Appendix A: Cardiac Life Support Fundamentals

Competency Areas

Area 1: Professional Responsibilities

1.5.a Work collaboratively with a partner.
1.5.b Accept and deliver constructive feedback.
1.5.c Work collaboratively with other emergency response agencies.
1.5.d Work collaboratively with other members of the health care team.
1.6.c Delegate tasks appropriately.

Area 5: Therapeutics

5.1.a Use manual maneuvers and positioning to maintain airway patency.
5.1.b Suction oropharynx.
5.1.c Suction beyond oropharynx.
5.1.d Utilize oropharyngeal airway.
5.1.g Utilize airway devices not requiring visualization of vocal cords and introduced endotracheally.
5.1.h Utilize airway devices requiring visualization of vocal cords and introduced endotracheally.
5.5.i Conduct automated external defibrillation.
5.5.j Conduct manual defibrillation.

Appendix 4: Pathophysiology

A. **Cardiovascular System**
Cardiac Conduction Disorder: Benign arrhythmias
Cardiac Conduction Disorder: Lethal arrhythmias
Cardiac Conduction Disorder: Life-threatening arrhythmias

Introduction

Paramedics and first responders are frequently dispatched to calls involving a cardiac arrest. An estimated 60% to 70% of all prehospital cardiac arrests occur in the home; the remainder occur in public places. Having a bystander who has initiated the proper prehospital care at the scene is definitely a plus—indeed, it often means the difference between life and death. Some paramedics might even find it difficult to remember successfully resuscitating a patient from cardiac arrest who did not either have citizen CPR or for whom the arrest was a witnessed event and an AED was immediately available.

This appendix explores planning for the resuscitation or "code," the roles of the code team leader and code team members, and ways that practice and planning can help increase your resuscitation success. The International Liaison Committee on Resuscitation and the American Heart Association, in conjunction with national agencies, such as the Canadian Heart and Stroke Foundation, revises the guidelines for emergency cardiovascular care and CPR every 5 years. This appendix describes how your agency can incorporate the latest guidelines into your codes.

Managing Cardiac Arrest

Although survival rates from prehospital cardiac arrest vary greatly, survival averages 6.4% based on reports from Canada and the United States. The "Chain of Survival" includes four essential links: early access, early CPR, early defibrillation, and early definitive care Figure A-1 ▸. Those communities that have made survival of a prehospital cardiac arrest a benchmark for measurable improvements in their health care systems have worked hard on each of these links.

Improving the Response to Cardiac Arrest: The SMART Way

When you are undertaking a community-based program to improve survival of prehospital cardiac arrest, consider adopting the management acronym SMART to describe the program's objectives: Specific, Measurable, Attainable and Achievable, Realistic and Relevant, and Timely. Here are a few questions that progressive communities should ask:

- Is there a universal access number (ie, 9-1-1), and do all members of the public know how and when to use it?
- Are all the dispatchers/communicators trained in CPR telephone instruction?
- Is a community CPR training program readily available at all times of the day and days of the week at little to no cost for the citizens? If so, does the public know it is available? Have 10% to 20% of the population been trained? (Part of attaining this objective can be addressed by convincing the public to take the self-help approach to CPR training as provided by the 30-minute CPR Anytime program.)
- Is CPR a requirement to graduate high school?

You are the Paramedic Part 1

Jim, a 54-year-old man, is playing basketball in an adult league on a Saturday afternoon at the local elementary school. He leaves the game to get a drink and starts to feel dizzy as he returns to the court. He suddenly drops to his knees and then to the floor. Fortunately, one of his teammates, Tom, took a cardiopulmonary resuscitation (CPR) course about 2 months ago, so he takes charge of the situation. Tom orders a teammate, "Go call 9-1-1 and tell them we have a cardiac arrest." Next, he tells someone else, "Go search for an AED."

About 2 minutes pass as the nearest first responder agency, which was located only a few blocks away, arrives on the scene. Your paramedics are still responding from a few kilometres away.

Upon arrival of your paramedic unit, you are led into the court by a teammate. You hear over the radio that a supervisor is en route as a back-up. As you approach the patient's side, you do a quick assessment of the scene for safety and potential hazards and then begin an initial assessment. Your general impression indicates a middle-aged, overweight male who is receiving good-quality CPR as judged by the counting you hear and the compressions. A first responder is attaching the pads and cables to their AED. These cables can easily be switched to your monitor, but this can wait until after the first shock.

You note the following findings while getting an initial report.

Initial Assessment	Recording Time: 2 Minutes
Appearance	CPR is in progress, patient is not vomiting, and the belly is not distended
Level of consciousness	U (Unresponsive)
Airway	Open with a head tilt–chin lift
Breathing	Being ventilated with a bag-valve-mask device with high-flow supplemental oxygen
Circulation	Receiving compressions at the two-rescuer rate/ratio

1. Arriving on the scene of an apparent cardiac arrest with bystanders who have initiated prehospital care, how should you evaluate the quality of the CPR?
2. Many elementary schools and public places have an AED available. How might that have helped in this situation?

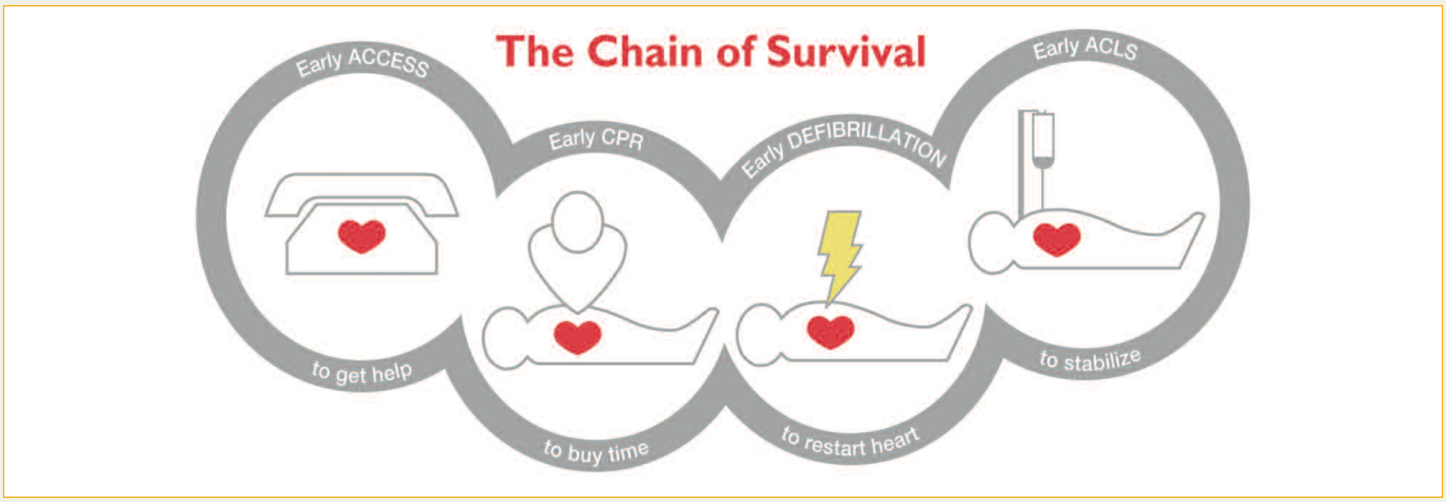


Figure A-1 The four links of the Chain of Survival.

- Are 100% of the responders to emergencies (police, fire, EMS) currently trained in CPR and the AED? Do all response vehicles have an AED?
- Are AEDs and qualified personnel who are trained in their use available in all locations of public assembly for more than 500 people or in high-risk locations?
- How long does it take for the first emergency responder to arrive on the scene? How long does it take for the paramedics to arrive?
- Is the EMS agency's medical director actively involved in reviewing all cardiac arrests and making quality improvements to the EMS system's response on a regular basis?
- Are the cardiac arrest events reported using the Recommended Guidelines for Uniform Reporting of Data from Out-of-Hospital Cardiac Arrest (The Utstein Style) so your community's data can be compared to the data of other progressive communities?
- How often does the code team practice its response and its teamwork in an effort to improve the success of future codes?

Notes from Nancy

Don't let your CPR skills get rusty. A patient's life may depend on them.

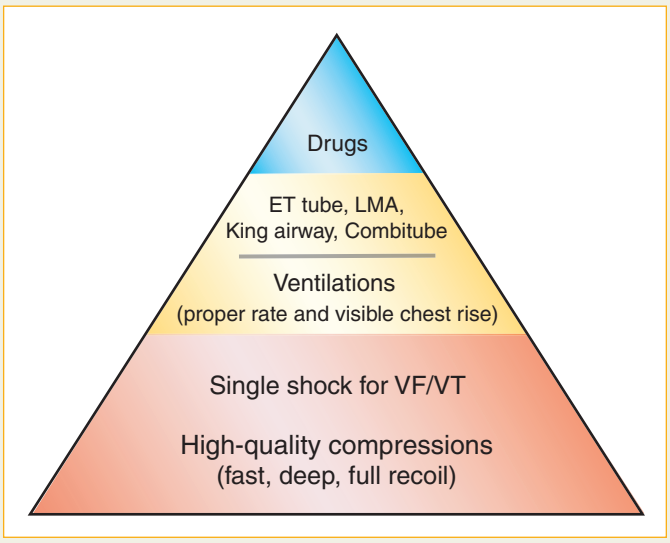


Figure A-2 The resuscitation pyramid. The success of a code relies on high-quality CPR.

