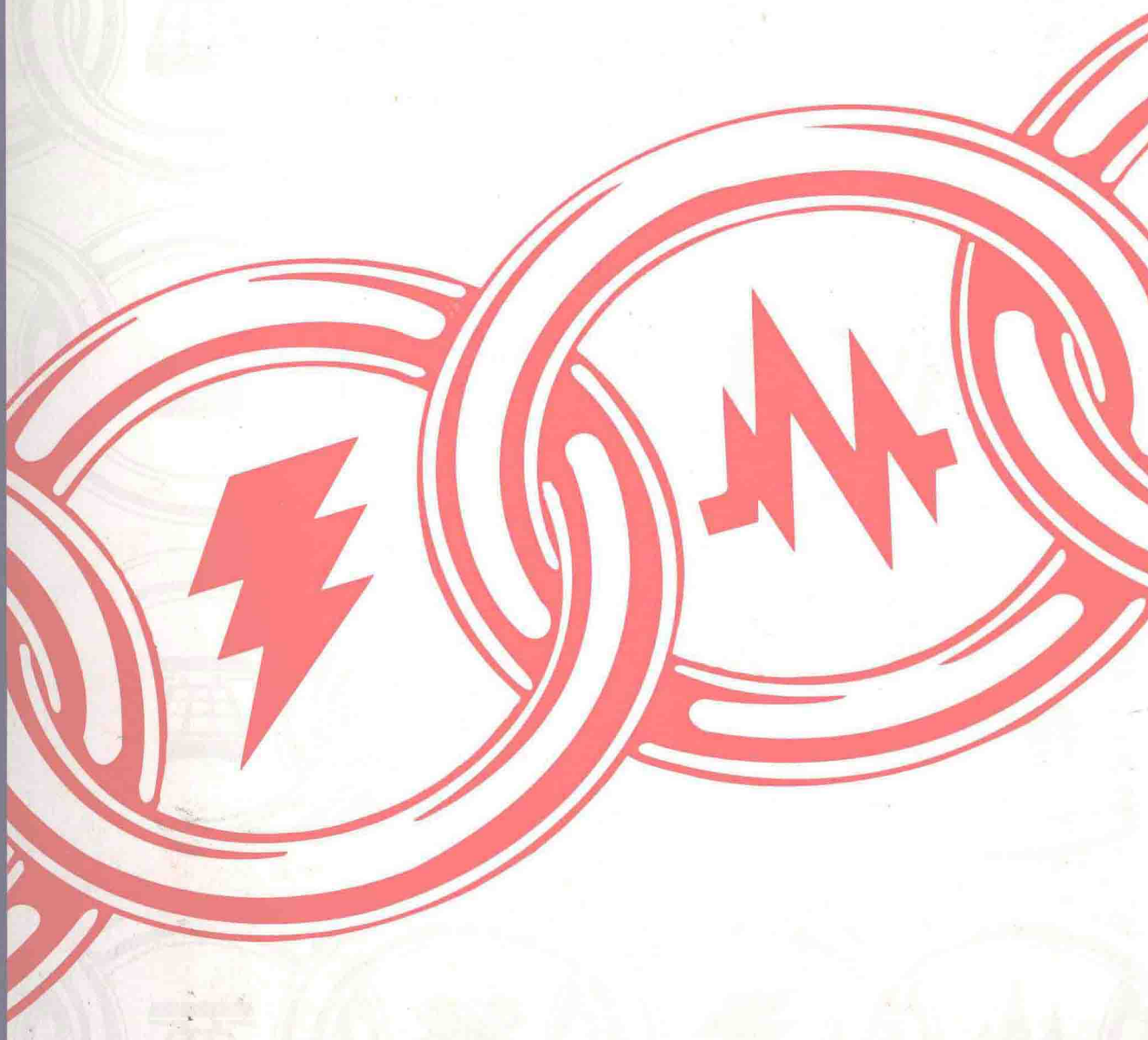
TEXTBOOK

American Heart Association℠

Fighting Heart Disease and Stroke

Advanced Cardiac Life Support



American Heart Association[SM]

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Textbook of Advanced Cardiac Life Support

Editor

Richard O. Cummins, MD, MPH, MSc

Subcommittee on Advanced Cardiac Life Support, 1991-1994

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shaping this work in all dimensions — style, literacy, accura and organization. He is highly competent, hardworking, and blessed with a sparkling wit and good humor. The final qual

Preface

Ask any healthcare worker, "Do you remember your first ACLS course?" You will be greeted with a wry smile and a nodding head. Most people recall vividly that information-packed, intense weekend course where instructors first introduced them to "the ACLS approach." The American Heart Association, with its support of emergency cardiac care training, has achieved an enormous educational success. Almost every medical institution and Emergency Medical Services System in the United States conducts BLS and ACLS training year round. Almost every doctor, nurse, medical student, respiratory therapist, emergency technician, and paramedic can be glimpsed, at some point in their career, clutching this ACLS textbook in their hand and cramming for an ACLS course.

