opportunity to implement the first 3 links in the Chain of Survival (early access, early CPR, and early defibrillation).33,34 The sequence of action for a rescuer with training and access to an AED is identical to that of CPR except for the added step of attaching and using the AED. AEDs are
The Sequence of BLS: Assessment, EMS Activation, the ABCs of CPR, and the “D” of Defibrillation

The BLS sequence described in this section applies to victims ≥8 years old. This sequence will be applied to older children, adolescents, and adults. For simplicity, the victim is consistently referred to as an “adult” to differentiate the victim from a “pediatric” victim who is <8 years old.

Assess Responsiveness
After determining that the scene is safe, the rescuer arriving at the side of the collapsed victim must quickly assess any injury and determine whether the person is responsive. Tap or gently shake the victim and shout, “Are you all right?” If the victim does not respond, the rescuer directs someone to activate the emergency medical response system (telephone 911 or appropriate emergency telephone number).

Activate the EMS System
Activate the EMS system by calling the appropriate local emergency response system telephone number. This number should be widely publicized in each community. The person who calls the EMS system should be prepared to give the following information as calmly as possible:172:

1. Location of the emergency (with names of office or room number or cross streets or roads, if possible)
2. Telephone number from which the call is being made
3. What happened: heart attack, auto crash, etc
4. Number of persons who need help
5. Condition of the victim(s)
6. What aid is being given to the victim(s) (eg, “CPR is being performed” or “we’re using an AED”)
7. Any other information requested. To ensure that EMS personnel have no more questions, the caller should hang up only when instructed to do so by the EMD.

The stage in the rescue process at which EMS activation is appropriate is determined by each country’s resuscitation council and is based on the facilities available, the remoteness...
from those facilities of the scene of collapse, and national and local practice. In the United States, for example, the EMS should be activated as soon as the adult victim is found to be unresponsive. In many countries in Europe, the EMS system is activated after the airway is opened, breathing is assessed, and the unresponsive victim is found to be not breathing. In Australia, the EMS system is activated after the rescuer delivers rescue breaths.

**Airway**

If the victim is unresponsive, the rescuer will need to determine whether the victim is breathing adequately. To assess breathing, the victim should be supine (lying on his or her back) with an open airway.

**Position the Victim**

For resuscitative efforts and evaluation to be effective, the victim must be supine and on a firm, flat surface. If the victim is lying face down, roll the victim as a unit so that the head, shoulders, and torso move simultaneously without twisting. The head and neck should remain in the same plane as the torso, and the body should be moved as a unit. The non-breathing victim should be supine with the arms alongside the body. The victim is now appropriately positioned for CPR.

**Rescuer Position**

The trained rescuer should be at the victim’s side, positioned to perform both rescue breathing and chest compression. The rescuer should anticipate the arrival of an AED, if appropriate, and should be prepared to operate it when it arrives.

**Open the Airway**

When the victim is unresponsive/unconscious, muscle tone is decreased and the tongue and epiglottis may obstruct the pharynx (Figure 7). The tongue is the most common cause of airway obstruction in the unresponsive victim. Because the tongue is attached to the lower jaw, when you move the lower jaw forward you will lift the tongue away from the back of the throat and open the airway. The tongue or the epiglottis, or both, may also create an obstruction when negative pressure is created in the airway by spontaneous inspiratory effort; this creates a valve-type mechanism that can occlude the entrance to the trachea.

If there is no evidence of head or neck trauma, use the head tilt–chin lift maneuver described below (Figure 8) to open the airway. Remove any visible foreign material or vomitus from the mouth. Wipe liquids or semiliquids out of the mouth with fingers covered with a glove or piece of cloth. Extract solid material with a hooked index finger while keeping the tongue and jaw supported with the other hand.

**Head Tilt–Chin Lift Maneuver**

To accomplish the head tilt maneuver, place one hand on the victim’s forehead and apply firm, backward pressure with your palm, tilting the head back. To complete the head tilt–chin lift maneuver, place the fingers of your other hand under the bony part of the lower jaw near the chin. Lift the jaw upward to bring the chin forward and the teeth almost to occlusion (Figure 8). This maneuver supports the jaw and helps tilt the head back. Do not press deeply into the soft tissue under the chin, because this might obstruct the airway. Do not use your thumb to lift the chin. Open the victim’s mouth to facilitate spontaneous breathing and to prepare for mouth-to-mouth breathing.

If the victim’s dentures are loose, head tilt–chin lift facilitates creation of a solid mouth-to-mouth seal. Remove the dentures if they cannot be kept in place.

**Jaw-Thrust Maneuver**

The jaw-thrust without head tilt maneuver for airway opening should be taught to both lay rescuers and healthcare providers. Place one hand on each side of the victim’s head, resting your elbows on the surface on which the victim is lying. Grasp the angles of the victim’s lower jaw and lift with both hands (Figure 9). If the lips close, you can retract the lower lip with your thumb. If mouth-to-mouth breathing is necessary while you maintain the jaw thrust, close the victim’s nostrils by placing your cheek tightly against them. This technique is very effective for opening the airway but fatiguing and technically difficult for the rescuer.
The jaw-thrust technique without head tilt is the safest initial approach to opening the airway of the victim with suspected neck injury because it usually can be done without extending the neck. Carefully support the head without tilting it backward or turning it from side to side.

**Recommendations for Opening the Airway**

The recommended technique for opening the airway must be simple, safe, easily learned, and effective. Because head tilt–chin lift meets these criteria, it should be the method of choice for lay rescuers performing BLS, and lay rescuers should use this technique unless trauma is suspected. Although all rescuers are taught both head tilt–chin lift and jaw thrust methods of opening the airway, the professional rescuers (BLS ambulance providers and other healthcare providers) should be proficient in both head tilt–chin lift and jaw thrust.

**Breathing**

**Assessment: Check for Breathing**

To assess breathing, place your ear near the victim’s mouth and nose while maintaining an open airway. Then, while observing the victim’s chest, (1) look for the chest to rise and fall, (2) listen for air escaping during exhalation, and (3) feel for the flow of air. If the chest does not rise and fall and no air is exhaled, the victim is not breathing. This evaluation procedure should take no more than 10 seconds.

Most victims with respiratory or cardiac arrest have no signs of breathing. Occasionally, however, the victim will demonstrate abnormal and inadequate breathing. Some victims demonstrate apparent respiratory efforts with signs of upper airway obstruction. These victims may resume effective breathing when you open the airway. Some victims may have a patent airway but may make only weak, inadequate attempts to breathe. Reflex gasping respiratory efforts (agonal respirations) are another form of inadequate breathing that may be observed early in the course of primary cardiac arrest. Absent or inadequate respirations require rapid intervention with rescue breathing. If you are not confident that respirations are adequate, proceed immediately with rescue breathing. Lay rescuers are taught to provide rescue breathing if “normal” breathing is absent.

If a victim resumes breathing and regains signs of circulation (pulse, normal breathing, coughing, or movement) during or after resuscitation, continue to help the victim maintain an open airway. Place the victim in a recovery position if the victim maintains breathing and signs of circulation.

**Recovery Position**

The recovery position is used in the management of victims who are unresponsive but are breathing and have signs of circulation (Class Indeterminate). When an unresponsive victim is lying supine and breathing spontaneously, the airway may become obstructed by the tongue or mucus and vomit. These problems may be prevented when the victim is placed on his or her side, because fluid can drain easily from the mouth.

Some compromise is needed between ideal position for maximum airway patency and optimal position to allow monitoring and support with good body alignment. A modified lateral position is used because a true lateral posture tends to be unstable, involves excessive lateral flexion of the cervical spine, and results in less free drainage from the mouth. A near-prone position, on the other hand, can hinder adequate ventilation because it splints the diaphragm and reduces pulmonary and thoracic compliance. Several versions of the recovery position exist, each with its own advantages. No single position is perfect for all victims. When deciding which position to use, consider 6 principles:

1. The victim should be in as near a true lateral position as possible, with the head dependent to allow free drainage of fluid.
2. The position should be stable.
3. Avoid any pressure on the chest that impairs breathing.
4. It should be possible to turn the victim on his or her side and to return to the back easily and safely, with concern for a possible cervical spine injury.
5. Good observation of and access to the airway should be possible.
6. The position itself should not cause an injury to the victim.

It is particularly important to avoid injury to the victim when turning the victim. If trauma is present or suspected, the victim should be moved only if an open airway cannot otherwise be maintained. This might be the case if, for example, a lone rescuer needs to leave the victim to get help. Monitor the victim, particularly for impairment of blood flow in the lowermost arm. If the victim remains in the recovery position for >30 minutes, turn the victim to the opposite side. Although no single specific recovery position can be recommended, the one illustrated (Figure 10) is suitable for training purposes.

**Provide Rescue Breathing**

When providing rescue breathing, you must inflate the victim’s lungs adequately with each breath.
Mouth-to-Mouth Breathing

Mouth-to-mouth rescue breathing is a quick, effective way to provide oxygen and ventilation to the victim. Your exhaled breath contains enough oxygen to supply the victim’s needs. To provide rescue breaths, hold the victim’s airway open, pinch the nose, and make a seal with your mouth over the victim’s mouth. Rest the palm of one hand on the victim’s forehead and pinch the victim’s nose closed with your thumb and index finger. Pinching the nose will prevent air from escaping through the victim’s nose. Take a deep breath and seal your lips around the victim’s mouth, creating an airtight seal. Give slow breaths, delivering each breath over 2 seconds, making sure the victim’s chest rises with each breath. Be prepared to deliver approximately 10 to 12 breaths per minute (1 breath every 4 to 5 seconds) if rescue breathing alone is required (see Figure 11).

The number of breaths delivered to initiate rescue breathing/ventilation varies throughout the world, and there is no data to suggest superiority of one number over the other. In the United States, 2 breaths are provided. In Europe, Australia, and New Zealand, 5 breaths are provided to initiate resuscitation. Each approach has its advantages. Delivery of fewer breaths will shorten the time to assessment of circulation/pulse and attachment of an AED (and possible defibrillation), but delivery of a greater number of breaths may help to correct hypoxia and hypercarbia. In the absence of data to support one number of breaths over another, it is appropriate to deliver 2 to 5 initial breaths, according to local custom.