Guidelines 2010: Emphasis on CPR First and Providing Uninterrupted, Quality CPR

For many years, the emphasis on quality CPR has seemed to slip as paramedics became more focused on intubation, drug administration, defibrillation, and other aspects of code management. Recent studies have shown that the quality of CPR is poor in both in-hospital and prehospital settings: The depth of compressions is inadequate, the rate of compressions is too slow, almost half the time no compressions are provided, the ventilations are too fast, and the chest is rarely allowed to fully recoil. Studies investigating the value of intubation and resuscitation drugs are inconclusive at best, but CPR is clearly important both before and after defibrillation. In addition, immediate CPR can double or triple the rate of survival from ventricular fibrillation (VF) sudden cardiac arrest.

In the 2005 CPR guidelines, however, there was a return to the emphasis on CPR. The 2010 guidelines take this emphasis a step further by changing the BLS sequence of steps from ABC (airway-breathing-chest compressions) to CAB (chest compressions-airway-breathing). In fact, the "resuscitation pyramid" is built on a strong base of high-quality CPR, as illustrated Figure A-2. The recognition that a paramedic's best chance of succeeding at resuscitation hinges on immediate initiation of continuous, uninterrupted high-quality CPR changes the focus of prehospital care. Today, given the renewed atten-

tion to high-quality CPR, the focus is on how to treat the patient quickly and without any CPR interruptions.

As you arrive on the scene of the code, you need to clearly understand that the success of the code relies on high-quality compressions and not on an IV, an ET tube, or any drug in your box. Work together with the BLS providers, assist them, compliment their efforts, and relieve them as they tire but do not interrupt or disrupt their efforts!

The Steps of CPR

The basic life support steps of CPR for the adult patient follow the algorithm shown in Figure A-3. They presume that an AED is not immediately available at the patient's side. Integration of the AED will be discussed later in this appendix. Prehospital providers (first responders and paramedics) must be trained and prepared to provide either one-rescuer CPR or two-rescuer CPR as available personnel dictate.

In some instances, single-rescuer CPR may have been started before EMS personnel arrive. To help make CPR easier to learn, remember, and perform, the general public or "lay rescuers" are taught a universal compression–ventilation ratio of 30:2. They are not taught to take a pulse, to perform rescue breathing, or to perform two-rescuer CPR. Paramedics should be thrilled and thankful to arrive on the scene and find a bystander who is both properly trained and willing to provide CPR. Unfortunately, studies have shown that bystander CPR is performed in only one third or fewer of witnessed cardiac arrests and that when performed, even by health care providers, it is not done well. Bystanders who have been trained previously in CPR are often reluctant to begin this procedure for the following reasons:

- CPR steps may have been too complicated and included too many steps to remember. The 2005 guidelines made a significant effort to simplify the steps taught to the public.
- Training methods may have been inadequate, and skill retention typically declines very rapidly after a course. This issue is being studied to try to determine which methods of training will produce the greatest skill retention. A video-based watch-and-do method, as opposed to watch-then-do, has been incorporated into many course revisions.
- Some members of the public may be afraid of transmitted diseases and therefore may be reluctant to perform mouth-to-mouth resuscitation. Those who are concerned are encouraged to use barrier devices. In addition, the technique of compression-only CPR is encouraged for those who are reluctant to do ventilations and for dispatcher-assisted CPR instruction.

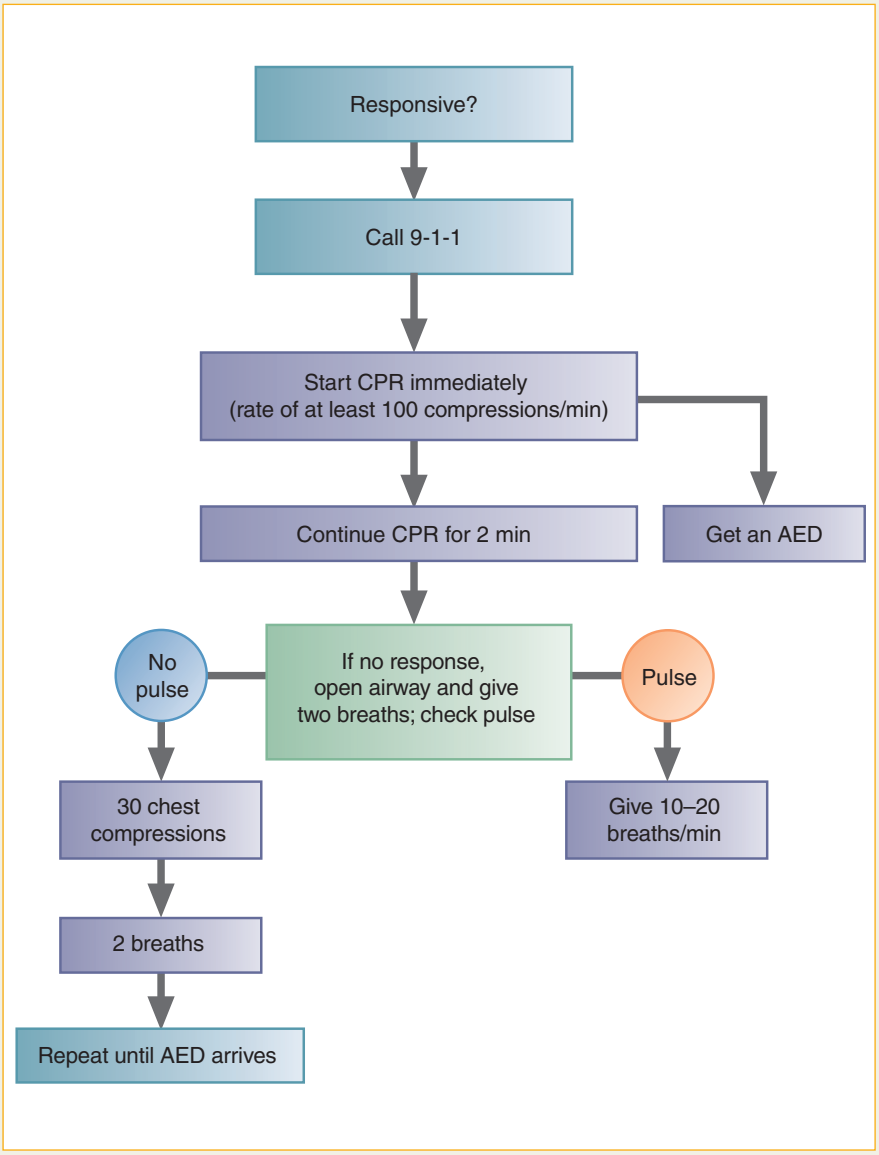


Figure A-3 The BLS adult health care provider algorithm.

Single-Rescuer CPR

Tom immediately began single-rescuer CPR when his teammate Jim dropped suddenly on the basketball court. The steps are shown in Skill Drill A-1.

1. Establish unresponsiveness and quickly scan the patient for signs of breathing. If there is no movement or response to shouting and shaking the adult patient, then the patient is considered "unresponsive" Step 1.
2. If you are by yourself, phone 9-1-1 (or the emergency number) and make sure the AED is immediately available.
   - If there is a second rescuer, send him or her to call 9-1-1 (or the emergency number) and get the AED or defibrillator.

Skill Drill A-1: Single-Rescuer Adult CPR

Step 1

Establish unresponsiveness and lack of adequate breathing. If there is no movement or response to shouting and shaking the adult patient, then the patient is considered "unresponsive". If you are by yourself, phone 9-1-1 (or the emergency number) and make sure the AED is immediately available. If there is a second rescuer, send him or her to call 9-1-1 (or the emergency number) and get the AED or defibrillator.

Step 2

Check for a pulse. Heath care providers are taught to check for a carotid pulse in the adult for at least 5 seconds but to spend no more than 10 seconds trying to locate the pulse.

Step 3

If there is no pulse, begin chest compressions.

Step 4

Open the airway according to your suspicion of spinal injury.

Step 5

Provide two breaths (one breath every 5 to 6 seconds). Continue cycles of 30 compressions and two breaths until the AED or defibrillator arrives.

Step 6

When the AED or defibrillator arrives, attach it to the patient. Analyze the rhythm. If the rhythm is shockable, give one shock and resume CPR immediately. Continue CPR for 2 minutes. If the rhythm is not shockable, resume CPR immediately. Continue CPR and recheck rhythm every 2 minutes for a shockable rhythm. Shock if indicated. Continue until ALS providers arrive or patient has a return of spontaneous circulation.

3. Check for a pulse. Health care providers are taught to check for a carotid pulse in the adult for at least 5 seconds but no more than 10 seconds (Step 2).
4. Deliver compressions in the centre of the chest between the nipples with the heel of the hand and with the second hand on top of the first. Compressions on an adult should be provided at a rate of at least 100/min, pressing at least 5 cm (2") and ensuring full chest recoil after each compression (Step 3).
5. If a pulse were present, the health care provider would open the airway and provide one rescue breath every 5 to 6 seconds. If no pulse were present, the health care provider would begin chest compressions.
6. Open the airway (Step 4). Use the head tilt–chin lift method unless trauma to the neck is suspected, in which case the jaw thrust maneuver may be more appropriate. Check for breathing.

- If there is no breathing, give two rescue breaths over 1 second each to achieve a visible chest rise. Do not overventilate the patient, as it can cause gastric distention and regurgitation Step 5.
- If the patient is breathing or resumes effective breathing, place him or her in the recovery position and monitor closely.

7. Continue the cycles of 30 compressions (push hard and fast, and allow full chest recoil) and two breaths (1-second duration each to achieve visible chest rise) until the AED or defibrillator arrives.
8. Check the patient's rhythm once the AED arrives, with the least amount of interruption in chest compressions as possible.
   - If it is a shockable rhythm, administer a single shock, resume CPR immediately for five cycles (approximately 2 minutes), and then reanalyze the rhythm Step 6.
   - If it is not a shockable rhythm, resume CPR immediately for five cycles (approximately 2 minutes).
9. Continue until ALS providers take over or the patient starts to move. The health care provider would determine whether the patient has a pulse at this point.