ACLS "clicked" with many of these participants. They caught the resuscitation bug. Over the years they continued to devote a major part of their professional life to learning more about cardiac emergencies. They became ACLS instructors, imparting their lessons to the next generations of ACLS providers. Most of the contributors to this textbook will see themselves in these words. Some of you reading this book for the first time will join the ranks of seasoned instructors and mature researchers.

ACLS challenges people with its "high density" of information. We must, however, avoid viewing ACLS as simply algorithms, protocols, and drug doses to stuff into our memories and regurgitate for some unsmiling instructor. The ACLS concept embodies much more than a collection of cognitive and psychomotor skills. At its core, ACLS presents a way of thinking, a systematic approach to dealing with people experiencing a cardiopulmonary emergency or even sudden death. ACLS presents a way for resuscitation providers to treat a desperately ill patient in a coordinated way, regardless of whether the response team consists of one person, two people, or a swirling group of 15. ACLS-trained providers will use the same guidelines, the same approaches, inside the hospital as outside the hospital, nationally as well as internationally.

Of necessity, ACLS also deals with death. ACLS starts with those people experiencing severe cardiopulmonary compromise. Their hearts have either stopped to function or are about to stop. Some hearts are too good to die — some are too sick to live. Part of your job is to determine which one you are treating. ACLS helps distinguish between those people who, through your quick and diligent efforts, return to continue their life and those people who plainly have reached the end of their life. They may need a hand to hold rather than a hand to pump their chest.

You are not going to save everyone with your ACLS techniques. In fact, most of your ACLS efforts for people in cardiac arrest will fail. The majority of resuscitation attempts end with death, not life. Life continues, however, in the victim's friends, relatives, and loved ones and in your colleagues who helped in the resuscitation attempt. Remember, the moment resuscitative efforts stop, you acquire a new set of patients — the family, the survivors, your team members, and yourself.

Sometimes ACLS leaves us with a tragedy — the tragedy of people whose hearts we get back but not their minds. These are the victims whose thoughts, creativity, and emotions diminish, perhaps even vanish, during the resuscitation attempt. We are left with a beating heart and moving lungs but little else. We must learn how to avoid this sad outcome. Rapid restoration of a beating heart remains the best way to restart a thinking brain. Yet many hospitals and communities have failed to develop strength in each link in the chain of survival. Every person who learns ACLS must ask whether his or her hospital and community has prepared itself to deal rapidly and effectively with sudden cardiac death.

Most of all, however, ACLS is about saving lives. ACLS is about "resuscitation." ACLS is about restoring life and turning back the catastrophe of sudden death or profound cardiac and respiratory compromise. ACLS is about people: with "foreign-body–obstructed trachea" comes a smiling child who insists on running with small toys in her mouth; with "lungs filled with pulmonary edema" comes a rheumatic young woman with three small children at home; with "coarse VF" comes a busy executive who forgot to hug his child that morning; with "profound vascular collapse" comes a grand matriarch whose anxious family is already filling the waiting room.

Finally, ACLS is about preparing yourself — preparing yourself to provide the best care possible for the most dramatic and emotional moment of a person's life. We think this book and the ACLS educational materials will prepare you for this moment, if you make the effort and devote the time. After all, the whole thing is about time — and about giving time back to your fellow man.

Richard O. Cummins, MD

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Essentials of ACLS

Chapter 1

Introduction

People's hearts stop beating every day. For many people this cessation of pulse is premature—their hearts should be too good to die.[1] Resuscitative efforts can restore these hearts to spontaneous activity before the brain has been permanently injured. The core purpose of emergency cardiac care (ECC) is to provide effective care as soon as possible to these hearts that have stopped beating. Rapid restoration of a spontaneously beating heart produces the best chance of achieving the ultimate goal—a thinking, feeling, healthy human being.

This chapter presents "the essentials" of advanced cardiac life support (ACLS). Do not think the chapter provides everything a person must know about ACLS or even everything needed to successfully complete the skills stations and the written evaluation of the ACLS course. This textbook presents a way of thinking about people in cardiac arrest. This chapter will help participants in an ACLS course achieve a better understanding of a person in cardiac arrest and help them begin to learn the roles and interventions used by resuscitation teams.

Here are the core knowledge and skills needed for ACLS:

For devices and procedures, participants must know
- Indications (knowledge)
- Precautions (knowledge)
- Proper use (hands-on practice)

For pharmacologic agents, participants must know
- *Why* an agent is used (actions)
- *When* to use an agent (indications)
- *How* to use an agent (dosing)
- *What to watch out for* (precautions)

Airway management and endotracheal intubation (core), including:

- Noninvasive airway techniques and devices (hands-on practice)
  - — Rescue position
  - — Nasal cannulae
  - — Venturi masks
  - — Oropharyngeal airways
  - — Pocket face masks and barrier devices
  - — Bag-valve mask
  - — Tracheobronchial suctioning
  - — Cricoid pressure
- Techniques to administer oxygen (hands-on practice)
  - — Oxygen tanks
  - — Cricothyrotomy (supplemental)
  - — Transtracheal catheter ventilation (supplemental)
- Endotracheal intubation (hands-on practice)