Gastric inflation frequently develops during mouth-to-mouth ventilation. Gastric inflation can produce serious complications, such as regurgitation, aspiration, or pneumonia. It also increases intragastric pressure, elevates the diaphragm, restricts lung movements, and decreases respiratory system compliance. Gastric inflation occurs when the pressure in the esophagus exceeds the lower esophageal sphincter opening pressure, causing the sphincter to open so that air delivered during rescue breaths enters the stomach instead of the lungs. During cardiac arrest, the likelihood of gastric inflation increases because the lower esophageal sphincter relaxes. Factors that contribute to creation of a high esophageal pressure and gastric inflation during rescue breathing include a short inspiratory time, a large tidal volume, and a high peak airway pressure.

Previous guidelines recommended that rescue breaths provide a tidal volume of 800 to 1200 mL delivered over 1 to 2 seconds. With respect to gastric inflation, a substantially smaller tidal volume would be safer but is ineffective in maintaining adequate arterial oxygen saturation unless supplemental oxygen can be delivered via a face mask or bag-valve mask.

To reduce the risk of gastric inflation during mouth-to-mouth ventilation, deliver slow breaths at the lowest tidal volume that will still make the chest visibly rise with each ventilation. For mouth-to-mouth ventilation in most adults, this volume will be approximately 10 mL/kg (approximately 700 to 1000 mL) and should be delivered over 2 seconds (Class IIa). This recommendation represents a slightly decreased range of tidal volume compared with previous guidelines, and it uses the upper limit of inspiratory time recommended in the previous guidelines. This new recommendation is intended to reduce the risk of gastric inflation (and its serious consequences) while maintaining adequate arterial oxygen saturation during respiratory and cardiac arrest.

If you take a deep breath before each ventilation, you will optimize your exhaled gas composition, ensuring that you will provide as much oxygen as possible to the victim. You are providing adequate ventilation if you see the chest rise and fall with each breath and you hear and feel the air escape during exhalation. When possible (eg, during 2-rescuer CPR), maintain airway patency to allow unimpeded exhalation between rescue breaths.

If initial (or subsequent) attempts to ventilate the victim are unsuccessful, reposition the victim’s head and reattempt rescue breathing. Improper chin and head positioning is the most common cause of difficulty with ventilation. If the victim cannot be ventilated after repositioning of the head, the healthcare provider (but not the lay rescuer) should proceed with maneuvers to relieve FBAO (see “Foreign-Body Airway Obstruction Management” below).

Mouth-to-Nose Breathing

The mouth-to-nose method of ventilation is recommended when it is impossible to ventilate through the victim’s mouth, the mouth cannot be opened (trismus), the mouth is seriously injured, or a tight mouth-to-mouth seal is difficult to achieve. Mouth-to-nose breathing may be the best method of providing ventilation while rescuing a submersion victim.
from the water. The rescuer’s hands often will be used to support the victim’s head and shoulders during rescue. The mouth-to-nose technique may enable the rescuer to begin rescue breathing as soon as the victim’s head is out of the water.

To provide mouth-to-nose breathing, tilt the victim’s head back with one hand on the forehead and use the other hand to lift the victim’s mandible (as in head tilt–chin lift) and close the victim’s mouth. Take a deep breath, seal your lips around the victim’s nose, and exhale into the victim’s nose. Then remove your lips from the victim’s nose, allowing passive exhalation (Figure 12). It may be necessary to open the victim’s mouth intermittently and separate the lips with the thumb to allow free exhalation; this is particularly important if partial nasal obstruction is present.

**Mouth-to-Stoma Breathing**

A tracheal stoma is a permanent opening at the front of the neck that extends from the surface of the skin into the trachea (Figure 13A). When a person with a tracheostomy requires rescue breathing, direct mouth-to-stoma ventilation should be performed. Place your mouth over the stoma, making an airtight seal around the stoma. Blow into the stoma until the chest rises (Figure 13B). Then remove your mouth from the patient, allowing passive exhalation.

A tracheostomy tube may be present in the tracheal stoma. This tube must be patent for either spontaneous ventilation or rescue breathing to occur. If the tube is not patent and you are unable to clear an obstruction or any secretions, remove and replace the tube. If a second tube is unavailable and the original tube is obstructed, remove the tube and provide rescue breathing through the stoma. If a significant volume of air escapes through the victim’s nose and mouth during ventilation through the tracheostomy, seal the victim’s mouth and nose with your hand or a tightly fitting face mask. Air escape is alleviated if you can provide ventilation through a tracheostomy tube with an inflated cuff.

**Mouth-to–Barrier Device Breathing**

Some rescuers prefer to use a barrier device during mouth-to-mouth ventilation. The use of barrier devices should be encouraged for rescuers who may perform CPR in areas outside the home, such as the workplace. Two broad categories of barrier devices are available: mouth-to-mask devices and face shields. Mouth-to-mask devices typically have a 1-way valve so that the victim’s exhaled air does not enter the rescuer’s mouth. Face shields usually have no exhalation valve, and the victim’s expired air escapes between the shield and the victim’s face. Barrier devices should have a low resistance to gas flow so that they do not impede ventilation.
The face shield should remain on the victim’s face during chest compressions and ventilations. If the victim begins to vomit during rescue efforts, immediately turn the victim onto his side, remove the face shield, and clear the airway. Proximity to the victim’s face and the possibility of contamination if the victim vomits are major disadvantages of face shields. In addition, the efficacy of face shields has not been documented conclusively. For these reasons, healthcare professionals and rescuers with a duty to respond should use face shields only as a substitute for mouth-to-mouth breathing and should use mouth-to-mask or bag-mask devices at the first opportunity.

Tidal volumes and inspiratory times for rescuer breathing through barrier devices should be the same as those for mouth-to-mouth breathing (in an adult, a tidal volume of approximately 10 mL/kg or 700 to 1000 mL delivered over 2 seconds and sufficient to make the chest rise clearly).

**Mouth-to-Mask Rescue Breathing**

A transparent mask with or without a 1-way valve is used in mouth-to-mask breathing. The 1-way valve directs the rescuer’s breath into the victim while diverting the victim’s exhaled air away from the rescuer. Some devices include an oxygen inlet that permits administration of supplemental oxygen.

Mouth-to-mask ventilation is particularly effective because it allows the rescuer to use 2 hands to create a mask seal. There are 2 possible techniques for using the mouth-to-mask device. The first technique positions the rescuer above the victim’s head (cephalic technique). This technique can be used by a single rescuer when the patient is in respiratory arrest (but not cardiac arrest) or during performance of 2-rescuer CPR. A jaw thrust is used in the cephalic technique, which has the advantage of positioning the rescuer so that the rescuer is facing the victim’s chest while performing rescue breathing (see Figure 15A and 15B).

In the second technique (lateral technique), the rescuer is positioned at the victim’s side and uses head tilt–chin lift. The lateral technique is ideal for performing 1-rescuer CPR, because the rescuer can maintain the same position for both rescue breathing and chest compressions (see Figure 16).

**Cephalic technique.** Position yourself directly above the victim’s head and perform the following steps:

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**Figure 14.** Face shield. The shield is placed over the mouth and nose with the opening at the center of the shield placed over the victim’s mouth. The technique of rescue breathing is the same as for mouth-to-mouth breathing.

![Figure 14](http://circ.ahajournals.org/)

**Figure 15.** Mouth-to-mask, cephalic technique. A, Using thumb and thenar eminence on the top of the mask. B, Circling the thumb and first finger around the top of the mask.
• Apply the mask to the victim’s face, using the bridge of the nose as a guide for correct position.
• Place your thumbs and thenar eminence (portion of the palm at the base of the thumb) along the lateral edges of the mask.
• Place the index fingers of both hands under the victim’s mandible and lift the jaw into the mask as you tilt the head back. Place your remaining fingers under the angle of the jaw (Figure 15A).
• While lifting the jaw, squeeze the mask with your thumbs and thenar eminence to achieve an airtight seal (see jaw thrust).
• Provide slow rescue breaths (2 seconds) while observing for chest rise.

An alternative method for the cephalic technique is to use the thumb and first finger of each hand to make a complete seal around the edges of the mask. Use the remaining fingers to lift the angle of the jaw and extend the neck (Figure 15B). With either variation of the cephalic technique, the rescuer uses both hands to hold the mask and open the airway. In victims with suspected head or neck (potential cervical spine) injury, lift the mandible at the angles of the jaw but do not tilt the head.

**Lateral technique.** Position yourself beside the victim’s head to provide rescue breathing and chest compressions:

• Apply the mask to the victim’s face, using the bridge of the nose as a guide for correct position.
• Seal the mask by placing your index finger and thumb of the hand closer to the top of the victim’s head along the border of the mask and placing the thumb of your other hand along the lower margin of the mask.
• Place your remaining fingers on the hand closer to the victim’s feet along the bony margin of the jaw and lift the jaw while performing a head tilt–chin lift (Figure 16).
• Compress firmly and completely around the outside margin of the mask to provide a tight seal.
• Provide slow rescue breaths while observing for chest rise.

Effective use of the mask requires instruction and supervised practice. During 2-rescuer CPR, the mask can be used in a variety of ways. The most appropriate method will depend on the experience of personnel and equipment available. Oral airways and cricoid pressure may be used with mouth-to-mask and any other form of rescue breathing.

If oxygen is not available, tidal volumes and inspiratory times for mouth-to-mask ventilation should be the same as for mouth-to-mouth breathing (in an adult, a tidal volume of approximately 10 mL/kg or 700 to 1000 mL delivered over 2 seconds and sufficient to make the chest rise clearly). If supplemental oxygen is used with the face mask, a minimum flow rate of 10 L/min provides an inspired concentration of oxygen ≥40%. When oxygen is provided, lower tidal volumes are recommended (tidal volume of approximately 6 to 7 mL/kg or 400 to 600 mL given over 1 to 2 seconds until the chest rises) (Class IIb). The smaller tidal volumes are effective for maintaining adequate arterial oxygen saturation, provided that supplemental oxygen is delivered to the device, but these smaller volumes will not maintain normocarbia.

