

The Chain of Survival

For many years, the American Heart Association has adopted, supported, and helped develop the concept of emergency cardiovascular care. The term *Chain of Survival* provides a useful metaphor for the elements of the emergency cardiovascular care systems-of-care concept. The Chain of Survival shows the actions that must take place to give the cardiac arrest victim the best chance of survival. Each link is independent, yet connected, to the links before and after. If any link is broken, the chance for a good outcome decreases.

Learning Objectives

At the end of this Part, you will be able to

- Describe the importance of high-quality CPR and its impact on survival
- Describe all of the steps in the Chain of Survival
- Apply the BLS concepts of the Chain of Survival

Overview

Cardiac arrest can happen anywhere—on the street, at home, or in a hospital emergency department (ED), inpatient bed, or intensive care unit. Elements in the system of care and order of actions in the Chain of Survival differ based on the situation. Care will depend on whether the victim has the arrest outside the hospital or inside the hospital. Care also depends on whether the victim is an adult, child, or infant.

Actions in the Chain of Survival differ according to setting (in-hospital vs out-of-hospital) and age group. Here are the specific Chains of Survival (Figure 1):

- Pediatric in-hospital cardiac arrest
- Pediatric out-of-hospital cardiac arrest
- Adult in-hospital cardiac arrest
- Adult out-of-hospital cardiac arrest

Figure 1. The American Heart Association 2020 Chains of Survival. Links in the Chain of Survival will differ based on whether the arrest occurs in or out of the hospital and the age of the victim. **A,** Pediatric In-Hospital Chain of Survival. **B,** Pediatric Out-of-Hospital Chain of Survival. **C,** Adult In-Hospital Chain of Survival. **D,** Adult Out-of-Hospital Chain of Survival.



Chain of Survival Elements

Although there are slight differences in the Chains of Survival based on the age of the victim and the location of the cardiac arrest, each includes the following elements:

- Prevention and preparedness
- Activating the emergency response system
- High-quality CPR, including early defibrillation
- Advanced resuscitation interventions
- Post-cardiac arrest care
- Recovery

Prevention and Preparedness

Prevention and preparedness are the foundation of early recognition of cardiac arrest and rapid response.

Out-of-hospital. Most out-of-hospital adult cardiac arrests are unexpected and happen at home. Successful outcomes depend on early high-quality CPR and rapid defibrillation in the first few minutes after the arrest. Organized community programs that prepare the public to respond quickly to a cardiac arrest are critical to improving outcomes.

Prevention includes measures to improve the health of individuals and communities.

Preparedness includes public awareness programs and training to help people recognize the signs of a heart attack and cardiac arrest and take effective action. Community CPR training and emergency response system development are important.

Emergency telecommunicators (ie, call takers, dispatchers) who give CPR instructions help increase rates of bystander CPR and improve outcomes. This telecommunicator-assisted CPR (T-CPR) enables the general public to perform high-quality CPR and early defibrillation.

Mobile phone apps or text messages can be used to summon members of the public who are trained in CPR. Mobile phone apps/mapping can help rescuers locate the nearest AED.

Widespread AED availability supports early defibrillation and saves lives. Public access defibrillation (PAD) programs are designed to reduce the time to defibrillation by placing AEDs in public places and training laypeople to use them.

In-hospital. In the hospital setting, *preparedness* includes early recognition and rapid response to the patient who may need resuscitation. For adult patients in the hospital, cardiac arrest usually happens as a result of serious respiratory or circulatory conditions that get worse. Healthcare providers can predict and prevent many of these arrests by careful observation, preventive care, and early treatment of prearrest conditions.

Once a provider recognizes cardiac arrest, immediate activation of the emergency response system, early high-quality CPR, and rapid defibrillation are essential. Many institutions conduct ongoing training in resuscitation response. Some maintain rapid response teams or medical emergency teams.