Recognition and therapy of the major ACLS emergency conditions (core):

- Universal algorithm
- Ventricular fibrillation/pulseless ventricular tachycardia (VF/VT)
- Pulseless electrical activity (PEA)
- Asystole
- Bradycardia
- Tachycardias
- Acute myocardial infarction (MI)
- Hypotension/shock/acute pulmonary edema

Electrical therapy (core), including:

- Defibrillation with automated external defibrillators (AEDs) (hands-on practice)
- Defibrillation with conventional defibrillators (hands-on practice)
- Attachment of defibrillators (conventional and AED) as a cardiac monitor
- Electrical cardioversion with conventional defibrillators
- Transcutaneous pacemakers (hands-on practice)
  - — Asynchronous pacing
  - — Synchronous pacing

Intravenous (IV) and invasive therapeutic and monitoring techniques, including:

- Peripheral IV lines (core)
  - — Hand, antecubital, saphenous, external jugular, femoral
- Central IV lines (supplemental)
  - — Internal jugular (Seldinger technique and triple-lumen catheters)
  - — Subclavian
- Pericardiocentesis (supplemental)
- Thoracentesis for tension pneumothorax (supplemental)

Recognition of the following rhythms (core):

- *Lethal rhythms*
  - — VF
  - — VT
  - — Artifact from lead detachment, movement, electrical interference
  - — Asystole
  - — PEAs (narrow-complex and wide-complex)

- *Nonlethal arrhythmias*
  - — Normal sinus rhythm
  - — Bradycardias: sinus bradycardia, atrioventricular (AV) nodal blocks (first-, second-, third-degree)
  - — Atrial tachycardia, atrial tachycardia with block, atrial flutter with various degrees of block, premature ventricular complexes (PVCs)
  - — Tachycardias: sinus tachycardia, atrial fibrillation, atrial flutter, paroxysmal supraventricular tachycardia (PSVT), wide-complex tachycardias
  - — Electrocardiographic (ECG) criteria for acute ischemia, acute injury, acute infarction (anterior, inferior)
  - — Pacemaker spikes

ACLS cardiovascular pharmacology (core), including the *Why?* (actions), *When?* (indications), *How?* (dosing), and *Watch out for!* (precautions) of the following agents:

- Electricity
- Oxygen
- Epinephrine
- Lidocaine
- Bretylium
- Magnesium sulfate
- Procainamide
- Sodium bicarbonate
- Atropine
- Dopamine
- Isoproterenol
- Vagal maneuvers (used as a drug)
- Adenosine
- Verapamil
- Diltiazem
- A β blocker (atenolol, propranolol, or metoprolol)
- Nitroglycerin
- Nitroprusside
- Dobutamine
- Morphine sulfate
- Furosemide
- A thrombolytic agent (the one used in the provider's work setting)

Early management (first 30 minutes) of the following special resuscitation situations (supplemental):

- Stroke
- Hypothermia
- Drowning and near-drowning
- Cardiac arrest associated with trauma
- Electrocution and lightning strike
- Cardiac arrest of the pregnant patient
- Possible drug overdose

Megacode leadership (core) and full participation (core), including:

- Knowledge and skills to manage the core Megacode scenario: *the first 10 minutes of an adult VF cardiac arrest.*
- The core Megacode scenario covers the following areas:
  - — Universal algorithm (for pulseless patient)
  - — Basic adult CPR (primary ABCD survey)
  - — VF/VT algorithm
  - — Appropriate use of the secondary ABCD survey
  - — Acceptable noninvasive airway management techniques
  - — Endotracheal intubation (only if professional role requires)
  - — IV techniques (peripheral line only)
  - — Defibrillation with AEDs and conventional defibrillators
  - — Use of pharmacologic agents: epinephrine, lidocaine, bretylium, procainamide, sodium bicarbonate, magnesium sulfate

Core ACLS Concepts

The Brain

- **Cerebral resuscitation is the most important goal.** ECC personnel must restart the heart as the first step toward that goal. Cerebral resuscitation—returning the patient to the prearrest level of neurological functioning—stands as the ultimate goal of ECC. Peter Safar has proposed the term *cardio-pulmonary-cerebral resuscitation* (CPCR) to replace the familiar CPR.[2] Many national and international experts support this proposal. Clinicians should always remember the term *cerebral*, for that word reminds us of our primary purpose: to return the patient to his or her best possible neurological outcome. Unless spontaneous ventilation and circulation are restored quickly, successful cerebral resuscitation cannot occur.[3]

The Patient

- **Never forget the patient.** Resuscitation challenges care providers to make decisions quickly, under pressure and in dramatic settings. Human nature can lead providers to focus on limited specific aspects of resuscitative attempts: getting the IV started, placing the tube, identifying the rhythm, remembering the "right" medication to use. Emergency care providers must constantly return to an overall view of each resuscitative attempt: is the airway adequate? are ventilations effective? what could have caused this arrest? what else could be wrong? what am I missing? The algorithms (flow diagrams) focus the provider on the most important aspects of a resuscitative effort: airway and ventilation, basic cardiopulmonary resuscitation (CPR), defibrillation of VF, and medications suitable for a particular patient and particular conditions.