Two-Rescuer CPR

Two-rescuer adult CPR provides the same cycle of 30 compressions to every two breaths as in the single-rescuer technique. Because the work is split between the two rescuers, it is more efficient and there is less interruption in the chest compressions to provide the ventilations. If an advanced airway has been inserted, asynchronous compressions and ventilations are possible. That is, the compressor simply presses hard, fast, and with full chest recoil at the rate of at least 100/min while the ventilator provides one breath (over 1 second's time, while observing for visible chest rise) every 6 to 8 seconds.

When you are using the two-rescuer technique, rotate the compressor every 2 minutes. To do so, ask the bystander to continue to assist and kneel on the other side of the patient. Now you can have an "active compressor" and an "on-deck compressor" who is ready to take over after the five cycles or 2-minute interval. Studies of rescuer fatigue show that the compressor tires after 2 to 5 minutes and that the quality of compressions will suffer if the compressor is not replaced. The steps in two-rescuer CPR are outlined here and in Skill Drill A-2:

1. Establish unresponsiveness and quickly scan the patient for signs of breathing. Send a helper to phone 9-1-1 and get the AED Step 1.
2. The health care provider should perform a carotid pulse check for 5 seconds (maximum of 10 seconds) Step 2.
3. One rescuer begins 30 compressions—centre of the chest at a rate of at least 100/min, pressing about 5 cm and ensuring full chest recoil. Count out loud so the second rescuer is prepared to ventilate as you get to "28 and 29 and 30" Step 3.
4. The second rescuer opens the airway according to your suspicion of spinal injury Step 4.
5. The second rescuer ventilates two times, each 1 second in duration and achieving visible chest rise. The ventilator should use a bag-valve-mask device with supplementary oxygen and an OPA. Position yourself approximately 45 cm above the head of the supine patient to allow for proper "E-C" or "OK" hand position and mask seal. During the waiting time, the second rescuer could apply the AED pads so it is ready to analyze at the 2-minute point Step 5.
6. Complete five cycles (approximately 2 minutes) and reassess the patient for a maximum of 10 seconds. If the AED has arrived and is attached, analyze the patient's ECG rhythm to determine whether it is shockable or nonshockable Step 6.
7. If it is a shockable rhythm or immediately following a shock (unless the patient wakes up), begin five cycles (approximately 2 minutes) of 30 compressions to two ventilations.
8. Complete five cycles (approximately 2 minutes) and reassess the patient for a maximum of 10 seconds.
9. Repeat Steps 5, 6, and 7 until ALS arrives and takes over or the medical director orders otherwise. As additional help arrives, prepare for transport or contact direct medical control.

Note: Once an advanced airway has been inserted, the compressions and ventilations are no longer in cycles. Instead, they are asynchronous, with the compressor providing 100/min without pauses for breaths and the ventilator giving 8 to 10 breaths/min (every 6 to 8 seconds). The compressor will get tired so be prepared to switch compressors every 2 minutes with no more than 10-second pauses, if any.

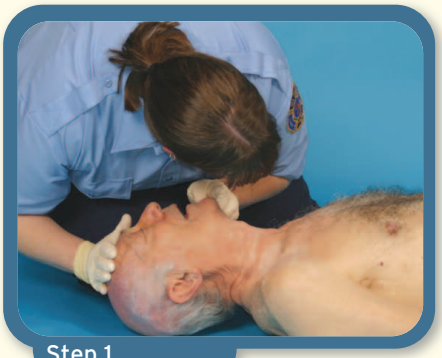
Modification in Technique for Children

Definitions

The age-old question raised to the pediatricians has been "For the purposes of resuscitation, what age defines a child?" Many pediatricians would simply say, "If the patient looks like a child, then he or she is a child; if the patient looks like an adult, then he or she is an adult." This vagueness is further complicated by the epidemic of childhood obesity. The 2005 guidelines use the following definitions of age groups for the purposes of resuscitation:

- **Newly born**—the infant at time of birth
- **Neonate**—the infant until discharge from the initial hospitalization
- **Infant**—younger than 1 year
- **Child**

Skill Drill A-2: Two-Rescuer Adult CPR

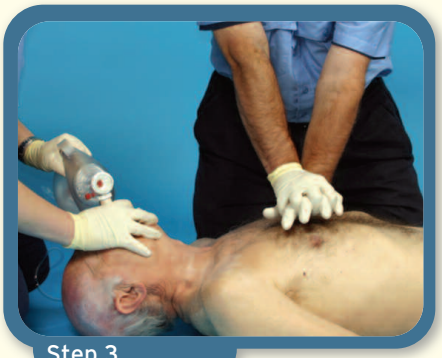


Step 1

Establish unresponsiveness and lack of adequate breathing.

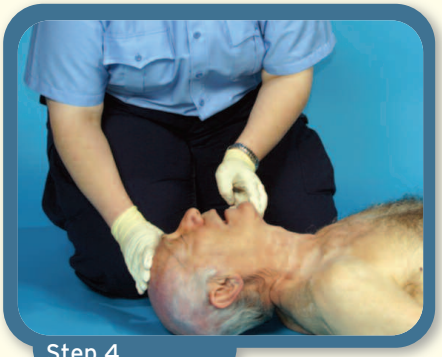
Step 2

Check for a pulse. Heath care providers are taught to check for a carotid pulse in the adult for at least 5 seconds but to spend no more than 10 seconds trying to locate the pulse.



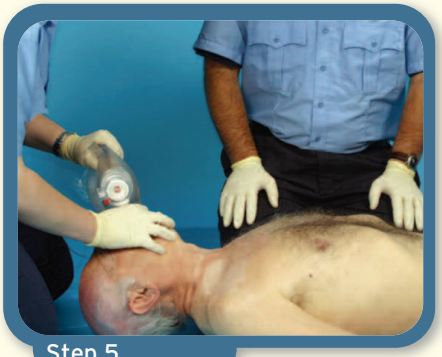
Step 3

If there is no pulse, begin chest compressions.



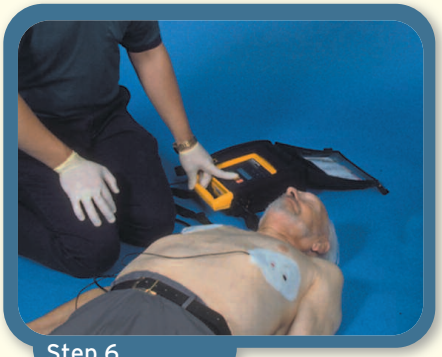
Step 4

Open the airway according to your suspicion of spinal injury.



Step 5

Second rescuer ventilates two times (one breath every 5 to 6 seconds). Continue cycles of 30 compressions and two breaths until the AED or defibrillator arrives.



Step 6

When the AED or defibrillator arrives, attach it to the patient. Analyze the rhythm. If the rhythm is shockable, give one shock and resume CPR immediately. Continue CPR for 2 minutes. If the rhythm is not shockable, resume CPR immediately. Continue CPR and recheck rhythm every 2 minutes for a shockable rhythm. Shock if indicated. Continue until ALS providers arrive or patient has a return of spontaneous circulation.

  - health care providers: age 1 year to adolescence (signs of puberty or secondary sexual characteristic development)
  - lay rescuers: ages 1 to 8
- **Adult**—adolescent and older

This appendix concentrates on infant, child, and adult patients. The care of newly born and neonatal patients is discussed in Chapter 40.

Child CPR

The technique of CPR has a few slight variations for children, as shown below in italics. Skill Drill A-3 ▸ shows the steps of one-rescuer child CPR.

1. Establish unresponsiveness and quickly scan the patient for signs of breathing. If there is no movement or the response to tapping and asking loudly *"Are you okay?"* the child is unresponsive.
   - Send someone to phone 9-1-1 (or the emergency number) and get the AED.

- If you are a lone rescuer for a sudden collapse, phone 9-1-1 (or the emergency number) and get the AED.
- If you are a lone rescuer and it was not a *sudden* collapse, proceed to the next step.

2. Check for a pulse (Step 1).
3. If there is no pulse, begin chest compressions. Use either one or two hands, depending on the child's size. Compressions are delivered at a rate of at least 100/min, pressing one third the anterior-posterior diameter of the chest (about 5 cm) and ensuring full chest recoil (Step 2).
4. Open the airway. Use the head tilt-chin lift method unless trauma to the neck is suspected, in which case the jaw-thrust maneuver may be more appropriate (Step 3).
5. If there is no breathing, give two effective rescue breaths over 1 second each to achieve visible chest rise. Do not over-ventilate the patient, as it can cause gastric distension and regurgitation. Use a child-sized bag-valve-mask device with supplementary oxygen, implement an oropharyngeal airway, and position the second rescuer or ventilator approximately 45 cm above the supine child's head. Use the "E-C" or "OK" method to ensure proper mask seal. If the patient is breathing or resumes effective breathing, place him or her in the recovery position and monitor closely (Step 4).
6. Continue cycles of 30 compressions (push hard and fast, and allow full chest recoil) and two breaths (1-second duration each to achieve visible chest rise) until the AED or defibrillator arrives. If there are two rescuers, health care providers are taught to give cycles of 15 compressions to two ventilations.
7. Check the patient's rhythm once the AED arrives, with the least amount of interruption in chest compressions as possible.
   - If there is a shockable rhythm, administer a single shock. Resume CPR immediately for five cycles (approximately 2 minutes), starting with chest compressions, and then reanalyze the rhythm.
   - If there is not a shockable rhythm, resume CPR immediately for five cycles (approximately 2 minutes). The public is trained to continue until ALS paramedics take over or the child starts to move. The health care provider would determine whether the patient has a pulse at this point (Step 5).