These volumes will reduce the risk of gastric inflation and its serious consequences. Bag-Mask Device

Bag-mask devices used in the prehospital setting consist of a self-inflating bag and a nonbreathing valve attached to a face mask. These devices provide the most common method of delivering positive-pressure ventilation in both the EMS and hospital settings. Most commercially available adult bag-mask units have a volume of approximately 1600 mL, which is usually adequate to produce lung inflation. In several studies, however, many rescuers were unable to deliver adequate tidal volumes to intubated manikins. Adult bag-mask units may provide a smaller tidal volume than mouth-to-mouth or mouth-to-mask ventilation because the lone rescuer may have difficulty obtaining a leak-proof seal to the face while squeezing the bag and maintaining an open airway. For this reason, self-inflating bag-mask units are most effective when 2 trained and experienced rescuers work together, one sealing the mask to the face and the other squeezing the bag slowly over 2 seconds (Figure 17). In fact,
in some countries (eg, Australia), bag-mask ventilation during BLS CPR is performed by 2 rescuers.

There are significant advantages to the use of small tidal volumes during resuscitation. Small tidal volume will reduce the risk of gastric inflation and its consequences, but it does risk the development of hypoxia and hypercarbia and their complications. The use of small tidal volumes with oxygen supplementation during resuscitation has been evaluated in laboratory and clinical settings. With smaller tidal volumes, airway pressure does not exceed the victim’s lower esophageal sphincter pressure, so lower tidal volumes will reduce gastric inflation and its potential consequences of regurgitation, aspiration, and pneumonia. Supplemental oxygen will ensure maintenance of oxygen saturation at these smaller tidal volumes.

If supplementary oxygen (minimum flow rate of 8 to 12 L/min with oxygen concentration >40%) is available, the rescuer skilled in bag-mask ventilation should attempt to deliver a smaller tidal volume (6 to 7 mL/kg or approximately 400 to 600 mL) over 1 to 2 seconds (Class IIb). Of course, in the clinical setting, the actual tidal volume delivered is impossible to determine. Tidal volume can be titrated to provide sufficient ventilation to maintain oxygen saturation and produce visible chest expansion. The tidal volume should be small enough to make the chest rise. It is important to note that this smaller tidal volume may be associated with the development of hypercarbia.

If oxygen is not available, the rescuer should attempt to deliver the same tidal volume recommended for mouth-to-mouth ventilation (10 mL/kg, 700 to 1000 mL) over 2 seconds. This tidal volume should result in very obvious chest rise.

An adult bag-mask device should have the following features:

- A nonjam inlet valve system allowing a maximum oxygen inlet flow of 30 L/min
- Either no pressure relief valve or, if a pressure relief valve is present, the pressure relief valve must be capable of being closed
- Standard 15-mm/22-mm fittings
- An oxygen reservoir to allow delivery of high concentrations of oxygen
- A nonbreathing outlet valve that cannot be obstructed by foreign material
- Ability to function satisfactorily under common environmental conditions and extremes of temperature

**Technique.** Bag-mask ventilation technique requires instruction and practice. The rescuer should be able to use the equipment effectively in a variety of situations.

If you are the only rescuer providing respiratory support, position yourself at the top of the victim’s head. If there is no concern about neck injury, tilt the victim’s head back and place it on a towel or pillow to achieve the sniffing position. Apply the mask to the victim’s face with one hand, using the bridge of the nose as a guide for correct position. Place the third, fourth, and fifth fingers of that hand along the bony portion of the mandible, and place the thumb and index fingers of the same hand on the mask. Maintain head tilt and jaw thrust to keep the airway patent and snug against the mask (Figure 18).

Compress the bag with your other hand and watch the chest to be sure it rises, indicating that ventilation is adequate. Deliver each breath over 2 seconds (using 1 to 2 seconds when you deliver smaller tidal volumes with oxygen supplementation). You may want to compress the bag against your body to achieve the selected tidal volume. It is critical to maintain an airtight seal during delivery of each breath.

Effective ventilation is more likely to be provided when 2 rescuers use the bag-mask system: 1 rescuer holds the mask and 1 rescuer squeezes the bag (Figure 17). The techniques for holding the mask are the same as for mouth-to-mask devices described above. If a third rescuer is available, cricoid pressure may be applied.

Bag-mask ventilation is a complex technique that requires considerable skill and practice. Such skill is difficult to maintain when used infrequently. Accordingly, alternative airway devices such as the laryngeal mask airway and the esophageal-tracheal Combitube are being introduced within the scope of BLS practice for healthcare providers. These devices are generally easier to insert than tracheal tubes, but they allow similar support of ventilation. These devices may provide acceptable alternatives to bag-mask ventilation for healthcare providers who are well trained and have sufficient opportunities to use these devices (Class IIIB). A detailed explanation of these devices is found in Part 6 of this document (see “Adjuncts for Oxygenation, Ventilation, and Airway Control”).

**Cricoid Pressure**

The cricoid pressure technique applies pressure to the victim’s cricoid cartilage. This pushes the trachea posteriorly, compressing the esophagus against the cervical vertebrae during rescue breathing. Cricoid pressure is effective in preventing gastric inflation, reducing the risk of regurgitation and aspiration. It should be used only if the victim is unconscious. Proper use of the cricoid pressure technique...
requires an additional rescuer to provide cricoid pressure alone, without diversion to other resuscitation activities. As a result, this technique should be used only by healthcare professionals when an extra rescuer is present. This means that during “2”-rescuer CPR, 3 rescuers would actually be required: 1 rescuer to perform rescue breathing, 1 to perform chest compressions, and 1 to apply cricoid pressure.

The technique for applying cricoid pressure is as follows:

1. Locate the thyroid cartilage (Adam’s apple) with your index finger.
2. Slide your index finger to the base of the thyroid cartilage and palpate the prominent horizontal ring below (cricoid cartilage).
3. Using the tips of your thumb and index finger, apply firm backward pressure to the cricoid cartilage (Figure 19).

Apply moderate rather than excessive pressure on the cricoid. Use of moderate pressure is particularly important if the victim is small.

**Rescue Breathing Without Chest Compressions**

Deliver 2 initial breaths slowly over 2 seconds each, allowing complete exhalation between breaths to diminish the likelihood of exceeding the esophageal opening pressure. This technique should result in less gastric inflation, regurgitation, and aspiration. For respiratory arrest, when chest compressions are not being performed, provide approximately 10 to 12 breaths per minute (1 breath every 4 to 5 seconds). Check every few minutes to ensure that the victim continues to show signs of circulation (see next section).

**Circulation**

**Assessment: No Pulse Check for Lay Rescuers**

Since the first resuscitation guidelines were published in 1968, the pulse check has been the “gold standard” method of determining whether the heart was beating. In the sequence of CPR, the absence of a pulse indicates cardiac arrest and the need to provide chest compressions. In the current era of early defibrillation, absence of a pulse is an indication for the attachment of the AED. Since 1992 several published studies have called into question the validity of the pulse check as a diagnostic test.

**TABLE 3. Sensitivity, Specificity, and Reliability of Pulse Check: Performance of Pulse Check as a Diagnostic Test**

<table>
<thead>
<tr>
<th></th>
<th>Pulse Is Present</th>
<th>Pulse Is Absent</th>
<th>Totals</th>
</tr>
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<tbody>
<tr>
<td>Rescuer thinks pulse is present</td>
<td>81 (Sensitivity: correct positive result of pulse check=all times a pulse was actually present)</td>
<td>6</td>
<td>87 (No. of times rescuer thought pulse present=a+b)</td>
</tr>
<tr>
<td>Rescuer thinks pulse is absent</td>
<td>66</td>
<td>53 (Specificity: correct negative result of pulse check=all times there actually was no pulse)</td>
<td>119 (No. of times rescuer thought pulse absent=c+d)</td>
</tr>
<tr>
<td>Totals</td>
<td>147 (Total number of study opportunities where a pulse was actually present=a+c)</td>
<td>59 (Total number of study opportunities where a pulse was actually absent=b+d)</td>
<td>206 (Total study opportunities=a+b+c+d)</td>
</tr>
</tbody>
</table>

Calculations derived from above:

a. Positive predictive value: Of the total times the rescuer thinks a pulse is present (total=87 times), a pulse is present=81/87 times=93%.

b. Negative predictive value: Of the total times the rescuer thinks a pulse is absent (total=119 times), a pulse is absent=53/119=45%.

c. Sensitivity: Rescuer’s ability to detect a pulse when one actually is present=81/147=55%.

d. Specificity: Rescuer’s ability to recognize that a pulse is absent when a pulse actually is absent=53/59=90%.

e. Accuracy=“rescuer correct”/total=(81 pulse correctly found+53 pulse correctly thought absent)/206=65%.

test for cardiac arrest, particularly when used by laypersons.226–235 This research has used manikin simulation,231 unconscious patients undergoing cardiopulmonary bypass,235 unconscious mechanically ventilated patients,232 and conscious “test persons.”227,232 These studies conclude that as a diagnostic test for cardiac arrest, the pulse check has serious limitations in accuracy, sensitivity, and specificity.