Basic Life Support

• The resuscitation continuum: Advanced cardiac life support (ACLS) is just the other end of basic life support (BLS). BLS (ie, CPR) attempts to give a person in cardiopulmonary arrest an open airway, adequate ventilation, and (through chest compressions) mechanical circulation to the vital organs. ACLS attempts to restore spontaneous circulation. ACLS is interconnected with basic and intermediate life support. Traditionally we have considered ACLS interventions to be defibrillation, endotracheal intubation, and IV medications. These distinctions have been blurred, however, by automated defibrillation, invasive airway devices that do not extend into the trachea, and sublingual and endotracheal administration of medications. What is formally called *ACLS* should now be considered the latter end of a continuum that starts with recognition of a cardiopulmonary/cardiovascular emergency and moves through defibrillation, advanced airway management, and rhythm-appropriate IV medications.

Either in-hospital or prehospital emergency personnel cannot provide proper ACLS without constant and careful attention to the features of BLS and proper assessment of the patient. The interventions performed will vary according to the setting. Prehospital care systems have many combinations of personnel and skill levels.[4,5] Recognition of the importance of early defibrillation for witnessed adult cardiac arrest has led to use of defibrillation by traditional BLS providers. The curriculum recommended by the American Heart Association (AHA) for early defibrillation, for example, provides protocol recommendations for the simplest response level.[6-9] This would be two-rescuer response teams with two people trained to the BLS level plus defibrillation. Many systems prefer a three-person response team with all three responders trained to an advanced level.[10] In-hospital response teams display the same variety as prehospital teams.[11,12]

Time

• Passage of time drives all aspects of ECC and determines patient outcomes.[13-15] The probability of survival declines sharply with each passing minute of cardiopulmonary compromise. Some interventions, like basic CPR, slow the rate at which this decline in resuscitation probability occurs. Other interventions, such as opening an obstructed airway or defibrillating VF, can restore a beating heart. The longer it takes to perform these interventions, however, the lower the chances of benefit.

The Cause

• Emergency personnel must identify medical conditions that lead to cardiac arrest as quickly as possible. Once these conditions are identified, rescuers must start appropriate therapy rapidly. This textbook includes specific recommendations on the "prearrest" period, including conditions to look for and interventions to provide. AMI is the most dramatic example of a condition that may lead to a cardiac arrest but for which effective therapy now exists. Time is a critical factor, for the effectiveness of thrombolytic therapy dramatically declines the longer patients or medical personnel take to make the diagnosis and start therapy.

Postresuscitation Care

• Emergency care providers must continue to provide appropriate evaluation and therapy in the period immediately after restoration of a spontaneous circulation. The ACLS course concentrates on resuscitation during a cardiac arrest and on critical actions to take 30 minutes before and 30 minutes after a cardiac arrest. The ACLS recommendations during the postresuscitation period assume that invasive hemodynamic monitoring is *not* available. Emergency care providers are often on their own during this period while awaiting transport to an emergency department or to a critical care area of the hospital.

The Chain of Survival Applies in All Settings

• Emergency care providers must never forget that the principles and recommendations for ECC apply to the prehospital cardiac arrest, the in-hospital cardiac arrest, and patients in emergency departments. The sequence of BLS, intermediate life support, and advanced life support is a continuum that applies equally in the intensive care unit, the patient's home, and the local shopping mall. This fact supports inclusion of material on AEDs for all ACLS course participants and instruction in their use.

The Phased-Response Approach

• Every resuscitative attempt possesses a structure, a time course, and a rich variety of intermediate stages. These include anticipation by the rescuers, entry into the resuscitative efforts, the resuscitative effort itself, maintenance of the patient, family notification, transfer, and critique.[16,17] Every resuscitative attempt produces psychological effects on the rescuers.[18-20] This is true whether the cardiac arrest occurs in a rural community, an emergency department, a sophisticated urban emergency medical services (EMS) system, or the intensive care unit of a tertiary care medical center. Outcomes will be better if we recognize this architecture, plan for it, and follow the appropriate steps.

Expected Deaths and Futile Resuscitations

• **For many people the last beat of their heart should be the last beat of their heart.** They have simply reached the end of their life, and resuscitative efforts are inappropriate, futile, undignified, and demeaning to both the patient and the rescuers. Once started, resuscitative efforts can acquire this same mantle of futility and inappropriateness. Good ACLS requires careful thought about when to start and when to stop resuscitative efforts.