Skill Drill A-4 ▸ shows the steps of two-rescuer child CPR, also summarized here.

1. Establish unresponsiveness and quickly scan the patient for signs of breathing. Send a helper to phone 9-1-1 and get the AED. The health care provider should perform a

You are the Paramedic Part 2

During the first 2 minutes of CPR with Tom and the first responders, a lot of teamwork has been going on. Tom is beginning to tire yet still wants to stay involved, so he becomes the "on-deck compressor." Another first responder has placed the AED next to Jim and relieved Tom; he becomes the compressor. Because Tom has been shown how to apply the AED electrodes, he is able to work around the compressor.

After approximately 2 minutes (five cycles) of CPR, a brief pause in care allows the team to analyze Jim's ECG. The AED begins to charge up, displaying a shockable rhythm such as ventricular fibrillation. In the meantime, Tom administers a few more compressions, and the ventilator removes the bag-valve-mask so oxygen does not flow near the patient. The first responder at the AED states, "I'm clear, you're clear, we're all clear," and proceeds to deliver a single shock. Jim's heavy body bounces on the hardwood floor but he does not awaken. The code team immediately begins the next five cycles of 30 compressions and two ventilations.

Vital Signs	Recording Time: 3 Minutes
Skin	Pale and clammy
Pulse	None palpable at carotid
Blood pressure	None
Respirations	Being ventilated with a bag-valve-mask device

Previously, the duration of time from stopping compressions to analyzing to charging and providing the traditional three-shock series would have been almost 2 minutes of no chest compressions. No perfusion of the brain and vital organs occurs when there is no circulation from rescuers compressing the chest properly. Every pause in compressions, even when it lasts for as little as a few seconds, requires the next few compressions to reprime the pump. For this reason, a pause to analyze the rhythm should last no longer than 10 seconds without chest compressions.

When a patient has a shockable rhythm and does respond appropriately to a shock, it often takes a minute or so for return of spontaneous circulation (ROSC). Unless the patient actually wakes up, immediately after the shock the rescuers should begin CPR with chest compressions.

3. What should you do next as the paramedic on the scene?
4. What is the advantage to perfusion and chest compressions from inserting an advanced airway during two-rescuer CPR?

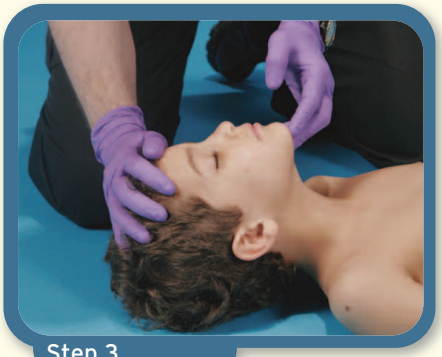
Skill Drill A-3: Single-Rescuer Child CPR

Step 1

Perform a carotid pulse check for 5 seconds (maximum of 10 seconds).

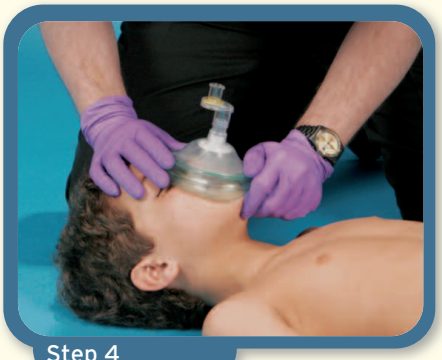
Step 2

Begin 30 compressions—centre of the chest, push hard and fast (rate of 100/min), and allow full chest recoil—using either one or two hands depending on the child's size. Compress one third to one half the depth of the chest.



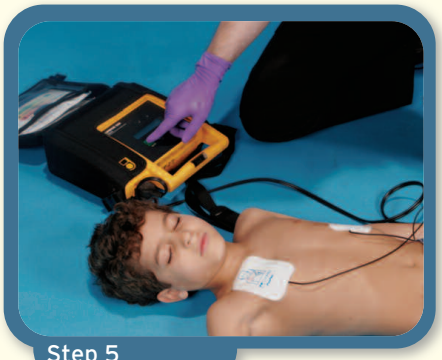
Step 3

Establish unresponsiveness. Open the airway.



Step 4

Ventilate two times for 1 second each to achieve visible chest rise. Use a child-sized pocket mask with a one-way valve.



Step 5

Complete five cycles (approximately 2 minutes) and reassess the patient for a maximum of 10 seconds. If the AED has arrived, attach it, using child pads if the child is between 1 and 8 years old. Decrease the AED energy level. Analyze the rhythm.

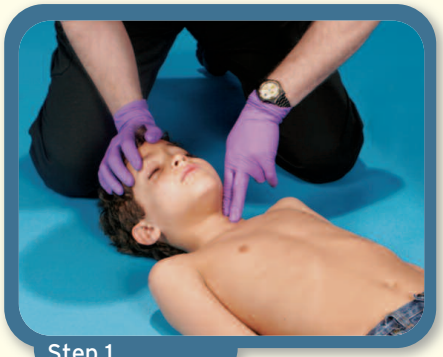
If the rhythm is shockable, administer a single shock and then resume CPR immediately for five cycles. Reanalyze the rhythm.

If the rhythm is not shockable, resume CPR immediately for five cycles.

carotid pulse check for 5 seconds (maximum of 10 seconds) (Step 1).

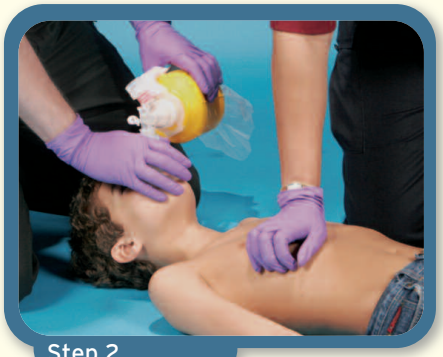
2. One rescuer begins 15 compressions—centre of the chest at a rate of at least 100/min, pressing about 5 cm and ensuring full chest recoil. Count out loud so the second rescuer is prepared to ventilate as you get to "13 and 14 and 15" (Step 2).
3. The second rescuer opens the airway according to your suspicion of spinal injury (Step 3).
4. The second rescuer ventilates two times, each 1 second in duration and achieving visible chest rise. The ventilator should use a bag-valve-mask device with supplementary oxygen and an OPA. Position yourself approximately 45 cm above the head of the supine patient to allow for proper "E-C" or "OK" hand position and mask seal. During the waiting time, the second rescuer could apply the AED pads so it is ready to analyze at the 2-minute point (Step 4).
5. Complete five cycles (approximately 2 minutes) and reassess the patient for a maximum of 10 seconds. If the AED has arrived and is attached, analyze the patient's ECG rhythm to determine whether it is shockable or nonshockable (Step 5).
6. If it is a shockable rhythm or immediately following a shock (unless the patient wakes up), begin five cycles

Skill Drill A-4: Two-Rescuer Child CPR



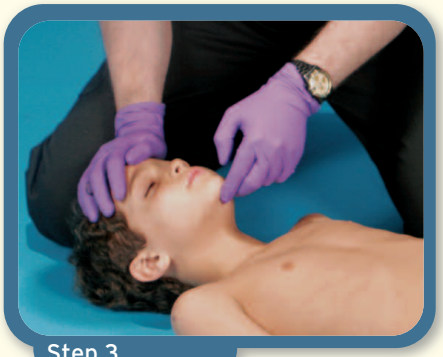
Step 1

Establish unresponsiveness and quickly scan the patient for signs of breathing. Send a helper to phone 9-1-1 and get the AED. Perform a carotid pulse check for 5 seconds (maximum of 10 seconds).



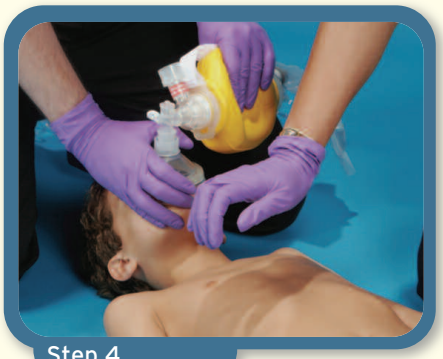
Step 2

One rescuer begins 15 compressions—centre of the chest at a rate of at least 100/min, pressing about 5 cm and ensuring full chest recoil.



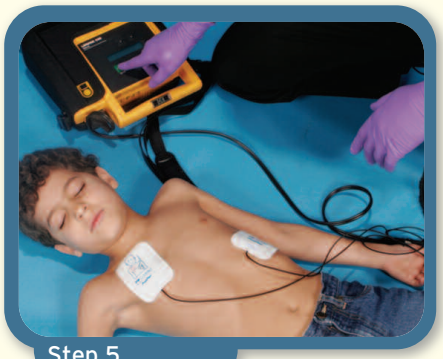
Step 3

The second rescuer opens the airway (according to suspicion of spinal injury).



Step 4

The second rescuer ventilates two times, each 1 second in duration and achieving visible chest rise.



Step 5

Complete five cycles (approximately 2 minutes) and reassess the patient for a maximum of 10 seconds. If the AED has arrived and is attached, analyze the patient's rhythm. If it is a shockable rhythm or immediately following a shock (unless the patient wakes up), begin five cycles (approximately 2 minutes) of 30 compressions to two ventilations. Complete five cycles (approximately 2 minutes) and reassess the patient for a maximum of 10 seconds.