When lay persons use the pulse check, they require a long time to decide whether a pulse is present. They then fail in 1 of 10 times to recognize the absence of a pulse or cardiac arrest (poor sensitivity). When lay rescuers assess unresponsive victims who do have a pulse, the rescuers miss the pulse in 4 of 10 times (poor specificity). Details of the published studies include the following conclusions:

1. Rescuers require far too much time to perform the pulse check: The majority of all rescue groups, including laypersons, medical students, paramedics, and physicians, take much longer than the recommended 5 to 10 seconds to check for the carotid pulse. In one study, half of the rescuers required more than 24 seconds to decide whether a pulse was present. With survival from VF falling by 7% to 10% for every minute defibrillation is delayed, time allotted to assessment of circulation must be brief. Only 15% of the participants correctly confirmed the presence of a pulse within 10 seconds, the maximum time currently allotted for a pulse check.235

2. When considered as a diagnostic test, the pulse check is extremely inaccurate. This accuracy can be expressed in a classic 2×2 matrix, based on results from a representative study235 (Table 3) and summarized as follows:

   a. Specificity (ability to correctly identify victims who have NO pulse and ARE in cardiac arrest) is only 90%; When subjects were pulseless, rescuers thought a pulse was present approximately 10% of the time. By mistakenly thinking a pulse is present when it is not, rescuers will fail to provide chest compressions and will not attach an AED for 10 of every 100 people in cardiac arrest. The consequences of such errors would be death without possibility of resuscitation for 10 of every 100 victims of cardiac arrest.

   b. Sensitivity (ability to correctly recognize victims who HAVE a pulse and ARE NOT in cardiac arrest) was only 55%. When the pulse was present, the rescuers assessed the pulse as being absent approximately 45% of the time. By erroneously thinking a pulse was absent, rescuers would provide chest compressions for approximately 4 of 10 potential victims who do not need them and would attach an AED, if available.

3. The overall accuracy was only 65%, leaving an error rate of 35%.

On review of this and other data, the experts and delegates at the 1999 Evidence Evaluation Conference and the International Guidelines 2000 Conference concluded that the pulse check could not be recommended as a tool for lay rescuers to identify victims of cardiac arrest in the CPR sequence. If rescuers use the pulse check to identify victims of cardiac arrest, they will “miss” true cardiac arrest at least 10 times out of 100. In addition, rescuers will provide unnecessary chest compressions (and may attach an AED) for many victims who are not in cardiac arrest and do not require such intervention. This error is less serious but still undesirable. The more serious error in this situation is clearly the potential failure to intervene for victims of cardiac arrest who require immediate intervention to survive.

Therefore, the lay rescuer should not rely on the pulse check to determine the need for chest compressions or use of an AED. Lay rescuers should not perform the pulse check and will not be taught the pulse check in CPR courses (Class IIa). Instead, lay rescuers will be taught to assess for “signs of circulation,” including normal breathing, coughing, or movement, in response to the rescue breaths. This guideline recommendation applies to victims of any age. Healthcare providers should continue to use the pulse check as one of several signs of circulation. Other signs of circulation include breathing, coughing, or movement.

It is expected that this guideline change will result in more rapid and more accurate identification of cardiac arrest. It should eliminate delays in provision of chest compressions and use of the AED. Most important, it should reduce the missed opportunities to provide CPR and early defibrillation for victims in cardiac arrest.

**Assessment: Check for Signs of Circulation**

These guidelines often refer to assessment of “signs of circulation.” For the lay rescuer, this means the following: deliver initial rescue breaths and evaluate the victim for normal breathing, coughing, or movement in response to the rescue breaths. The lay rescuer will look, listen, and feel for breathing while scanning the victim for signs of other movement. Lay rescuers should look for “normal breathing” to minimize confusion with agonal respirations.

When healthcare professionals assess signs of circulation, they add a pulse check while simultaneously evaluating the victim for breathing, coughing, or movement. Professional rescuers are instructed to look for “breathing” because they are trained to distinguish between agonal breathing and other forms of ventilation not associated with cardiac arrest.

**In practice, the assessment for signs of circulation for the lay rescuer is performed as follows:**

1. Provide initial rescue breaths to the unresponsive, non-breathing victim.
2. Look for signs of circulation.
   a. With your ear near the victim’s mouth, look, listen, and feel for normal breathing or coughing.
   b. Quickly scan the victim for any signs of movement.
3. If the victim is not breathing normally, coughing, or moving, immediately begin chest compressions.

This assessment should take no more than 10 seconds. Healthcare providers should perform a pulse check in conjunction with assessment for signs of circulation. If you are not confident that circulation is present, begin chest compressions immediately.

When a pulse check is performed for the victim >1 year of age, the carotid artery is the preferred artery to palpate, although the femoral artery may be used as an alternative. Pulses will persist in these arteries even when hypotension and poor perfusion cause peripheral pulses to disappear. To
locate the carotid artery, maintain a head tilt with one hand on the victim’s forehead and locate the trachea with 2 or 3 fingers of the other hand (Figure 20A). Slide these 2 or 3 fingers into the groove between the trachea and the muscles at the side of the neck, where the carotid pulse can be felt (Figure 20B). Use only gentle pressure so that you do not compress the artery. The artery on the side of the neck toward you is typically most readily palpated.

Provide Chest Compressions
Chest compressions for CPR are serial, rhythmic applications of pressure over the lower half of the sternum. These compressions create blood flow by increasing intrathoracic pressure or directly compressing the heart. Blood circulated to the lungs by chest compressions, accompanied by properly performed rescue breathing, will most likely deliver adequate oxygen to the brain and other vital organs until defibrillation can be performed.

Theoretical and animal and human data supports a rate of chest compression >80 per minute to achieve optimal forward blood flow during CPR. For this reason, a compression rate of 100 per minute is recommended (Class IIB). The compression rate refers to the speed of compressions, not to the actual number of compressions delivered in 1 minute. A compression rate of approximately 100 per minute will result in delivery of fewer than 100 compressions per minute by the single rescuer who must interrupt chest compressions to deliver rescue breaths. The actual number of chest compressions delivered per minute depends on the accuracy and consistency of the rate of chest compressions and the time the rescuer requires to open the airway and deliver rescue breaths.

Previous versions of the adult BLS guidelines recommended a ratio of 15 compressions to 2 ventilations for 1-rescuer CPR and a ratio of 5 compressions to 1 ventilation for 2-rescuer CPR. A ratio of 15:2 provides more chest compressions per minute (approximately 64 versus 50) than a ratio of 5:1. There is evidence to suggest that adult cardiac arrest victims are more likely to be saved if a higher number of chest compressions are delivered during CPR, even if the victims receive fewer ventilations. The quality of rescue breathing and chest compressions is not affected by compression-ventilation ratio.

During cardiac arrest, the coronary perfusion pressure gradually rises with the performance of sequential compressions. This pressure is higher after 15 uninterrupted chest compressions than it is after 5 chest compressions. Therefore, after each pause for ventilation, several compressions must be performed before previous levels of brain and coronary perfusion are reestablished. For these reasons, a ratio of 15 compressions to 2 ventilations is recommended for 1 or 2 rescuers (Class IIB) until the airway is secured. This applies to adult BLS provided by both laypersons and healthcare providers. Research is ongoing to determine the benefits of further increasing the number of compressions between ventilations during CPR. Once the airway is secured (protected) with a cuffed tracheal tube (as discussed in the ACLS guidelines), compressions may be continuous and ventilations may be asynchronous, with a ratio of 5 compressions to 1 ventilation.

During actual CPR, rescuers often compress at a slower rate than 100 per minute. For teaching and during performance of CPR, therefore, some form of audio timing prompt may help to achieve the recommended compression rate of approximately 100 per minute (Class IIB).

The victim must be in the horizontal, supine position on a firm surface during chest compressions to optimize the effect of the compressions and blood flow to the brain. When the head is elevated above the heart, blood flow to the brain is reduced or eliminated. If the victim cannot be removed from a bed, place a rigid board, preferably the full width of the bed, under the victim’s back to avoid diminished effectiveness of chest compression.

Chest Compression Technique
Proper hand placement is established by identifying the lower half of the sternum. The guidelines below may be used, or you may choose alternative techniques to identify the lower sternum.

1. Place your fingers on the lower margin of the victim’s rib cage on the side nearer you (Figure 21A).
2. Slide your fingers up the rib cage to the notch where the ribs meet the lower sternum in the center of the lower part of the chest.
3. Place the heel of one hand on the lower half of the sternum (Figure 21B) and the other hand on top of the first, so that the hands are parallel (Figure 21C). Be sure the long axis of the heel of your hand is placed on the long axis of the sternum. This will keep the main force
of compression on the sternum and decrease the chance of rib fracture. Do not compress over the lowest portion of the base of the sternum (the xiphoid process).

4. Your fingers may be either extended or interlaced but should be kept off the chest.

If you have difficulty creating sufficient force during compressions, an acceptable alternative hand position is to grasp the wrist of the hand on the chest with your other hand and push downward with both. This technique is helpful for rescuers with arthritic hands and wrists.

A simplified method of achieving correct hand position has also been used in various settings for teaching laypersons the chest compression technique.* To find a position on the lower half of the sternum, the rescuer is instructed to place the heel of one hand in the center of the chest between the nipples. This method has been used with success for >10 years in dispatcher-assisted CPR and other settings.*

Effective compression is accomplished by attention to the following guidelines:

1. Lock the elbows in position, with the arms straightened. Position your shoulders directly over your hands so that the thrust for each chest compression is straight down on the sternum (Figure 22). If the thrust is not in a straight downward direction, the victim’s torso has a tendency to roll; if this occurs, a part of the force of compressions will be lost, and the chest compressions may be less effective.

2. Depress the sternum approximately 1 1/2 to 2 inches (4 to 5 cm) for the normal-sized adult. Rarely, in very small victims, lesser degrees of compression may be sufficient to generate a palpable carotid or femoral pulse. Alternatively, in large victims, sternal compression depth of 1 1/2 to 2 inches (4 to 5 cm) may be inadequate, and a slightly greater depth of chest compression may be needed to generate a carotid or femoral pulse. Optimal sternal compression is generally gauged by identifying the compression force that generates a palpable carotid or femoral pulse. However, this validation of pulses requires at least 2 healthcare providers (one provides compressions while the other attempts to palpate the pulse), and it may yield misleading results. Detection of a pulse during CPR does not necessarily mean that there is optimal or even adequate

blood flow, because a compression wave may be palpated in the absence of effective blood flow. The best method of providing adequate compression force is to depress the sternum 1 1/2 to 2 inches (4 to 5 cm) with each compression.

3. Release the pressure on the chest to allow blood to flow into the chest and heart. You must release the pressure completely and allow the chest to return to its normal position after each compression. Keep your hands in contact with the victim’s sternum to maintain proper hand position. Chest compressions should be performed at a rate of approximately 100 per minute.