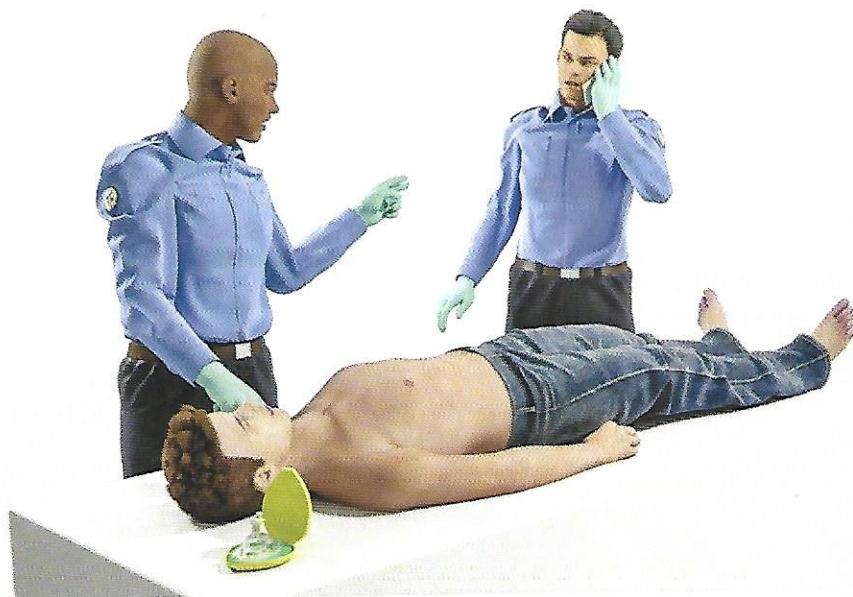
Activating the Emergency Response System

Out-of-hospital. Activating the emergency response system usually means shouting for nearby help and phoning 9-1-1 or the local emergency response number. In the workplace, every employee should know how to activate the emergency response system in their setting (Figure 2A). The sooner a rescuer activates the emergency response system, the sooner the next level of care will arrive.

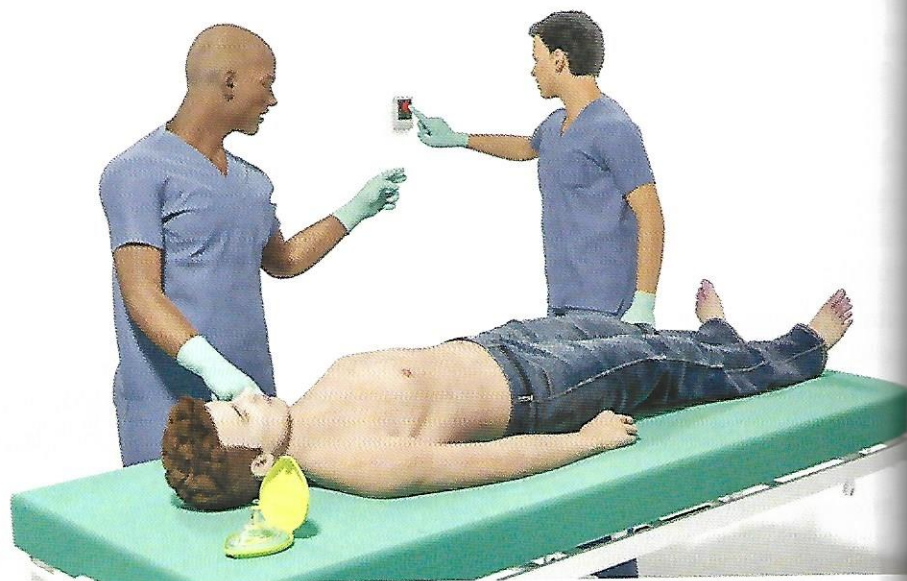
In-hospital. Activation of the emergency response system in the hospital setting is specific to each institution (Figure 2B). A provider may activate a code, summon the rapid response team or medical emergency team, or ask someone else to do it. The sooner a provider activates the emergency response system, the sooner the next level of care will arrive.

Figure 2. Activate the emergency response system in your setting. **A,** Out-of-hospital setting in the workplace. **B,** In-hospital setting.

A



B



High-Quality CPR, Including Early Defibrillation

Out-of-hospital and in-hospital. High-quality CPR with minimal interruptions and early defibrillation are the actions most closely related to good resuscitation outcomes. High-quality CPR started immediately after cardiac arrest combined with early defibrillation can double or triple the chances of survival. These time-sensitive interventions can be provided both by members of the public and by healthcare providers. Bystanders who are not trained in CPR should at least provide chest compressions (also called *Hands-Only CPR*). Even without training, bystanders can perform chest compressions with guidance from emergency telecommunicators over the phone (T-CPR).

Advanced Resuscitation Interventions

Out-of-hospital and in-hospital. Advanced interventions may be performed by medically trained providers during a resuscitation attempt. Some advanced interventions are obtaining vascular access, giving medications, and placing an advanced airway. Others are obtaining a 12-lead electrocardiogram (ECG) or starting advanced cardiac monitoring. In both settings, high-quality CPR and defibrillation are key interventions that are the foundation of a successful outcome.

Out-of-hospital. Lay rescuers provide high-quality CPR and defibrillation with an AED until a multirescuer team takes over the resuscitation attempt. This high-performance team will continue high-quality CPR and defibrillation and may perform advanced interventions.