(approximately 2 minutes) of 30 compressions to two ventilations.

7. Complete five cycles (approximately 2 minutes) and reassess the patient for a maximum of 10 seconds.
8. Repeat Steps 5, 6, and 7 until ALS arrives and takes over or the medical director orders otherwise. As additional help arrives, prepare for transport or contact direct medical control.

Infant CPR

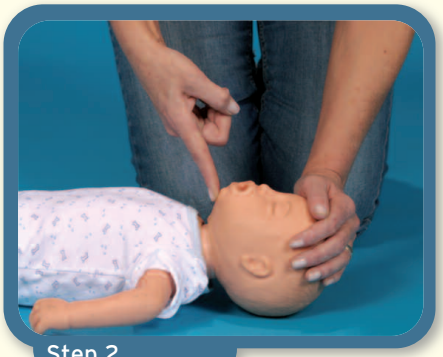
The technique of CPR for an infant has a few slight variations (shown in italics below), as described in Skill Drill A-5 ▸.

1. Establish unresponsiveness and quickly scan the patient for signs of breathing. Send a helper to phone 9-1-1 and get the AED.
2. Check for a brachial or femoral pulse in the infant, but do not spend more than 10 seconds trying to locate the pulse.
3. Begin chest compressions. Compressions are delivered in the centre of the chest just below the nipple line. Use two fingers to compress. Compressions on an infant should be provided at a rate of at least 100/min, pressing one third the anterior-posterior diameter of the chest (about 4 cm) and ensuring full chest recoil Step 1.
4. If not already done, phone 9-1-1 (or the emergency number).

Skill Drill A-5: Infant CPR

Step 1

Establish unresponsiveness, lack of breathing, and check for a brachial or femoral pulse. Give compressions at a rate of at least 100/min to a depth of at least one third the anterior-posterior depth of the chest, allowing for full chest recoil.



Step 2

Open the airway according to your suspicion of spinal injury.

Step 3

Give two effective rescue breaths over 1 second each to achieve visible chest rise. Continue cycles of 30 compressions to two breaths until an AED is available.

5. Open the airway (Step 2). Use the heal tilt-chin lift method (do not hyperextend the neck) unless trauma to the neck is suspected, in which case the jaw-thrust maneuver may be more appropriate.
6. Provide one rescue breath every 3 to 5 seconds (Step 3).
7. Continue cycles of 30 compressions (push hard and fast, and allow for full chest recoil) and two breaths (1-second duration each to achieve visible chest rise) until an AED is available. If there are two rescuers, health care providers are taught to provide cycles of 15 compressions to two ventilations. The compressions can be done using the two-hands encircling method (Figure A-4).

Defibrillation

Early in the steps of CPR, a rescuer or helper is sent to fetch the AED. Many communities have placed AEDs in public places such as health clubs, public pools, concert halls, sports venues, airports, schools, and government buildings.

The AED has been shown to be an effective lifesaving treatment for adults and children older than 1 year. The AEDs used on children from 1 to 8 years of age usually will have a pediatric-sized electrode and some type of switch or attenuator device designed to reduce the amount of electricity delivered to the smaller-sized patient. The AEDs used on patients older than 8 years do not require attenuator devices and the adult electrodes are acceptable to use. These units are preprogrammed so that the user does not have to select a dose. Manual defibrillator units require the operator to select the appropriate dose.

Shockable Rhythms

The two shockable ECG rhythms are ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT). When a patient is in a shockable rhythm, the heart is quivering but blood is not pumping. Defibrillation stuns the heart muscle momentarily and allows the patient's normal conduction system to resume control. If the patient is not defibrillated, the VF will ultimately deteriorate to asystole or flatline.

In the first moments of a cardiac arrest, when the patient is in VF or VT, the heart is oxygenated and "ready" to receive a shock. This explains why the rescuer should begin the steps of CPR and get the AED attached as quickly as possible. If a shock is recommended in this circumstance, administer it immediately—the chances of a successful defibrillation drop 7% to 10% for every minute that passes.

When the VF or VT is not "fresh," however, a rapid shock is not always the best initial treatment. When a patient is in cardiac arrest for an interval of 4 to 5 minutes or longer, even if the initial ECG showed a shockable rhythm, the success rate is poor because the heart is no longer "ready" for a shock. Instead, perfusion and oxygenation are needed first. The 2010 guidelines state that it is more appropriate to begin with CPR, proceeding with five cycles or approximately 2

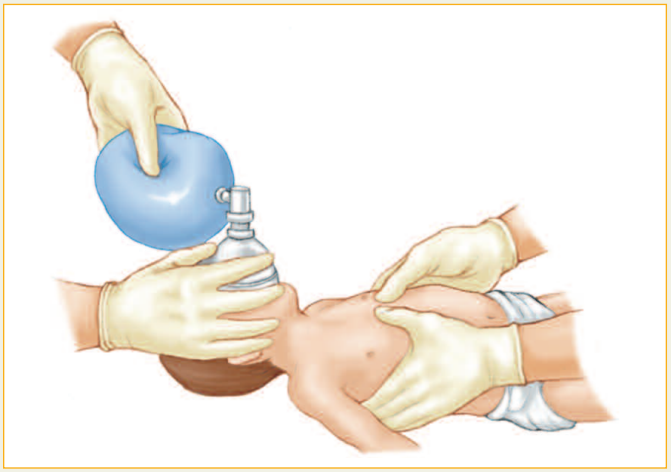


Figure A-4 The primary method of providing chest compressions to the infant when there are two rescuers is to use the two-hands chest encircling method. Compress one third to one half the depth of the chest just below the imaginary line between the nipples.

minutes of 30 compressions to two ventilations, and then analyze the patient's ECG. If the patient is still in VF or VT at this point, he or she would be ready for a dose of electricity.

Shock First or Compressions First?

The decision to deliver a shock first versus provide CPR compressions first is a local direct medical control policy decision. Many medical directors implement a policy similar to the following:

- If the paramedic witnesses the cardiac arrest and has the AED in hand, he or she should analyze the rhythm first and, if it is a shockable rhythm, proceed with a shock.
- If the cardiac arrest is not witnessed by the paramedic, then five cycles (2 minutes) of CPR should be performed prior to analyzing and then shocking the patient if the AED recommends it.
- The decision of whether to count bystander CPR as the first 2 minutes is a judgment call. If you enter the room and observe high-quality compressions being performed (at the proper rate and depth, and with full chest recoil), it probably makes the most sense to allow the bystander to finish out the 2 minutes, unless he or she is tiring, and apply the electrodes around the compressor. Then, at the 2-minute point, you will be ready to analyze and shock, if recommended.

The 2010 guidelines reaffirm the 2005 guidelines, stating when any rescuer witnesses a cardiac arrest, paramedics should start CPR immediately and use an AED or defibrillator as soon as possible. In such instances, 1 to 2 minutes of CPR may be considered before attempting defibrillation. Before the publication of the 2005 guidelines, two studies suggested a potential benefit of CPR first rather than shock first. Subsequent studies, after the 2005 guidelines were published, show that CPR before attempting defibrillation was not associated with a significant difference in survival to hospital discharge. Therefore, shocking first without a period of mandatory CPR is appropriate if a shockable rhythm if present.

The success rate for a biphasic dose is excellent (better than 93%) if the heart is ready to receive the shock. The three-shock series of defibrillation that was taught prior to 2005 no longer makes sense because it would mean delaying compressions for the sake of two additional shocks that will probably not work at this point. If the shock does not work, the patient needs 2 minutes of high-quality CPR. The health care provider can then quickly reanalyze the rhythm and shock as recommended by the device.

Effective Shocks and Special Circumstances

When a shock is effective, occasionally the patient wakes up. That result is dramatic, of course, but the majority of the effective defibrillations will take a minute or so to produce an effective return of circulation. For this reason, as soon as the patient is defibrillated, you should immediately begin compressions. Don't be surprised if the patient does begin to move after a minute or so; you can then cease the compressions and check for a pulse, respirations, and blood pressure.

Because defibrillator pads or electrodes are safer, paddles are rarely used today. Instead, the patient's ECG is monitored and displayed throughout the arrest—not just when taking a "quick look" or when asking the AED to analyze the rhythm. Thus it is possible to observe VF or VT while compressions are being done and begin to charge up the unit. Once the AED is fully charged, the operator should clear all rescuers and deliver the shock. With this approach, compressions can be

Controversies

What Happened to the Gold Standard of Airway Care?

The use of advanced airway devices seems to be deemphasized in the 2005 guidelines—particularly the use of the endotracheal (ET) tube, which previously was considered the "gold standard." When used by skilled BLS paramedics, bag-valve-mask ventilation with supplementary oxygen can be as effective as an ET tube in terms of oxygenation, ventilation, and protection from aspiration for short transportation times.

Many service medical directors have been reluctant to train their first responders in the optional endotracheal intubation skill because of the marginal results when the skill is not practiced frequently. In the past, unrecognized, uncorrected esophageal intubations or tube dislodgements occurred with unacceptable frequency. One study of paramedics providing pediatric intubations in the prehospital environment revealed that 8% of patients arriving at the emergency department had a tube in their esophagus. Another study in a large adult group of cardiac arrests found that 25% of the tubes were in the esophagus or pharynx. As a consequence, airway options now favour good bag-valve-mask ventilation technique and use of easier-to-insert devices such as the laryngeal mask airway (LMA), King airway, Combitube, or similar airways.

delivered while the unit is charging, which minimizes the interruption.

The code team member who delivers the shock *must* always first clear the patient! It is also recommended that the ventilation device be removed from the patient mask or detached from the advanced airway to prevent oxygen from flowing across the patient's chest while a shock is being delivered, as the simultaneous delivery poses a fire hazard.