4. Effective cerebral and coronary perfusion has been shown to occur when 50% of the duty cycle is devoted to the chest compression phase and 50% to the chest relaxation phase.236–238 The duration of CPR affects the mechanism of CPR.257–261 In CPR of short duration, blood flow is generated more by the cardiac pump mechanism. When the duration of cardiac arrest or resuscitation with chest compressions is prolonged, the heart becomes less compliant. Only in this setting does the thoracic pump mechanism dominate. When the thoracic pump mechanism dominates, however, the cardiac output generated by chest compression decreases significantly.256–261

Over the past 20 years, there has been important research regarding techniques and devices to improve blood flow during CPR, including pneumatic vest CPR,262 interposed abdominal compression CPR (IAC-CPR),263–265 and active compression-decompression CPR (ACD-CPR).266–272 Recent evaluation of these devices in humans254,262–272 has resulted in more specific recommendations for their use. The interested reader will find a more expanded discussion of this topic in Part 6 of this publication.

During cardiac arrest, properly performed chest compressions can produce systolic arterial blood pressure peaks of 60 to 80 mm Hg, but diastolic blood pressure is low.261 Mean blood pressure in the carotid artery seldom exceeds 40 mm Hg.261 Cardiac output resulting from chest compressions is probably only one fourth to one third of normal and decreases during the course of prolonged conventional CPR.261 You can optimize blood flow during chest compression if you use the recommended chest compression force and chest compression duration and maintain a chest compression rate of approximately 100 per minute.255

Airway-breathing-circulation (“ABC”) is the specific sequence used to initiate CPR in the United States and in the ILCOR Guidelines. In The Netherlands, however, “CAB” (compression-airway-breathing) is the common sequence of CPR, with resuscitation outcomes similar to those reported for the ABC protocol in the United States.273 No human studies have directly compared the ABC technique of resuscitation with CAB. Hence, a statement of relative efficacy cannot be made and a change in present teaching is not warranted. Both techniques are effective.

**Compression-Only CPR**

Mouth-to-mouth rescue breathing is a safe and effective technique that has saved many lives. Despite decades of experience indicating its safety for victims and rescuers alike, some published surveys have documented reluctance on the part of professional and lay rescuers to perform mouth-to-mouth ventilation for unknown victims of cardiac arrest. This reluctance is related to fear of infectious disease transmission.274–278 If a person is unwilling or unable to perform mouth-to-mouth ventilation for an adult victim, chest compression-only CPR should be provided rather than no attempt at CPR being made (Class IIa).

Current evidence indicates that the outcome of chest compression without mouth-to-mouth ventilation is significantly better than no CPR at all in the setting of adult cardiac arrest.64–68 Some evidence in animal models and limited adult clinical trials suggests that positive-pressure ventilation is not essential during the initial 6 to 12 minutes of adult CPR.64–67 The Cerebral Resuscitation Group of Belgium also showed...
no difference in outcome of CPR between victims who received mouth-to-mouth ventilation with chest compression and those who received compressions only.38

Several mechanisms may account for the effectiveness of chest compression alone. Studies have demonstrated that spontaneous gasping can maintain near-normal minute ventilation, \( \text{Paco}_2 \) and \( \text{PaO}_2 \) during CPR without positive-pressure ventilation.66,279 Because the cardiac output generated during chest compressions is only 25% of normal, there is also a reduced requirement for ventilation to maintain optimal ventilation/perfusion relationships.280,281

Chest compression–only CPR is recommended only in the following circumstances:

1. When a rescuer is unwilling or unable to perform mouth-to-mouth rescue breathing (Class IIa), or
2. For use in dispatcher-assisted CPR instructions where the simplicity of this modified technique allows untrained bystanders to rapidly intervene (Class IIa).

**Cough CPR**

Self-initiated CPR is possible. Its use, however, is limited to clinical situations in which the patient has a monitored cardiac arrest, the arrest was recognized before loss of consciousness, and the patient can cough forcefully.257–260 These conditions are typically present during only the first 10 to 15 seconds of the cardiac arrest. The increase in intrathoracic pressure that occurs with coughing will generate blood flow to the brain and maintain consciousness.

**Defibrillation**

Most adults with sudden, witnessed, nontraumatic cardiac arrest are found to be in VF.38 For these victims the time from collapse to defibrillation is the single greatest determinant of survival.1,3,27,38,46 Survival from VF cardiac arrest declines by approximately 7% to 10% for each minute without defibrillation.47 Healthcare providers should be trained and equipped to provide defibrillation at the earliest possible moment for victims of sudden cardiac arrest.

Early defibrillation in the community is defined as a shock delivered within 5 minutes of EMS call receipt. This 5-minute call-to-defibrillation interval in the community is a Class I recommendation.

Early defibrillation also must be provided in hospitals and medical facilities. First responders in medical facilities should be able to provide early defibrillation to collapsed patients in VF in all areas of the hospital and ambulatory care facilities (Class I recommendation). In these areas healthcare providers should be able to deliver a shock within 3 ± 1 minutes of arrest for a high percentage of patients. To achieve these goals, BLS providers must be trained and equipped to use defibrillators and must rehearse use of the defibrillator present in their clinical area.

For further information, refer to “Part 4: The Automated External Defibrillator” and “Part 6, Section 2: Defibrillation.”

**CPR Performed by 1 and 2 Rescuers**

**CPR Performed by 1 Rescuer**

Laypersons with no specific duty or expectation to respond to emergencies in the workplace should be taught 1-rescuer CPR only, because the 2-rescuer technique is infrequently used by laypersons in rescue situations. If 2 rescuers are present, they can alternate performing 1-rescuer CPR. Whether 1- or 2-rescuer CPR is performed, rescuers should ensure scene safety. One-rescuer CPR should be performed as follows:

1. **Assessment:** Determine unresponsiveness (tap or gently shake the victim and shout). If unresponsive,
2. **Activate the EMS system:** This should be performed according to local practice. In many countries and regions, activation of the EMS system is delayed until it has been determined that the victim is not breathing.
3. **Airway:** Position the victim and open the airway by the head tilt–chin lift or jaw-thrust maneuver.
4. **Breathing:** Assess breathing to identify absent or inadequate breathing.
   - If the victim is unresponsive with normal breathing, and spinal injury is not suspected, place the victim in a recovery position, maintaining an open airway.
   - If the adult victim is unresponsive and not breathing, begin rescue breathing. In the United States and many other countries, 2 initial breaths are provided, but up to 5 breaths are recommended in areas such as Europe, Australia, and New Zealand. If you are unable to give the initial breaths, reposition the head and reattempt ventilation. If you are still unsuccessful in making the chest rise with each ventilation after an attempt and reattempt:
     — Lay rescuers should provide chest compressions and begin the cycle of 15 compressions and 2 ventilations. Each time you open the airway to attempt ventilation, look for an object in the throat. If you see an object (such as a foreign body), remove it.
     — Healthcare providers follow the unresponsive FBAO sequence.
   - Be sure the victim’s chest rises with each rescue breath you provide.
   - Once you deliver the effective breaths, assess for signs of circulation.
5. **Circulation.** Check for signs of circulation: after the initial breaths, look for normal breathing, coughing, or movement by the victim in response to the initial breaths. Healthcare providers should also feel for a carotid pulse—take no more than 10 seconds to do this. If there are no signs of circulation, begin chest compressions:
   - Locate proper hand position.
   - Perform 15 chest compressions at a rate of approximately 100 per minute. Depress the chest 1 1/2 to 2 inches (4 to 5 cm) with each compression. Make sure you allow the chest to rebound to its normal position after each compression by removing all pressure from the chest (while still maintaining contact with the sternum and proper hand position). Count “1 and, 2 and, 3 and, 4 and, 5 and, 6 and, 7 and, 8 and, 9 and, 10 and, 11, 12, 13, 14, 15.” (Any mnemonic that accomplishes the same compression rate is acceptable. For ease of recollection, use the “and” only up to the number 10.)
   - Open the airway and deliver 2 slow rescue breaths (2 seconds each).
• Find the proper hand position and begin 15 more compressions at a rate of 100 per minute.
• Perform 4 complete cycles of 15 compressions and 2 ventilations.

6. Reassessment: Reevaluate the victim according to local protocol. In the United States, this will be after 4 cycles of compressions and ventilations (15:2 ratio); elsewhere, reevaluation may be recommended only if the victim shows some sign of recovery. Check for signs of circulation (10 seconds). If there are no signs of circulation, resume CPR, beginning with chest compressions. If signs of circulation are present, check for breathing.
• If breathing is present, place the victim in a recovery position and monitor breathing and circulation.
• If breathing is absent but signs of circulation are present, provide rescue breathing at 10 to 12 times per minute (1 breath every 4 to 5 seconds) and monitor for signs of circulation every few minutes.
• If there are no signs of circulation, continue compressions and ventilations in a 15:2 ratio.
• Stop and check for signs of circulation and spontaneous breathing every few minutes (according to local protocol).
• Do not interrupt CPR except in special circumstances.
• If adequate spontaneous breathing is restored and signs of circulation are present, maintain an open airway and place the patient in a recovery position.

Entrance of a Second Rescuer to Replace the First Rescuer
When another rescuer is available at the scene, that rescuer should activate the EMS system (if not done previously) and perform 1-rescuer CPR when the first rescuer becomes fatigued. This should be done with as little interruption of CPR as possible. When the second rescuer arrives, you should assess the victim’s responsiveness, breathing, and signs of circulation before CPR is resumed.

CPR Performed by 2 Rescuers
All professional rescuers (BLS ambulance providers, healthcare professionals, and appropriate laypersons who have a duty or obligation to respond, such as lifeguards or police) should learn both the 1-rescuer and the 2-rescuer techniques. When possible, airway adjunct methods such as mouth-to-mouth devices should be used.