The Chain of Survival in Your Community

• **ACLS cannot exist in a vacuum.** We must examine closely the community in which cardiac arrests occur. We each may focus on an individual skill or role in resuscitative attempts—intubation, defibrillation, proper identification of rhythms, or sequencing of medications. Our success in these interventions, however, often depends on the performance of others. Successful outcomes depend on how well all these efforts are linked together in what has been termed the *chain of survival.*[14,15] The concept of a linked chain applies to cardiac arrests in-hospital as well as arrests in the prehospital arena. The chain of survival has four links:

- Early access—a cardiac emergency must be recognized and responded to
- Early CPR—some efforts at opening the airway, ventilation and blood circulation must occur as soon as possible
- Early defibrillation—identification and treatment of VF is the single most important intervention
- Early ACLS—advanced airway control and rhythm-appropriate IV medications must be administered rapidly

Failure to examine and strengthen all of these links condemns emergency personnel and the patient to inferior outcomes.

The Primary-Secondary Survey Approach to Emergency Cardiac Care

Taking an ACLS course for the first time makes some people anxious. They often focus on such psychomotor skills as intubation and starting central lines and worry about rhythm recognition and how to remember medications.

Emergency personnel need a systematic approach to resuscitation and cardiorespiratory emergencies. With an organized approach they will feel more comfortable about individual roles and about the tasks they face as a resuscitation team. Emergency medicine teaches a simple and familiar approach: **primary survey followed by the secondary survey.**[21] This approach provides a powerful conceptual tool for the ACLS provider to use when approaching cardiac care emergencies.

Key Points

In the primary survey, focus on basic CPR and defibrillation:

First "A-B-C-D"

- **A**irway: open the airway
- **B**reathing: provide positive-pressure ventilations
- **C**irculation: give chest compressions
- **D**efibrillation: shock VF/pulseless VT

In the secondary survey, focus on intubation, IV access, rhythms, and drugs and on why the cardiorespiratory arrest occurred:

Second "A-B-C-D"

- **A**irway: perform endotracheal intubation
- **B**reathing: assess bilateral chest rise and ventilation
- **C**irculation: gain IV access, determine rhythm, give appropriate agents
- **D**ifferential Diagnosis: search for, find, and treat reversible causes

The primary and secondary approach applies to more than just full cardiac arrests. Providers should learn to apply the primary ABCD survey and the secondary ABCD survey to all cardiac arrests, to all prearrest and postarrest patients, and during all major decision points in a difficult resuscitative effort.

The Primary Survey

In the primary survey, focus on basic CPR and defibrillation.

First "A-B-C-D"

Airway:
- Open the airway.

Breathing:
- Provide positive-pressure ventilation.

Circulation:
- Give chest compressions.

Defibrillation:
- Shock VF/pulseless VT.

In the primary ABCD survey personnel recognize that a person has experienced a cardiac arrest and start resuscitative efforts as follows: open the airway, initiate breathing, start chest compressions, and search for and

shock VF if present (using either conventional or automated defibrillators).

All people involved in emergency care must master the primary survey. For example, the first person to discover a cardiac arrest in a general hospital floor would initiate the primary survey, in the course of which he or she would identify the cardiac arrest, call for help, and perform the basic ABCs of CPR. The first assistant to arrive would be asked to get the automated external defibrillator or the "crash cart." The first action to do when the cart arrives is complete the primary survey by looking for VF with the defibrillator. If VF or pulseless VT is present, shock it immediately with up to three shocks.

At this point, move to the secondary survey.

The Secondary Survey

The secondary survey repeats the same **A-B-C-D** mnemonic, but now each letter reminds the rescuer to perform more in-depth interventions and assessments.

Second "A-B-C-D"

Airway:

- Establish advanced airway control.
- Perform endotracheal intubation.

Breathing:

- Assess the adequacy of ventilation via endotracheal tube.
- Provide positive-pressure ventilations.

Circulation:

- Obtain IV access to administer fluids and medications.
- Continue CPR.
- Provide rhythm-appropriate cardiovascular pharmacology.

Differential Diagnosis:

- Identify the possible reasons for the arrest. Construct a differential diagnosis to identify reversible causes that have a specific therapy.

A. The Primary ABCD Survey

Preliminary First Actions

These are performed just before the "A" (Airway) of the primary ABCD survey.

- Assess responsiveness.
- "Call Fast."
- Appropriately position the victim.
- Appropriately position the rescuer.

Assess Responsiveness. "Man down—unconscious, unresponsive" is a familiar and riveting call in emergency care. Always assume that such people have cardiac arrest or respiratory arrest, or both, until proven otherwise. Establish unresponsiveness with the traditional "shake and shout": gently shake the person and shout, "Are you OK?" But for people with possible trauma the "shake" can aggravate traumatic injuries, and "touch and talk" is the better approach. These techniques distinguish the person who is asleep or who has a depressed sensorium from the person who is clinically comatose.