You should review the following special circumstances for defibrillation and understand the solutions or modifications to the procedure should they arise:

- **The patient is an infant.** A manual defibrilator is preferred. If a manual defibrilator is not available, an AED with pediatric dose attenuation is desirable. If neither is available, an AED without a dose attenuator may be used.
- **The patient has a hairy chest and the electrodes will not stick.** Quickly shave the patient just as you would to do a 12-lead ECG.
- **The patient is submersed in water or soaking wet.** Get out of the rain, quickly move the patient to your office (the ambulance), or remove the patient from the pool and dry him or her off prior to applying the electrodes or shocking.
- **The patient has an AICD or pacemaker.** An anterior-posterior and anterior-lateral locations are generally acceptable in patients with AICDs or pacemakers. It is reasonable to avoid placing pads or paddles directly over the implanted device, and place the pads or paddles at least a few centimeters away from the device.
- **The patient has a transdermal medication patch on the chest.** Quickly remove the patch and wipe the chest dry. Be aware that you can absorb nitroglycerin into your own skin if you do not use disposable gloves.

The Adult Pulseless Arrest Algorithm

The algorithm used to manage an adult in cardiac arrest builds on the BLS adult health care provider algorithm discussed earlier in this appendix. After making sure the patient has been placed on supplementary oxygen, the monitor or defibrillator is used to determine whether the patient is still in a shockable rhythm. The algorithm Figure A-5 ▸ separates the treatment approach into two basic pathways: shockable rhythms (VF or VT) or nonshockable rhythms (asystole or pulseless electrical activity).

The key difference in management from the past approaches is that some preplanning is done so that the medications are drawn up and ready to administer prior to the rhythm checks. The medications are administered during CPR and compressions need not stop for this treatment.

As long as the patient has an effective BLS airway and is being adequately ventilated, placement of an advanced airway (ET tube, LMA, King airway, or Combitube)—although helpful—should never take priority over delivery of high-quality compressions or a shock when needed. Practice your intubation techniques so you are able to insert the advanced airway device with no more than a 10-second interruption in chest compressions.

Controversies

Advanced Airways

In some settings, the LMA, King airway, and Combitube are superior to bag-valve-mask ventilation and oxygenation. Surprisingly, research shows that these devices are equivalent to the ET tube in the adult patient. In addition, the Combitube and King airway offer protection from aspiration of the stomach contents into the lungs. The LMA, King airway, and Combitube are similar in several ways:

- They are advanced airway techniques that are inserted blindly.
- They are placed orally and inserted past the hypopharyngeal space.
- They are easy to use and do not require extensive training in laryngoscopy.

Training selected paramedics on the use of these devices may expand the number of patients who are afforded an advanced airway when one is needed.

Managing Patients in VF or VT

This arm of the algorithm for the adult pulseless arrest patient states that the paramedic should perform CPR and do a rhythm check at each 2-minute point. If the patient is in a shockable rhythm, administer a single shock and immediately begin compressions. If three rescuers are doing CPR (ventilator, active compressor, and on-deck compressor) and an advanced airway has been placed, the compressions and ventilations can be asynchronous. Medications should be prepared and administered while doing CPR. A timekeeper can remind the code

At the Scene

IV or IO?

The 2005 guidelines expanded the use of intraosseous (IO) access beyond children to adults. The algorithm for the adult pulseless arrest patient clearly states that IO is an acceptable type of access to the patient's circulation. Due to the hollow nature of the long bones, infused fluids or medications administered by the IO route will reach the central circulation as fast as those injected into a central venous line (eg, internal jugular or subclavian vein). With the introduction of newer, easier-to-use IO devices such as the FAST1 for the sternum site and the bone injection gun (BIG) and EZ-IO bone drill for the leg, use of IO cannulation is becoming more common in the cardiac arrest patient.

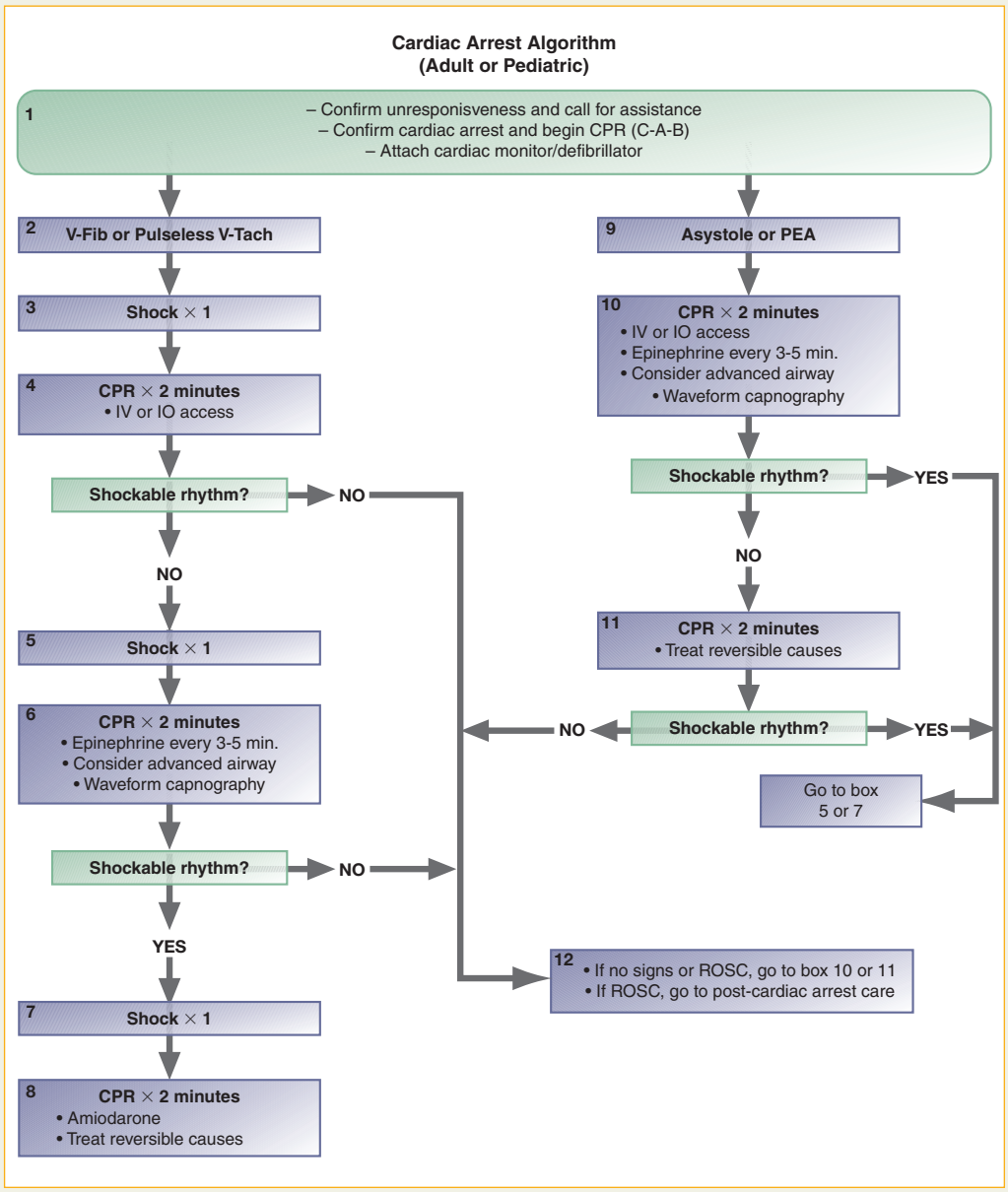


Figure A-5 The pulseless arrest algorithm from the 2010 guidelines.

team leader what should be coming up in the next 30 seconds, in the next 15 seconds, and so on.

Drug therapy for VF or VT includes a vasopressor given every 3 to 5 minutes. The vasopressor of choice is 1 mg of epinephrine administered either IV or IO. A single dose of vasopressin 40 U IV or IO may be substituted for the first and/or second dose of epinephrine.

After the third shock, you may decide to administer an antiarrhythmic such as amiodarone (300 mg IV or IO once) or lidocaine (1 to 1.5 mg/kg first dose, then 0.5 to 0.75 mg/kg IV or IO, up to a maximum of 3 doses, or 3 mg/kg). If the patient has torsade de pointes, consider giving magnesium (loading dose 1 to 2 g IV or IO). After each drug has been administered, allow it to circulate and then reanalyze the patient at the next 2-minute point. If the patient remains in a shockable rhythm, administer another shock.

Managing Patients in Asystole or Pulseless Electrical Activity

This arm of the algorithm calls for the paramedic to provide CPR and do a rhythm check at each 2-minute point. If the patient is in a nonshockable rhythm, such as asystole or pulseless electrical activity (PEA), the potential cause must be taken into consideration. The "Hs and Ts" listed in Table A-1 ▸ are a good way to remember the causes of asystole or PEA. Some of these issues can be managed in the prehospital environment; others will require intervention in the emergency department.

If three rescuers are doing CPR (ventilator, active compressor, and on-deck compressor) and an advanced airway has been placed, the compressions and ventilations can be asynchronous. Medications should be prepared and administered while doing CPR. A timekeeper can remind the code team leader what should be coming up in the next 30 seconds, in the next 15 seconds, and so on.

Drug therapy for asystole and PEA includes a vasopressor every 3 to 5 minutes. The vasopressor of choice is 1 mg of epinephrine administered either IV or IO. A single dose of vasopressin 40 U IV or IO may be substituted for either the first or second epinephrine dose (but not both).