In 2-rescuer CPR, one person is positioned at the victim’s side and performs chest compressions. The other professional rescuer remains at the victim’s head, maintains an open airway, monitors the carotid pulse to assess effectiveness of chest compressions, and provides rescue breathing. The compression rate for 2-rescuer CPR is 100 per minute. The compression-ventilation ratio is 15:2, with a pause for ventilation of 2 seconds each until the airway is secured by a cuffed tracheal tube. Exhalation occurs between the 2 breaths and during the first chest compression of the next cycle. When the person performing chest compressions becomes fatigued, the rescuers should change positions with minimal interruption of chest compressions.

Reassessment During 2-Rescuer CPR
The rescuers must monitor the victim’s condition to assess the effectiveness of the rescue effort. The person ventilating the victim assumes the responsibility for monitoring signs of circulation and breathing.

To assess the effectiveness of the partner’s chest compressions, the professional rescuer should check the pulse during compressions. To determine whether the victim has resumed spontaneous breathing and circulation, chest compressions must be stopped for 10 seconds at approximately the end of the first minute of CPR (or per local protocol) and every few minutes thereafter. (See No. 6, Reassessment, above.)

Epidemiology, Recognition, and Management of FBAO
Complete airway obstruction is an emergency that will result in death within minutes if not treated. The most common cause of upper-airway obstruction is obstruction by the tongue during loss of consciousness and cardiopulmonary arrest. An unresponsive victim can develop airway obstruction from intrinsic (tongue and epiglottis) and extrinsic (foreign body) causes. The tongue may fall backward into the pharynx, obstructing the upper airway. The epiglottis can block the entrance of the airway in unconscious victims. Blood from head and facial injuries or regurgitated stomach contents may also obstruct the upper airway, particularly if the victim is unconscious. Extrinsic causes may also produce airway obstruction, although the frequency is difficult to determine.

FBAO is a relatively uncommon but preventable cause of cardiac arrest. This form of death is much less common than death caused by other emergencies (1.2 deaths from choking per 100 000 population versus 1.7 per 100 000 for drowning, 16.5 per 100 000 for motor vehicle crashes, and 198 per 100 000 for coronary heart disease).282–285

FBAO is not a common problem among submersion/near-drowning victims. Water does not act as a (solid) foreign body and does not obstruct the airway.296 Many submersion victims do not aspirate water at all, and any aspirated water will be absorbed in the upper airway and trachea. Near-drowning victims require immediate provision of CPR, particularly rescue breathing, to correct hypoxia. Therefore, efforts to relieve FBAO are not recommended for treatment of the victim of near-drowning. Such efforts may produce complications and will delay CPR, the most important treatment for the submersion victim.286 (For further information, see “Part 8, Section 3: Special Challenges in ECC: Submersion or Near-Drowning.”)

Causes and Precautions
FBAO should be considered as a cause of deterioration in any victim, especially a younger victim, who suddenly stops breathing, becomes cyanotic, and falls unconscious for no apparent reason.

FBAO in adults usually occurs during eating and meat is the most common cause of obstruction. A variety of other foods and foreign bodies, however, have caused choking in children and some adults.289–294 Common factors associated with choking on food include attempts to swallow large, poorly chewed pieces of food, elevated blood alcohol levels, and dentures.299–295 Elderly patients with dysphagia are also at risk for FBAO and should take care while drinking and eating. In restaurants, choking emergencies have been
Recognition of FBAO

Foreign bodies may cause either partial or complete airway obstruction. With partial airway obstruction, the victim may be capable of either "good air exchange" or "poor air exchange." With good air exchange, the victim is responsive and can cough forcefully, although frequently there is wheezing between coughs. As long as good air exchange continues, encourage the victim to continue spontaneous coughing and breathing efforts. At this point the rescuer should not interfere with the victim's own attempts to expel the foreign body but should stay with the victim and monitor these attempts. If partial airway obstruction persists, activate the EMS system.

The victim with FBAO may immediately demonstrate poor air exchange or may demonstrate initially good air exchange that progresses to poor air exchange. Signs of poor air exchange include a weak, ineffective cough, high-pitched noise while inhaling, increased respiratory difficulty, and possibly cyanosis. Treat a victim with partial obstruction and poor air exchange as if he had a complete airway obstruction—you must act immediately.

With complete airway obstruction the victim is unable to speak, breathe, or cough and may clutch the neck with the thumb and fingers. Movement of air is absent. The public should be encouraged to use the universal distress signal for choking emergencies (Figure 23). Ask the victim whether he or she is choking. If the victim nods, ask the victim if he or she can speak—if the victim is unable to speak, this indicates that a complete airway obstruction is present and you must act immediately.

If complete airway obstruction is not relieved, the victim's blood oxygen saturation will fall rapidly because the obstructed airway prevents entry of air into the lungs. If you do not succeed in removing the obstruction, the victim will become unresponsive, and death will follow rapidly.

Relief of FBAO

Several techniques are used throughout the world to relieve FBAO, and it is difficult to compare the effectiveness of any one method with another. Most resuscitation councils recommend one or more of the following: the Heimlich abdominal thrusts, back blows, or chest thrusts. The level of evidence regarding any of these methods is weak, largely contained in case reports, cadaver studies, small studies involving animals, or mechanical models. Unfortunately, implementation of a randomized, prospective study to compare techniques for relief of FBAO in humans would be extremely difficult. Mechanical models of choking have been unsatisfactory. Cadaver studies can provide excellent models of unresponsive/unconscious victims, but they cannot replicate awake, responsive choking victims. Therefore, current recommendations are based on a low level of evidence (LOE 5 to 8), with an emphasis on the need to simplify information taught to the lay rescuer.

The Heimlich maneuver (also known as subdiaphragmatic abdominal thrusts or abdominal thrusts) is recommended for lay rescuer relief of FBAO in responsive adult (≥8 years of age) and child (1 to 8 years of age) victims in the United States, Canada, and many other countries. It is not recommended for relief of FBAO in infants. The Heimlich maneuver is also recommended by the AHA and several other resuscitation councils for use by healthcare providers for unresponsive adult and child (but not infant) victims.

Some resuscitation councils (eg, the European Resuscitation Council) recommend that the rescuer provide up to 5 back blows/slaps as the initial maneuver, with the back slaps delivered between the shoulder blades with the heel of the rescuer's hand. If back slaps fail, up to 5 abdominal thrusts are then attempted, and groups of back slaps and abdominal thrusts are repeated. In countries such as Australia, back slaps and lateral chest thrusts are recommended for relief of FBAO in adults.

The Heimlich abdominal thrusts elevate the diaphragm and increase airway pressure, forcing air from the lungs. This may be sufficient to create an artificial cough and expel a foreign body from the airway. Successful relief of FBAO in responsive victims has been reported in the lay press and in medical case studies. Abdominal thrusts, however, may cause complications. For this reason, the Heimlich maneuver should never be performed unless it is necessary.
complications of the Heimlich maneuver include damage to internal organs, such as rupture or laceration of abdominal or thoracic viscera. In fact, victims who receive the Heimlich maneuver should be medically evaluated to rule out any life-threatening complications. To minimize the possibility of complications, do not place your hands on the xiphoid process of the sternum or on the lower margins of the rib cage. Your hands should be below this area but above the navel and in the midline. Some complications may develop even if the Heimlich maneuver is performed correctly. Regurgitation may occur as a result of abdominal thrusts and may be associated with aspiration.

**Heimlich Maneuver With Responsive Victim Standing or Sitting**

Stand behind the victim, wrap your arms around the victim’s waist, and proceed as follows (Figure 24). Make a fist with one hand. Place the thumb side of your fist against the victim’s abdomen, in the midline slightly above the navel and well below the tip of the xiphoid process. Grasp the fist with your other hand and press the fist into the victim’s abdomen with a quick inward and upward thrust. Repeat the thrusts until the object is expelled from the airway or the victim becomes unresponsive. Each new thrust should be a separate and distinct movement administered with the intent of relieving the obstruction.

The Heimlich maneuver is repeated until the object is expelled or the victim becomes unresponsive (loses consciousness). When the victim becomes unresponsive, the EMS system should be activated, and the lay rescuer will attempt CPR. The healthcare provider will proceed with the sequence of actions to relieve FBAO in the unconscious victim (see below).

**The Self-Administered Heimlich Maneuver**

To treat his or her own complete FBAO, the victim makes a fist with one hand, places the thumb side on the abdomen above the navel and below the xiphoid process, grasps the fist with the other hand, and then presses inward and upward toward the diaphragm with a quick motion. If this is unsuccessful, the victim should press the upper abdomen quickly over any firm surface, such as the back of a chair, side of a table, or porch railing. Several thrusts may be needed to clear the airway.

**Chest Thrusts for Responsive Pregnant or Obese Victim**

Chest thrusts may be used as an alternative to the Heimlich maneuver when the victim is in the late stages of pregnancy or is markedly obese. Stand behind the victim, with your arms directly under the victim’s armpits, and encircle the victim’s chest. Place the thumb side of one fist on the middle of the victim’s breastbone, taking care to avoid the xiphoid process and the margins of the rib cage. Grab the fist with your other hand and perform backward thrusts until the foreign body is expelled or the victim becomes unresponsive.

If you cannot reach around the pregnant or extremely obese person, you can perform chest thrusts with the victim supine. Place the victim on his or her back and kneel close to the victim’s side. The hand position and technique for the application of chest thrusts are the same as for chest compressions during CPR. In the adult, for example, the heel of the hand is on the lower half of the sternum. Deliver each thrust with the intent of relieving the obstruction.

**Lay Rescuer Actions for Relief of FBAO in the Unresponsive Victim**

Previous Guidelines recommendations for treatment of FBAO in the unresponsive victim were long, they took considerable time to teach, and they were often confusing for the student. When training programs attempt to teach large amounts of material, they fail to achieve core educational objectives (eg, the psychomotor skills of CPR), and the result is poor skills retention and performance. Focused training on small amounts of information results in superior levels of student performance compared with traditional CPR courses. This compelling data indicates a need to simplify CPR training for laypersons.

Epidemiological data does not distinguish between FBAO fatalities in which the victim is responsive when first encountered and those in which the victim is unresponsive when first encountered by rescuers. The total number of all deaths caused by choking is small, however, so the likelihood that a rescuer will encounter an unconscious victim of FBAO is small. Cardiac arrest caused by VF is far more common than cardiac arrest caused by complete FBAO.