"Call Fast" for help. Once unresponsiveness is verified, the rescuer should immediately call for help. In the hospital or emergency department the rescuer should call out loudly for someone to help. Sometimes just step quickly to the doorway and shout, eg, "I need help at once in Room 3A!" The person who responds to this local call should be told to go activate the emergency response system. Inside a medical facility this call will go to the hospital paging operator or another designated operator. Outside the hospital the person who responds should be told to immediately call the local 911 system (activate EMS).

Personnel must always be filled with a great sense of urgency to get back to the patient to open the airway and verify that airway obstruction has not occurred. If and when someone arrives to help, send that person to activate the emergency response system, then return quickly to perform the A and B steps of CPR.

The AHA gives a high priority to a *call for help* once unresponsiveness is verified.[22] This approach underscores the principle that advanced care—in the form of electrical defibrillation, advanced airway management, and IV medications—must be brought to the patient as soon as possible. A rescuer should never forget that the prime chance for a successful resuscitation comes from decreasing the interval from the onset of the emergency to the restoration of an effective spontaneous circulation.

Special Case 1: the "Lone Rescuer"

What should the "lone rescuer" do when no one hears the local call for help? This question has stimulated much discussion in ECC. Do you begin full CPR with chest compressions, or do you leave the victim for the time it takes to activate emergency response personnel? A simple message—"Phone First"—has been adopted for the lone adult lay rescuer, but the professional trained rescuer can appreciate the subtleties involved and the need for judgment and individualized decision making. The AHA recommendations convey the need to provide a simple message to the lay rescuers.

The basic dilemma is whether the victim has experienced a respiratory arrest from an obstructed airway, a comatose state, a drug overdose, a postictal state, or any number of other causes of respiratory arrest. When rescuers suspect an obstructed airway, they should perform the AB sequence first. For example, the healthy adult who collapses in a restaurant while rushing to the bathroom should be evaluated first for an unobstructed airway.

Special Case 2: the "Lone Rescuer" With an Automated Defibrillator

An adult who is breathing normally may suddenly grasp his or her chest in severe pain and collapse in front of witnesses. Such a person is probably experiencing a lethal arrhythmia, such as VF. This person needs immediate defibrillation, and any delay in getting the defibrillator to this person will decrease the probability of successful return of spontaneous circulation. This includes, in particular, the delay involved in performing the traditional "1 minute of CPR" that has been recommended in the past for the "lone rescuer." For the lone rescuer with immediate access to a defibrillator, the recommended sequence is

- Assess responsiveness
- Call locally for help
- Open the airway **(A)**
- Confirm unobstructed airway with two breaths **(B)**
- Confirm pulselessness **(C)**
- Retrieve and operate the defibrillator **(D)**.

Note: This sequence omits the chest compressions.

Special Case 3: the "Lone Rescuer" With Remote Access to a Telephone

The other element for decision making is the time required to activate either the hospital's or the community's emergency response system. A delay of 1 to 2 minutes in CPR to activate the EMS system is acceptable for people with VF, assuming you return at once and begin the ABCs. If your jogging partner collapses on an isolated running trail, however, and there is a 15-minute run to the nearest telephone, you face some tough decisions. A 30-minute round trip on a deserted jogging trail to a telephone will leave the victim an intolerably long time without the benefits of CPR, yet CPR alone will be of little help if the adult, witnessed-collapse victim is in VF (80% to 90% probability in this scenario). Common sense would suggest that a trained health professional would ensure an open airway, provide several precordial thumps, and continue CPR for at least 10 to 15 minutes. The former recommendation to continue until the rescuer is exhausted is too severe since reasonably fit people can continue CPR well over 60 minutes before becoming exhausted.

Appropriately Position the Victim. If the cardiac arrest victim is not on a firm surface, roll the person over as one unit. If you suspect that trauma may have occurred in the collapse, maintain the head, neck, and trunk in a straight line to stabilize the cervical spine.

Do this by kneeling beside the person and placing one hand on the back of the head and neck. With the other hand roll the patient slowly toward you. Follow this method if there is any suspicion of cervical spine injury. Look for signs of bleeding around the head. Always think of associated trauma to the cervical spine when attempting CPR on people who fell from heights, who fell with great force when they collapsed, who had been diving head first, who were struck by lightning, or who were involved in a motor vehicle accident.

When two people are available to turn a prone victim over, the second person should be positioned at the head of the patient to maintain in-line head stabilization while the patient is turned. Do *not* apply firm traction on the head if you suspect a cervical spine injury. When the person is in bed, a firm support must be placed under the thoracic cage. Hospitals should maintain a plywood board for the purpose of CPR.

Appropriately Position the Rescuer. The most efficient position for a single rescuer is to kneel at the level of the victim's shoulders. In this position the single rescuer will not have to move his knees to move from the mouth to the chest of the victim.

THE PRIMARY ABCD SURVEY: Details of Performance

(A) Open the airway
(B) Assess breathlessness
(B) Ventilate the patient
(C) Confirm pulselessness
(C) Perform closed-chest compressions
(D) Defibrillate VF/VT

(A) Open the Airway. As a first step, the mouth should be opened and the upper airway inspected for foreign objects, vomitus, or blood. If present, these should be removed with the fingers covered with gauze or a piece of cloth or by turning the patient on the side, paying careful attention to the possibility of a cervical spine injury.