Consider administering atropine, 1 mg IV/IO, for asystole or a slow PEA rate of less than 60. This dose can be repeated every 3 to 5 minutes up to a maximum of three doses. If the patient changes to VF or VT at any point or when the rhythm is checked every five cycles of CPR (approximately 2 minutes), move back to the shockable side of the algorithm. After each drug has been administered, allow it to circulate and then reanalyze the patient at the next 2-minute point.

Table A-1 The "Hs and Ts": Factors Contributing to Cardiac Arrest

- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypokalemia/hyperkalemia
- Hypoglycemia
- Hypothermia
- Toxins
- Tamponade, cardiac
- Tension pneumothorax
- Thrombosis (coronary or pulmonary)
- Trauma

Continuous quantitative waveform capnography is now recommended for intubated patients throughout the periarrest period. When quantitative waveform capnography is used for adults, it provides confirmation of tracheal tube placement, monitoring of CPR quality, and early detection of ROSC. Because blood circulates through the lungs where carbon dioxide is exhaled, the waveform can monitor circulation due to either the effectiveness of chest compressions or ROSC. Ineffective CPR results in a low or decreasing end-tidal CO2, whereas improvements in CPR quality or a return of spontaneous circulation results in an increasing or abrupt rises in end-tidal CO2, respectively.

Useful Adjuncts to Assist in the Return of Spontaneous Circulation

Several devices are available to provide feedback to rescuers on the quality of their compressions (rate, depth, and chest recoil). In addition, three devices hold considerable promise in improving the quality and consistency of the compressions as well as improving the blood flow during CPR: the impedance threshold device (ITD) and two mechanical compression adjuncts.

Impedance Threshold Device

The impedance threshold device (ITD) has been shown to enhance the vacuum in the chest, which forms during the chest recoil phase of CPR. Imagine a bellows fanning a fireplace. As the bellows opens to its full size, it sucks in air. A similar process occurs when the chest wall re-expands—the vacuum that results pulls air into the lungs and blood back into the heart. An ITD selectively prevents that unnecessary air from rushing into the chest, maximizing the vacuum during the recoil phase of the compression. This results in enhanced return of blood that increases cardiac output, blood pressure, and perfusion to vital organs. In theory, this may improve survival rates. Use of the ITD may improve circulation during CPR and may increase the ROSC in cardiac arrest patients. This device was considered acceptable and useful (a Class IIa rating) in the 2005 guidelines.

More recently, the ITD was the subject of large, multicentre prehospital trial to determine its true role in the management of a patient in cardiac arrest. This large study was published in January 2011, and demonstrates a small benefit in survival to hospital discharge with favourable neurologic function for those in whom the device was used during prehospital resuscitation from cardiac arrest. The device did, however, increase the risk of pulmonary edema in those who survived. Paramedics and first responders must remember that when the patient's pulse returns, the ITD should be removed from the ventilation system because it is designed to be used in conjunction with compressions and may impair blood flow, if not removed, when there is a ROSC. The ILCOR has not yet modified its class of recommendation based on this new evidence. Paramedics should refer to their local or regional medical directives and protocols, and consult with their medical director, regarding the role of the ITD in their region.

Figure A-6 The ResQPOD®, an impedance threshold device.

Load-Distributing Band CPR Device

The AutoPulse device is a mechanical device designed to deliver consistent, uninterrupted chest compressions and potentially improve hemodynamics during cardiac arrest. This automated, portable device squeezes the entire chest, thereby improving blood flow to the heart and brain during cardiac arrest. Its use can also free up rescuers to focus on other lifesaving interventions and eliminate fatigue from the performance of CPR chest compressions. One trial comparing the AutoPulse device with manual CPR showed no improvement in 4-hour survival and worse neurologic outcome when the device was used. There is insufficient evidence to support the routine use of this device and further studies are needed.

The AutoPulse can be integrated into a code as follows:

1. Ensure that CPR is in progress and that effective, high-quality compressions are being provided.

Figure A-7 The AutoPulse® non-invasive cardiac support pump.

2. Align the patient on the AutoPulse platform.
3. Close the band over the patient's chest.
4. Press the start button (AutoPulse performs the compressions automatically).
5. Provide bag-valve-mask ventilation at a rate of two ventilations for every 30 compressions. Each ventilation should be given over 1 second to provide visible chest rise.
6. If an advanced airway is in place (ET tube, LMA, King airway, or Combitube), there are no longer cycles of compressions to ventilations. The compression rate is a continuous 100/min; the ventilation rate is 8 to 10/min.
7. After 2 minutes of CPR, reassess for pulse and/or shockable rhythm (maximum of 10 seconds).

Thumper CPR Device

The Thumper is an adjunct to CPR that provides both continuous chest compressions (100/min) and ventilations. It can be used with a pocket mask or an advanced airway. Because this device is powered by oxygen and delivers oxygen when it ventilates, it does go through a large volume of oxygen. If you use the Thumper, plan to carry additional portable oxygen tanks equipped with high-pressure hose adapters to facilitate rapid transfer of the gas. Use these high-pressure adapters in the ambulance and keep them available for use in the emergency department if the Thumper is used to transport the patient to the emergency department. The Thumper has been particularly helpful in prolonged resuscitation attempts. Despite its utility, the device has not resulted in improved survival from cardiac arrest.

Figure A-8 The Thumper CPR system.

Scene Choreography and Teamwork

During resuscitation, plenty of tasks need to be performed. This is where teamwork comes in. Teamwork divides the task while multiplying the chances for a successful resuscitation. There is a role for each health care provider who is committed to fulfilling his or her part. Experience tells us that teams who practice together regularly are more successful in their resuscitation attempts.

You are the Paramedic Part 3

After providing CPR, two shocks with the AED, BLS airway management, an IV, a vasopressor, and then a third shock, the patient has a return of spontaneous circulation. He is being closely monitored and assisted with ventilation at 12 times/min because he is beginning to take some breaths on his own.

Reassessment	Recording Time: 10 Minutes
Level of consciousness	P (Responsive to painful stimuli)
Pulse	96 beats/min, regular
Blood pressure	110/70 mm Hg
Respirations	8 breaths/min, assisted to 12
Spo_2	96% being ventilated with supplemental oxygen
ECG	12-lead shows acute myocardial infarction

5. Because this patient has experienced a return of spontaneous circulation prior to an advanced airway being placed, should one now be inserted?
6. If so, which device would be appropriate if experienced paramedics are present?
7. If you were using an impedance threshold device on the bag-valve-mask device, should it be continued?

At the Scene

Beware the Misplaced Tube!

The 2010 guidelines include recommendations on tube placement confirmation and continuous monitoring of the tube's position to avoid its dislodgment. To ensure that the tube is inserted in the correct location, after the tube is seen to pass through the vocal cords and the tube position is verified by chest expansion and auscultation during positive-pressure ventilation, the rescuer should obtain additional confirmation of placement using an end-tidal CO2 detection device. No single confirmation technique including clinical signs or the presence of water vapour in the tube is completely reliable. To ensure the tube does not dislodge, the guidelines recommend continuous quantitative waveform capnography throughout the periarrest period. A sudden drop in end-tidal CO2 suggests a displaced tracheal tube.

Figure A-9 Even though Saku Koivo is an individual, hockey is a team sport.

Hockey is a team sport that requires every team member to play a specific role. The coach determines who will be on the bench and selects the lines for a particular game. The team captain and assistant captains have a leadership role on and off the ice, using their skill and experience to mentor newer players. The job of the centre and wing men is to forecheck and try to put the puck in the opponent's net, while defensemen and goalie protect the net from the other team's attempts to score. Hockey is a team sport. Each member of the team has a specific role, whether it is scoring, defense, or penalty killing. All team members must be totally committed to the success of the team rather than their own personal achievements Figure A-9 ▸.

The intense preparation and teamwork that characterize any type of high-level sports team hold a few pertinent lessons for code team members:

- Athletes do not only excel on their own. They need the support of their team and coach.
- The coach helps the team members understand the rules of the game and prepare for its challenges.
- The coach drills the athletes with routines or plays and provides constant feedback and plenty of practice opportunities to measure their progress.
- The team trains with the best equipment, eats nutritious meals, develops a positive mental attitude about winning, and gets plenty of rest after enduring rigorous demanding physical and mental exercise.
- When it is time to compete, team members are well prepared, on time, and ready to go. The coach can support them from the sidelines and may offer signals and guidance or "plays" in some sports, but he or she can't compete for the team.

Code team members who are rested, fit, and well nourished, and who bring a positive attitude to their work, practice their skills, know the "plays," and work together as a team are on top of their game. They are ready to resuscitate patients. To be successful, your team needs to take the following steps:

- Know the plays expertly and automatically. This takes a lot of practice. When there are questions, use posters and pocket cards to explain and prepare.
- Listen to your "coaches." They have the best interests of the patients in mind—and your best interests, too.
- Have a "practice ethic." Pull out the manikins and run mock codes or simulations frequently. Collect data on the cumulative time of interruptions of compressions so that the team has feedback and can work to improve its performance.
- Remember that success equals practice, a positive mental attitude, well-designed plays (ie, algorithms), and excellent coaching.
- Recognize that the effectiveness of the team is not about you. It's about succeeding as a group. Patients are counting on you to get this right!

Code Team Member and Code Team Leader Roles

Whether you are a code team member or a code team leader, you should know both your own role and the roles of the other members of your code team during the resuscitation attempt. This will help you anticipate what steps are coming next and see how your role is an essential part of the resuscitation attempt. Whatever skills you are trained and appropriately authorized to perform, it is essential to the success of the resuscitation that you are prepared, have practiced regularly, have mastered the algorithms, and are committed to success.