Expert panelists at the 1999 Evidence Evaluation Conference and at the International Guidelines 2000 Conference agreed that lay rescuer BLS courses should focus on teaching a small number of essential skills. These essential skills were identified as relief of FBAO in the responsive/conscious victim and the skills of CPR. Teaching the complex skills of
relief of FBAO in the unresponsive/unconscious victim to lay rescuers is no longer recommended (Class IIb). If the adult choking victim becomes unresponsive/unconscious during attempts to relieve FBAO, the lone lay rescuer should activate the EMS system (or send someone to do it) and begin CPR. In fact, chest compressions may be effective for relief of FBAO in the unresponsive victim. A recent study using cadaver subjects (an acceptable model of the unresponsive/unconscious victim of FBAO) has shown that chest compressions may create a peak airway pressure that is equal to or superior to that created by abdominal thrusts. If the lay rescuer appears to encounter an unsuspected airway obstruction in the unresponsive victim during the sequence of CPR after attempting and reattempting ventilation, the rescuer should continue the sequence of CPR, with chest compressions and cycles of compressions and ventilations.

The lay rescuer should attempt CPR with a single addition—each time the airway is opened, look for the obstructing object in the back of the throat. If you see an object, remove it. This recommendation is designed to simplify layperson CPR training and ensure the acquisition of the core skills of rescue breathing and compression while still providing treatment for the victim with FBAO.

**Finger Sweep and Tongue-Jaw Lift**

The finger sweep should be used by healthcare providers only in the unresponsive/unconscious victim with complete FBAO. This sweep should not be performed if the victim is responsive or is having seizures.

With the victim face up, open the victim’s mouth by grasping both the tongue and lower jaw between the thumb and fingers and lifting the mandible (tongue-jaw lift). This action draws the tongue away from the back of the throat and from a foreign body that may be lodged there. This maneuver alone may be sufficient to relieve an obstruction. Insert the index finger of your other hand down along the inside of the cheek and deeply into the victim’s throat, to the base of the tongue. Then use a hooking action to dislodge the foreign body and maneuver it into the mouth so that it can be removed (Figure 26). It is sometimes necessary to use the index finger to push the foreign body against the opposite side of the throat to dislodge and remove it. Be careful to avoid forcing the object deeper into the airway.

**Healthcare Provider Sequence for Relief of FBAO in the Unresponsive Victim**

Victims of FBAO may initially be responsive when encountered by the rescuer and then become unresponsive. In this circumstance the rescuer will know that FBAO is the cause of the victim’s symptoms. Victims of FBAO may be unresponsive when initially encountered by the rescuer. In this circumstance the rescuer will probably not know that the victim has FBAO until repeated attempts at rescue breathing are unsuccessful.

**Healthcare Provider Relief of FBAO in a Responsive Victim Who Becomes Unresponsive**

If you observe the victim’s collapse and you know it is caused by FBAO, the following sequence of actions is recommended:

1. Activate the emergency response system at the proper time in the CPR sequence. If a second rescuer is available, send the second rescuer to activate the EMS system while you remain with the victim. Be sure the victim is supine.
2. Perform a tongue-jaw lift, followed by a finger sweep to remove the object.
3. Open the airway and try to ventilate; if you are unable to make the victim’s chest rise, reposition the head and try to ventilate again.
4. If you cannot deliver effective breaths (the chest does not rise) even after attempts to reposition the airway consider FBAO. Straddle the victim’s thighs (see Figure 26) and perform the Heimlich maneuver (up to 5 times).
5. Repeat the sequence of tongue-jaw lift, finger sweep, attempt (and reattempt) to ventilate, and Heimlich maneuver (steps 2 through 4) until the obstruction is cleared and the chest rises with ventilation or advanced...
procedures are available (ie, Kelly clamp, Magill forceps, cricothyrotomy) to establish a patent airway.

6. If the FBAO is removed and the airway is cleared, check breathing. If the victim is not breathing, provide slow rescue breaths. Then check for signs of circulation (pulse check and evidence of breathing, coughing, or movement). If there are no signs of circulation, begin chest compressions.

To deliver abdominal thrusts to the unresponsive/unconscious victim, kneel astride the victim’s thighs and place the heel of one hand against the victim’s abdomen, in the midline slightly above the navel and well below the tip of the xiphoid. Place your second hand directly on top of the first. Press both hands into the abdomen with quick upward thrusts (Figure 27). If you are in the correct position, you will be positioned over the midabdomen, unlikely to direct the thrust to the right or left. You can use your body weight to perform the maneuver.

Two types of conventional forceps are acceptable for removal of a foreign body, the Kelly clamp and the Magill forceps. Forceps should be used only if the foreign body is seen. Either a laryngoscope or tongue blade and flashlight can be used to permit direct visualization. The use of such devices by untrained or inexperienced persons is unacceptable. Cricothyrotomy should be performed only by healthcare providers trained and authorized to perform this surgical procedure.

Healthcare Provider Relief of FBAO in Victims Found Unresponsive

If the victim is found to be unresponsive and the cause is unknown, the following sequence of actions is recommended:

1. Activate the emergency response system at the appropriate time in the CPR sequence. If a second rescuer is available, send that rescuer to activate the EMS system while you remain with the victim.
2. Open the airway and attempt to provide rescue breaths. If you are unable to make the chest rise, reposition the victim’s head (reopen the airway) and try to ventilate again.
3. If the victim cannot be ventilated even after attempts to reposition the airway, straddle the victim’s knees (see Figure 27) and perform the Heimlich maneuver (up to 5 times).
4. After 5 abdominal thrusts, open the victim’s airway using a tongue-jaw lift and perform a finger sweep to remove the object.
5. Repeat the sequence of attempts (and reattempts) to ventilate, Heimlich maneuver, and tongue-jaw lift and finger sweep (steps 2 through 4) until the obstruction is cleared or advanced procedures are available to establish a patent airway (eg, Kelly clamps, Magill forceps, or cricothyrotomy).
6. If the FBAO is removed and the airway is cleared, check breathing. If the victim is not breathing, provide 2 rescue breaths. Then check for signs of circulation (pulse check and evidence of breathing, coughing, or movement). If there are no signs of circulation, begin chest compressions.

Unique CPR Situations

Changing Locations During CPR Performance

If the location is unsafe, such as a burning building, move the victim to a safe area and then immediately start CPR. Do not move a victim for convenience from a cramped or busy location until effective CPR is provided and the victim shows a return of signs of circulation or until help arrives. Whenever possible, perform CPR without interruption.

Stairways

In some instances a victim must be transported up or down a flight of stairs. It is best to perform CPR at the head or foot of the stairs and, at a predetermined signal, to interrupt CPR and move as quickly as possible to the next level, where CPR can be resumed. Interruptions should be brief and must be avoided if possible.

Litters

Do not interrupt CPR while transferring a victim to an ambulance or other mobile emergency care unit. If the victim is placed on a low-wheeled litter, the rescuer can stand alongside, providing chest compressions with the locked-arm position. If the victim is placed on a high litter or bed, it may be necessary for the rescuer to kneel beside the victim on the bed or litter to gain the needed height over the victim’s sternum.

Generally, CPR should be interrupted only when tracheal intubation is being performed by trained personnel, an AED or manual defibrillator is being applied or used, or there are problems with transportation. If the rescuer is alone, a momentary delay of CPR is necessary to activate the EMS system. Secretive interventions should not prevent potential rescuers from providing CPR to the best of their ability.

Pitfalls and Complications of BLS

CPR can support life when it is performed properly. Even properly performed CPR, however, can result in complications. Fear of complications should not prevent potential rescuers from providing CPR to the best of their ability.

Potential Complications of Rescue Breathing

The most common complication of rescue breathing is gastric inflation resulting from excess ventilation volume and rapid flow rates. Rescue breathing frequently causes gastric inflation, especially in children. This inflation can be minimized by maintaining an open airway and limiting ventilation volumes to just the point at which the chest rises adequately. This is best achieved by providing slow rescue breaths (allow 2 seconds per breath in adults). Gastric inflation can be further minimized by ensuring that the airway remains open during inspiration and expiration. Unfortunately, in 1-rescuer CPR this is difficult, but it can be performed during 2-rescuer CPR. When possible, an additional rescuer should apply cricoid pressure to minimize gastric inflation.

Marked inflation of the stomach may promote regurgitation and reduce lung volume by elevating the diaphragm. If the stomach becomes distended during rescue breathing, recheck and reopen the airway and look for the rise and fall of the chest. Avoid factors (rapid breaths, short inspiratory times, forceful breaths) that may contribute to the development of high airway pressure. Continue slow rescue breathing and do not attempt to expel the stomach contents. Experience has shown that attempts to relieve stomach inflation with application of manual pressure over
the victim’s upper abdomen is almost certain to cause regurgitation if the stomach is full. If regurgitation does occur, turn the victim’s entire body to the side, wipe out the mouth, return the body to the supine position, and continue CPR.

Potential Complications of Chest Compression
Proper CPR techniques lessen the possibility of complications. Assess for signs of circulation before performing compressions, but allow only 10 seconds to do this. If in any doubt, assume that there is no circulation and begin chest compressions.

Even properly performed chest compressions can cause rib fractures in adult patients. However, rib fractures and other injuries rarely complicate CPR in infants and children. Other complications may occur despite proper CPR technique, including fracture of the sternum, separation of the ribs from the sternum, pneumothorax, hemothorax, lung contusions, lacerations of the liver and spleen, and fat emboli.

These complications may be minimized by use of proper hand position during chest compressions, but they cannot be prevented entirely. Concern for injuries that may complicate CPR should not impede prompt and energetic application of CPR. The only alternative to timely initiation of effective CPR for the victim of cardiac arrest is death.

Rescuer Safety During CPR Training and CPR Performance
Safety during CPR training and in actual rescue situations has gained increased attention. The following recommendations should minimize possible risk of infectious complications to instructors and students during CPR training and actual CPR performance. The recommendations for manikin decontamination and rescuer safety originally established in 1978 by the Centers for Disease Control have been updated twice by the AHA, the American Red Cross, and the Centers for Disease Control and Prevention. Additional recommendations for manikin decontamination have been developed by such organizations as the Australian National Health and Medical Research Council.