In addition to the head tilt—chin lift maneuver of basic CPR, all emergency personnel should learn the jaw-thrust technique of opening the airway. In the jaw thrust the rescuer stands or kneels at the head of the patient and grasps the mandible of the jaw with the fingertips while the hands are placed at the sides of the patient's face. The mandible is lifted forward. A position with the elbows on the stretcher or backboard is usually the most comfortable one for the rescuer. The jaw-thrust technique must be learned by all rescuers who may encounter patients with the combination of cervical spine injuries and respiratory compromise. It maintains a neutral position of the cervical spine while resuscitative attempts continue. This technique is used almost solely for trauma patients by out-of-hospital response teams.

(B) Assess Breathlessness. An assessment of the ability to move air is quickly made when the rescuer opens the airway with the head tilt—chin lift maneuver and then "looks, listens, and feels" for air movement. The look, listen, and feel technique is performed with the rescuer's head in a position with the ear placed almost touching the patient's mouth and the face turned toward the victim's chest. The rescuer "listens and feels" for breathing with his or her ear and simultaneously "looks" at the victim's chest for any respiratory movements. The rescuer may note that the victim has resumed breathing with the airway-opening maneuvers. Continued maintenance of an open airway may be the only rescue action required at this point.

When the rescuer confirms breathlessness by this basic CPR step, he or she enters the entire spectrum of airway management problems in cardiac arrest. The ACLS team leader will be responsible for all aspects of airway management throughout the resuscitative attempt. These topics are covered in more detail in chapter 2, "Adjuncts for Airway Control, Ventilation, and Oxygenation." Once breathlessness is confirmed, the rescuer must ask

- Is the absence of air movement due to an obstructed airway?
- What maneuver should I perform to check for an obstructed airway?
- If the airway is obstructed, what maneuver should I perform to clear it?
- If ventilations are needed, what ventilatory adjunct should I use?
- Are rate and volume of ventilations optimal?
- Are the ventilations effective?

(B) Ventilate the Patient. If immediately available, insert an oropharyngeal airway and begin ventilations with a pocket face mask. The professional emergency rescuer should always have some form of barrier ventilation device. Pocket face masks, preferably with a one-way valve, at a ratio of one mask per bed, should be ubiquitous in all patient care areas of a hospital. They can be placed in a wall-mounted holder at the head of the bed. They should be present on all code carts.

Provide two rescue ventilations over 2 to 4 seconds. Maintain proper head tilt to allow exhalation of the breath. Give adequate time (1 to 2 seconds per ventilation) to allow for exhalation. Ventilations with this slow inspiratory flow rate are recommended so that the esophageal opening pressure will not be exceeded and the chances of gastric distention, regurgitation, and aspiration are decreased.

At this point the rescuer must make several important observations. First, did the air of the first breath go in? Did the chest rise? Could the rescuer hear the sound of air escaping during passive exhalation? If air did not enter easily and the chest did not rise, then you must take steps to correct what may be an obstructed airway. In this situation the best first step is to repeat quickly the head tilt—chin lift maneuver and try again. If still unsuccessful, the person has, by definition, an obstructed airway, and you must then follow the protocols for the obstructed airway.

Remember that the next step, closed-chest compressions, will be completely ineffective if the patient cannot be successfully ventilated.

If experienced personnel are available, cricoid pressure should be applied continuously until definitive airway protection is achieved with endotracheal intubation. This effective but neglected technique uses the rigid cartilaginous tracheal rings to occlude the esophagus. When performed correctly it occludes the esophagus so that ventilations do not enter the stomach and produce gastric distention. It helps ensure that the ventilations enter the lungs. If gastric distention is avoided, the chances of regurgitation are decreased. If regurgitation does occur, cricoid pressure may prevent aspiration or airway obstruction. Airway management and ventilation techniques are discussed in detail in chapter 2.

(C) Confirm Pulselessness. Once breathlessness is established the rescuer should quickly check for a pulse at the carotid artery on the side closer to the rescuer. The pulse check should last for 5 to 10 seconds because the pulse may be present but difficult to detect if slow, irregular, weak, or rapid.

At this point the rescuer has confirmed a "full" cardiac arrest. Faced with a victim who is unconscious, unresponsive, breathless, and without a pulse, the rescuer must perform chest compressions and artificial ventilations at once. Activate the code team (if in a hospital) or the EMS system if outside the hospital. This may have occurred with the initial determination of unresponsiveness and local call for help.

(C) Perform Closed-Chest Compressions. The technique for chest compressions is discussed in the BLS texts. From the perspective of people learning ACLS, remember that it is your responsibility to check for the quality and effectiveness of chest compressions and ventilation throughout the resuscitative effort. ACLS personnel must be thoroughly familiar with basic CPR techniques, not only to supervise and monitor the performance of others but also to be ready for that inevitable day when the ACLS team leader arrives "first on the scene" of a cardiac arrest.