Code Team Member Roles

A code team member may be called on to perform all of the following roles (and more):

- **Ventilator**—managing the airway. This team member's duties include suctioning the patient, applying cricoid pressure, ventilating the patient with a bag-valve-mask device, inserting an advanced airway device (ie, LMA, ET tube, King airway, or Combitube), and maintaining manual in-line immobilization of the head and neck.
- **Active compressor**—providing high-quality chest compressions. The only responsibility of this team member is to compress for 2 minutes and be the on-deck compressor for 2 minutes.
- **On-deck compressor.** At the 2-minute point, this team member needs to be ready to relieve the compressor without any interruption in compressions. Other functions include assisting with application of mechanical CPR adjunct device (if available), checking on vital signs, and preparing the patient for transport.
- **Other support personnel**—responsible for analyzing the ECG and delivering shocks, gaining venous (IV or IO) access, providing documentation for the patient care report, and supporting family members.

Code Team Leader Roles

Every resuscitation team needs a leader to organize the efforts of the group in a manner similar to that of a conductor leading the individual musicians in an orchestra. Clearly the code team leader must know all of the specific skills and be able to perform each skill expertly—occasionally the code team leader will serve as the backup for a team member who may be having a tough time inserting a tube or gaining IV access. The code team leader is often responsible for making sure everything gets done at the right time in the right way, however.

The roles of the code team leader may include all of the following:

- Taking the patient's history and performing the physical examination.
- Interpreting the ECG.
- Keeping track of the time.
- Making a medication decision following the algorithm.
- Clearly delegating tasks to code team members.
- Completing documentation after the resuscitation attempt.
- Talking with direct medical control.
- Controlling the resuscitation scene.

Code team leaders must also model excellent behaviour and leadership skills for their team and all others who may be involved in the resuscitation. The code team leader should help train future team leaders, seek to improve the effectiveness of the entire team through continuous quality improvement, and practice after the resuscitation to help prepare for the next code.

Controversies

To Terminate or Not to Terminate in the Prehospital Environment

Rescuers who begin BLS are taught to continue until one of the following events occurs:

- Effective spontaneous circulation and ventilation are restored.
- Care is transferred to a higher level of care provider, who in turn may determine whether the patient is not responsive to the resuscitative attempt.
- Reliable criteria indicating irreversible death are present.
- The rescuer is unable to continue because of exhaustion or the presence of dangerous environmental hazards or because continuation of the resuscitation effort places other lives in jeopardy.
- A valid DNR order is presented to the rescuers.
- The resuscitation reaches a point where termination of resuscitation is appropriate based on local or regional protocols, where available.

The 2005 guidelines say the following about lengthy resuscitative efforts and transporting cardiac arrest patients:

- There are very few instances that require transporting a nontraumatic cardiac arrest patient who has failed a successfully executed prehospital ACLS resuscitation effort to an emergency department to continue the resuscitation attempt.
- In the absence of mitigating factors, prolonged resuscitative efforts are unlikely to be successful. If ROSC of any duration occurs, however, it may be appropriate to consider extending the resuscitative effort.
- Rare exceptions may include severe prehospital hypothermia (eg, submersion in icy water) and drug overdose. A successfully executed prehospital resuscitation includes an "adequate trial" of BLS and ALS.

Transporting a deceased patient who is refractory to proper BLS and ACLS is considered unethical. Protocols for pronouncement of death and appropriate transport of the body by non-EMS vehicles should be established. Many jurisdictions have developed or adopted termination of resuscitation protocols that permit paramedics to discontinue a resuscitation effort after a predetermined endpoint is reached. Although paramedics may terminate a resuscitation, pronouncement of death may require a physician. Many services access direct medical control for this pronouncement. Every paramedic should be aware of termination of resuscitation protocols that exist in their jurisdiction, be knowledgeable in their regional protocols, and know how to obtain pronouncement of death, if required.

You are the Paramedic Part 4

Your patient experienced an acute myocardial infarction, causing his heart to go into VF. Fortunately, his teammate responded quickly and initiated the links in the Chain of Survival. After a week in the hospital, the patient went home to his family with a supervised weight loss and exercise program.

A Plan for a Code

The following plan is merely an example and is not the "only way"; obviously, different communities have different resources that arrive at different times in different ways. The point is that you need a plan and you need to practice this plan diligently.

This example focuses on a prehospital EMS agency response to a cardiac arrest in a private home, assuming a five-person team that could arrive on different units (eg, first responder, paramedic, supervisor) at different times in the first few minutes. Roles for the adult scenario include Compressor 1, Compressor 2, Ventilator, Code Team Leader, and the paramedic supervisor:

- **Compressor 1.** Responsible for doing high-quality chest compressions (100/min, press hard and fast, and full chest recoil), stays in position and compresses for 2 minutes and then rests for 2 minutes (for the duration of the time the patient is pulseless), may assist with application of the Thumper (provided Compressor 2 is continuing uninterrupted compressions).
- **Compressor 2.** Responsible for doing high-quality chest compressions (100/min, press hard and fast, and full chest recoil), stays in position and compresses for 2 minutes and then rests for 2 minutes (for the duration of the time the patient is pulseless), may assist with application of the Thumper (provided Compressor 1 is continuing uninterrupted compressions).
- **Ventilator.** Responsible for providing ventilations (bag-valve-mask, oropharyngeal airway, oxygen) at a ratio of 30:2 ensuring visible chest rise with each ventilation (1 second in duration). May need to briefly suction the patient as necessary. Will assist with the transition from BLS airway to advanced airway (not a high priority). Once an advanced airway is placed, ventilate 8 to 10 times/min to achieve visible chest rise over a 1-second duration for each ventilation.
- **Code team leader.** Responsible for initial ECG analysis and defibrillation with a single shock. Responsible for overall timing of the code and reassessment after 2 minutes of cycles of CPR with the interruption not to exceed 10 seconds. After the initial shock (or ascertaining "no shock" rhythm), proceed to establish IV or IO access (no medications down the tube), then begin a vasopressor every 3 to 5 minutes (1 mg epinephrine, with vasopressin as an acceptable substitute for the first or second—but not both—doses of epinephrine), help to transition the airway from BLS to an advanced airway (ET tube, Combitube, King airway, or LMA), and continue with single shocks every 2 minutes if patient is still in VT or VF. Make the decision with input from the code team and direct medical control that the resuscitation should be terminated if there is no ROSC in the first 15 minutes. If there is ROSC, administer the appropriate antidysrrhythmic (eg, amiodarone, lidocaine), ensure appropriate ventilations, and assist the team in preparing for transport.
- **Paramedic supervisor.** Bring in the Thumper and work with one of the compressors to transition the patient to mechanical CPR compressions with minimal interruption. Assist the medic with IV or IO, advanced airway placement, and preparation of medications, and contact direct medical control, per local protocols.

Termination of Resuscitation

The 2010 guidelines make an attempt to provide paramedics with guidelines on when termination of resuscitation is appropriate. For adults experiencing out-of-hospital cardiac arrest receiving BLS only, the BLS providers can consider terminating resuscitation before transporting the patient if *all* of the following are present:

- arrest not witnessed by EMS provider or first responder
- no ROSC after three complete rounds of CPR and AED analyses
- no AED shocks delivered

When ALS personnel are present, ALS providers can consider terminating resuscitation of an adult before transporting the patient if *all* of the following are present:

- arrest not witnessed (by anyone)
- no bystander CPR provided
- no ROSC after complete ALS care in the field
- no shocks delivered

Implementation of these rules includes contacting direct medical control for field pronouncement and termination of resuscitation when the criteria are met.

These rules can reduce the rate of unnecessary transport by up to 60%, decreasing the associated road hazards, inadvertent exposure of EMS personnel to potential biohazards, and the high cost of pronouncement in the emergency department.

No such criteria have been established for the pediatric population because no predictors of resuscitation outcome have been validated for out-of-hospital cardiac arrest in this population.

EMS personnel must consult their medical director and local or regional medial directives for termination of resuscitation protocols and policies in their region.

Vital Vocabulary

asynchronous In CPR, when two rescuers do ventilations and compressions individually and not timed or waiting for the other rescuer to pause.

code team leader The code team member who has the responsibility for managing the rescuers or team members during a cardiac arrest, as well as choreographing the effort of the group.

code team member A member of the resuscitation team trying to revive the patient.

You are the Paramedic Summary

1. **Arriving on the scene of an apparent cardiac arrest with bystanders who have initiated prehospital care, how should you evaluate the quality of CPR?**

Look at the depth of compressions, listen to hear if the compressor is counting to 30, and observe for full chest recoil.

2. **Many elementary schools and public places have an AED available. How might that have helped in this situation?**

The teammates could have quickly obtained the AED, and Tom could have used it within the first 4 minutes or the electrical phase of the arrest.

3. **What should you do next as the paramedic on the scene?**

Take over the role of the code team leader and focus on perfusion and choreographing the arrest.

4. **What is the advantage to perfusion and chest compressions from inserting an advanced airway during two-rescuer CPR?**

With an advanced airway inserted, the two rescuers can switch over to asynchronous CPR with compressions at 100/min and ventilations every 6 to 8 seconds.

5. **Because this patient experienced a return of spontaneous circulation prior to an advanced airway being placed, should one be inserted?**

As time is available. As long as the patient will tolerate an ET tube and you have an experienced paramedic, it would be appropriate to insert one.

6. **If so, which device would be appropriate if an experienced paramedic is present?**

For the patient with ROSC and no gag reflex, the ET tube makes the most sense.

7. **If you were using an impedance threshold device on the bag-valve-mask device, should it be continued?**

No. This device is designed for use with the patient in cardiac arrest during CPR. It should not be used after resuscitation.