Disease Transmission During CPR Training
The risk of disease transmission during CPR training is extremely low. Use of CPR manikins has never been shown to be responsible for an outbreak of infection, and a literature search through March 2000 revealed no reports of infection associated with CPR training. To date, an estimated 70 million people in the United States have had direct contact with manikins during CPR training courses without reported infectious complications.

Under certain circumstances, manikin surfaces can present a very small risk of disease transmission. Therefore, manikin surfaces should be cleaned and disinfected in a consistent manner after each rescuer use and after each class.

Two important practices are needed to minimize risk of transmission of infectious agents during CPR training. First, rescuers should avoid any contact with any saliva or body fluids present on the manikins.

Second, internal manikin parts, such as the valve mechanisms and artificial lungs in manikin airways, invariably become contaminated during use and must be thoroughly cleaned between uses. A wide variety of manikins are commercially available, and it is impossible here to detail the cleaning required for each model and type. Instructors and training agencies should carefully follow the manufacturers’ recommendations for manikin use and maintenance.

There is no evidence to date that HIV can be transmitted by casual personal contact, indirect contact with inanimate surfaces, or an airborne route. The primary retroviral agent that causes acquired immunodeficiency syndrome (AIDS), HIV, is comparatively delicate and is inactivated in <10 minutes at room temperature by a number of disinfectants, including those agents recommended for manikin cleaning. If current recommendations published by the AHA and manikin manufacturers for manikin cleaning and decontamination are carefully followed, risk of transmission of HIV and hepatitis B virus (HBV), as well as bacterial and fungal infections, should be minimized.

Disease Transmission During Actual Performance of CPR
The vast majority of CPR performed internationally is provided by healthcare and public safety personnel, many of whom assist in ventilation of respiratory and cardiac arrest victims who are unknown to the rescuer. A layperson is far less likely to perform CPR than healthcare providers, and the layperson is most likely to perform CPR in the home, where 70% to 80% of respiratory and cardiac arrests occur. The actual risk of disease transmission during mouth-to-mouth ventilation is quite small; only 15 reports of CPR-related infection were published between 1960 and 1998, and no reports have been published in scientific journals from 1998 through March 2000. Researchers have found that there is little reluctance by lay rescuers to perform CPR on family members, even in the presence of vomitus or alcohol on the breath. At last report (1998), the cases of disease transmission during CPR include Helicobacter pylori, Mycobacterium tuberculosis, meningococcus, herpes simplex, Shigella, Streptococcus, Salmonella, and Neisseria gonorrhoeae. No reports on transmission of HIV, HBV, hepatitis C virus, or cytomegalovirus were found. Nevertheless, despite the remote chances of its occurring, fears regarding disease transmission are common in the current era of universal precautions. Indeed, not only laypersons but also physicians, nurses, and even BLS instructors are extremely reluctant to perform mouth-to-mouth ventilation. The most commonly stated reason for not performing mouth-to-mouth ventilation is fear of contracting AIDS. In one survey, only 5% of 975 respondents reported a willingness to perform chest compression with mouth-to-mouth ventilation on a stranger, whereas 68% would do so because they were “definitely” willing to perform chest compression alone if it was offered as an effective alternative CPR technique. The attitude of rescuers who have actually performed mouth-to-mouth ventilation is much different regarding fear of infectious disease. Of bystanders who performed CPR in one study, 92% stated that they had no fear of infectious disease.
The rescuer who responds to an emergency for an unknown victim should be guided by individual moral and ethical values and knowledge of risks that may exist in various rescue situations. The rescuer should assume that any emergency situation involving exposure to certain body fluids has the potential for disease transmission for both the rescuer and victim. If a rescuer is unwilling or unable to perform mouth-to-mouth breathing, chest compressions alone should be attempted, because it may increase the chances for survival (Class IIa). This is particularly true if the victim is exhibiting gasping breaths or if the time to defibrillation is likely to be short.64–67,348

The greatest concern over the risk of disease transmission should be directed to persons who perform CPR frequently, particularly healthcare providers, both in hospital and out of hospital. If appropriate precautions are taken to prevent exposure to blood or other body fluids, the risk of disease transmission from infected persons to providers of out-of-hospital emergency health care should be no higher than that for those providing emergency care in the hospital.

The probability that a rescuer (lay or professional) will become infected with HBV or HIV as a result of performing CPR is minimal.349 Although transmission of HBV and HIV between healthcare workers and patients has been documented as a result of blood exchange or penetration of the skin by blood-contaminated instruments,350 transmission of HBV and HIV infection during mouth-to-mouth resuscitation has not been documented.324,351 There is evidence that some face masks are of proven efficacy in reducing the risk of transmission of pathogens (diseases) during exposure to blood, saliva, and other body fluids.* OSHA supports this observation. Several studies confirm that there is a risk of transmission of pathogens during resuscitative efforts by either the airborne route355 or direct contact. The magnitude of the risk is unknown but probably low. After performing mouth-to-mouth resuscitation on a person suspected of having tuberculosis, the optimal preventive therapeutic agent has not been established. Some authorities suggest use of 2 or more agents.360

Performance of mouth-to-mouth resuscitation or invasive procedures can result in the exchange of blood between the victim and rescuer. This is especially true in cases of trauma or if either victim or rescuer has breaks in the skin on or around the lips or soft tissues of the oral cavity mucosa. Thus, a theoretical risk of HBV and HIV transmission during mouth-to-mouth resuscitation exists.361

Because of the concern about disease transmission between victim and rescuer, rescuers with a duty to provide CPR should follow precautions and guidelines such as those established by the Centers for Disease Control and Prevention369 and the Occupational Safety and Health Administration.362 These guidelines include the use of barriers, such as latex gloves, and manual ventilation equipment, such as a bag mask and other resuscitation masks with valves capable of diverting the victim’s expired air away from the rescuer. Rescuers who have an infection that may be transmitted by blood or saliva should not perform mouth-to-mouth resuscitation if circumstances allow other immediate or effective methods of ventilation.

Several studies confirm that there is a risk of transmission of pathogens (diseases) during exposure to blood, saliva, and other body fluids.9 OSHA supports this observation. Several devices have been developed to minimize risk of pathogen exposure to the rescuer. Participants in BLS courses should be taught to use a barrier device (face shield or face masks) when a mouth-to-mask device is not available and mouth-to-mouth ventilation would place the rescuer at risk. Face masks may be more effective barriers to oral bacteria than face shields. In fact, all face masks with 1-way valves prevent the transmission of bacteria to the rescuer side of the mask. Face shields, on the other hand, contaminated the rescuer side of the shield in 6 of 8 tests.356

Because the efficacy of face shields has not been proven, those with a duty to respond should learn during CPR training how to use masks with 1-way valves and other manual ventilation devices.210,211 Masks without 1-way valves and inline filters (including those with S-shaped devices) offer little, if any, protection and should not be considered for routine use.210,211 Intubation with tracheal tubes and other airway adjuncts obviates the need for mouth-to-mouth resuscitation and enables ventilation that is equal to or more effective than the use of masks alone.366–371 Early intubation is encouraged when equipment and trained professionals are available. Resuscitation equipment known or suspected to be contaminated with blood or other body fluids should be discarded or thoroughly cleaned and disinfected after each use.372

**CPR: The Human Dimension**

Since 1973, millions of people throughout the world have learned CPR. Although CPR is considered by some to be the most successful public health initiative in recent times, the cardiac arrest survival rate to hospital discharge averages

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15%, with some studies reporting a favorable neurological status among such survivors.273

Serious long-lasting physical and emotional symptoms may occur in rescuers who participate in unsuccessful resuscitation attempts. Rescuers may experience grief reactions, stress, and anxiety. The stress of the experience often leaves the rescuer feeling fatigued and uncertain, which may result in chronic anxiety and depression.

A “critical incident debriefing” may allow rescuers to work through their feelings and their grief. Debriefings are most useful after an unsuccessful CPR attempt, and efforts should be made to include all members of the resuscitation team. In these sessions, rescuers discuss their thoughts, feelings, and performance. Participants should analyze what was done and why, with a discussion of things that went right and things that went wrong. The critical incident debriefing is also a time for learning something that may be useful next time. The human dimension of CPR is often not discussed. Because of its importance, it should be incorporated into CPR training and practice.

For additional information, see “Part 6, Section 7A: The Resuscitation Attempt as a ‘Critical Incident’: Code Critique and Debriefing.”

BLS Research Initiatives

Continued improvement of BLS programs requires ongoing scientific research. This resuscitation research must ultimately translate into effective programs to teach CPR to anyone who may witness a cardiac arrest, so that if cardiac arrest occurs, the EMS system is activated immediately, CPR is skillfully performed, and survival is maximized. In many critical areas, insufficient data is available to guide resuscitation experts and clinicians. Because scientific data is lacking in some areas, portions of the current guidelines are based on information derived from limited published data, some clinical experience, and consensus of experts.

BLS is a fundamental therapy, yet many questions remain to be answered about circumstances of arrest that are fundamental to development of CPR skill sequences. To develop optimal sequences for CPR action, it is important to know how often rescuers are alone and how often second rescuers are present. Research is needed about a variety of aspects of programs of public access to defibrillation: what is the optimum retraining interval for anticipated rescuers? What factors should guide placement of AEDs in communities? Should rescuers perform 1 minute of CPR before defibrillation? Further research is needed to identify optimal chest compression—ventilation rates and ratios and methods to differentiate victims who require chest compression from those who do not. In addition, research is needed to increase the number of people who learn CPR and to identify optimal ways to teach CPR to lay rescuers and healthcare providers. CPR programs must be simplified to remove distracting information and emphasize core elements, and then simplified programs must be evaluated to ensure that participants can learn, remember, and demonstrate the steps of CPR. Future changes and advances in CPR based on sound scientific investigation will undoubtedly improve the quality, delivery, and outcome of BLS.

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Part 3: Adult Basic Life Support

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