In-hospital. The high-performance team in a hospital may include physicians, nurses, respiratory therapists, pharmacists, and others. In addition to advanced interventions, extracorporeal CPR may be used in certain resuscitation situations.

Post-Cardiac Arrest Care

Out-of-hospital. After return of spontaneous circulation (ROSC), all cardiac arrest victims receive post-cardiac arrest care. Post-cardiac arrest care includes routine critical care support, such as artificial ventilation and blood pressure management. This care begins in the field and continues during transport to a medical facility.

In-hospital. A multidisciplinary team provides this advanced level of care. Providers focus on preventing the return of cardiac arrest and tailor specific therapies to improve long-term survival. Post-cardiac arrest care may occur in the ED, cardiac catheterization lab (cath lab), intensive care unit, or coronary care unit.

The patient may undergo a cardiac catheterization procedure. During this procedure, a catheter is inserted in an artery (most frequently the groin or wrist) and threaded through the blood vessels to the patient's heart to evaluate heart function and blood flow. Some cardiac problems, such as a blocked artery, may be fixed or other problems diagnosed.

Recovery

Recovery from cardiac arrest continues long after hospital discharge. Depending on the outcome, the survivor of cardiac arrest may need specific interventions. Interventions may be needed to address the underlying cause of cardiac arrest or to provide cardiac rehabilitation. Some patients need rehabilitation focused on neurological recovery. Psychological support for the patient and family are important during the recovery period. Rescuers also may benefit from psychological support.

Comparison of the In-Hospital and Out-of-Hospital Chains of Survival

Five key elements affect all Chains of Survival (Table 1). Those elements are initial support, resuscitation teams, available resources, resuscitation constraints, and level of complexity. Table 1 shows key differences in initial support, resuscitation teams, and available resources between the in-hospital and out-of-hospital settings. Resuscitation constraints and level of complexity are the same in both settings.

Table 1. Comparison of 5 Key Elements in the Chains of Survival

Element	In-hospital cardiac arrest	Out-of-hospital cardiac arrest
Initial support	Depends on an in-hospital system of appropriate surveillance, monitoring, and prevention with responsive primary provider teams	Depends on community and EMS providers for support
Resuscitation teams	Resuscitation efforts depend on <ul style="list-style-type: none"> The smooth interaction of an institution's various departments and services (such as the patient ward, ED, cardiac cath lab, and intensive care unit) A multidisciplinary team of professional providers, which includes physicians, nurses, respiratory therapists, pharmacists, counselors, and others 	Resuscitation efforts depend on <ul style="list-style-type: none"> Lay rescuers who need to recognize an unresponsive victim and quickly activate the emergency response system Lay rescuers who perform CPR and use an AED (if available), as a high-performance team take over resuscitation efforts EMS, who transports the victim to a medical facility for continued care
Available resources	Depending on the facility, in-hospital multidisciplinary teams may have immediate access to additional personnel as well as resources of the ED, cardiac cath lab, and intensive care unit .	Available resources may be limited in the out-of-hospital settings. <ul style="list-style-type: none"> AED access: AEDs may be available through a local PAD program or included in emergency or first aid equipment. Untrained rescuers: T-CPR by untrained rescuers performs lower quality CPR. EMS high-performance team: The only resources may be those they brought with them. Additional backup resources and equipment may take some time to arrive.
Resuscitation constraints	Factors that may affect both settings include crowd control, family presence, space constraints, resources, training, patient transport, and device failures .	
Level of complexity	Resuscitation attempts, both in and out of the hospital, are typically complex . They require teamwork and coordination between rescue and care providers.	

Key Differences in Adult and Pediatric Chains of Survival

In adults, cardiac arrest is often sudden and frequently results from a cardiac cause. In children, however, cardiac arrest is often secondary to respiratory failure or shock. Both respiratory failure and shock can be life-threatening.

Prevention of cardiac arrest is the first link in the pediatric Chains of Survival (Figures 1A and B). Early identification of respiratory or circulatory problems and appropriate treatment may prevent progression to cardiac arrest. Early identification also may maximize survival.

Review Questions

1. In which locations do most out-of-hospital cardiac arrests occur?
 - a. Healthcare clinics
 - b. Homes
 - c. Recreational facilities
 - d. Shopping centers
2. Which is the most common cause of cardiac arrest in children?
 - a. Cardiac problem
 - b. Congenital or acquired heart defect
 - c. Respiratory failure or shock
 - d. Infection and sepsis
3. What is the third link in the adult out-of-hospital Chain of Survival?
 - a. Advanced life support
 - b. High-quality CPR
 - c. Prevention
 - d. Defibrillation

See Answers to Review Questions in the Appendix.