(D) Defibrillate VF and VT if Identified. The initial "call for help" or "phone fast" after assessing unresponsiveness should result in someone's arriving at the side of the cardiac arrest victim with a defibrillator. As soon as a defibrillator arrives, the rescuer should attach the device and "hunt for VF/VT."

Numerous clinical and epidemiological studies[5,23] have confirmed repeatedly two simple observations:

- Almost every adult (over 90% in most studies) who survives sudden nontraumatic cardiac arrest was resuscitated from VF.
- The success of defibrillation is remarkably time-dependent.

The probability of defibrillating someone back to a perfusing rhythm declines about 2% to 10% per minute, starting with an estimated probability of 70% to 80% survival at time zero. These depressing statistics mean that if you have not managed to shock a patient in VF within 10 minutes of the collapse, the probability of survival approaches zero.

Conceptually defibrillation no longer belongs solely to ACLS. The widespread availability of AEDs has rendered defibrillation an intermediate intervention between BLS and ACLS. Chapter 4 on defibrillation includes both conventional and automated external defibrillation and presents the rationale for early defibrillation.

Steps for Defibrillation Using Conventional (Manual) Defibrillators

1. Turn on defibrillator.
2. Select energy level at 200 J.
3. Set "lead select" switch on "Paddles" (or lead I, II, or III if monitor leads are used).
4. Position conductor pads on patient (or apply gel to paddles).
5. Position paddles on patient (sternum-apex).
6. Visually check the monitor display and assess the rhythm (subsequent steps assume VF/pulseless VT is present).
7. Announce to the team members, "Charging defibrillator—stand clear!"
8. Press "charge" button on apex paddle (right hand) on defibrillator controls.
9. When the defibrillator is fully charged, state firmly in a forceful voice the following chant (or some suitable equivalent) before each shock:
   - *"I am going to shock on three. One, I'm clear."* (Check and make sure you are clear of contact with the patient or the stretcher and equipment.)
   - *"Two, you're clear."* (Make a visual check to ensure that no one continues to touch the patient or stretcher. In particular, do not forget about the person doing ventilations. That person should not have hands on the ventilatory adjuncts, including the endotracheal tube!)
   - *"Three, everybody's clear."* (Check yourself one more time before pressing the shock buttons.)
10. Apply 25 lb pressure on both paddles.
11. Press the two "discharge" buttons simultaneously.
12. Check the monitor screen. If unquestionable VF/VT remains, recharge the defibrillator at once. Check a pulse if there is any question about the rhythm display (eg, a lead has been dislodged or the paddles are not displaying the correct signal).
13. Shock at 200 to 300 J, then at 360 J, repeating the same verbal statements noted above.

Steps for Defibrillation Using AEDs*

All AEDs operate using four basic steps:

1. *Power*: Turn power on.
2. *Attachment*: Attach to the patient.
3. *Analysis*: Place into "analyze" mode.
4. *Shock*: Press shock button.

1. *Power*: Turn power on.
2. *Attachment*:
   - Open adhesive defibrillator pads.
   - Attach defibrillator cables to the pads.
   - Expose adhesive surface.
   - Attach pads to the patient (upper right sternal border and cardiac apex).
3. *Analysis*:
   - Announce to the team members, "Analyzing rhythm—stand clear!" (Verify that there is no patient movement and that no one is in contact with the patient.)
   - Press the "analyze" control.
4. *Shock*: (If VF/VT is present, the device will charge to 200 to 360 J and signal that a shock is indicated.)
   - Announce, "Shock is indicated—stand clear!"
   - Verify that no one is touching the patient.
   - Press the "shock" button when signalled to do so.
5. Repeat these steps until VF/VT is no longer present. The device will signal "no shock indicated." In general, shock in sets of three without interposed CPR or pulse checks. After a set of three shocks, provide 1 minute of CPR and ventilations.

*Fully automated AEDs will require some variations in these steps.

B. The Secondary ABCD Survey

In the secondary ABCD survey the rescuers return to the ABCDs but at a more advanced level.

Airway

- Reassess the adequacy of the original airway-opening techniques.
- Direct personnel to secure the airway with further airway adjuncts, most definitively endotracheal intubation.

Breathing

- Assess status of ventilations after endotracheal intubation.
- Make necessary adjustments.
- Assess movement of the chest with ventilations.
- Examine for the presence of bilateral breath sounds.

Circulation

- Obtain IV access.
- Attach monitor leads.
- Identify rhythms and rates.
- Measure blood pressure (noninvasive blood pressure measurements).
- Provide rhythm-appropriate and vital-sign–appropriate medications.

> This rhythm-driven selection of medications has been the traditional emphasis in ACLS courses. Rescuers, however, must have a broader clinical perspective, and they can gain this perspective if they consider the full ABCD picture.

Differential Diagnosis

Consider the possible causes of the cardiac emergency and of the observed rhythms. This review provides help in refractory cardiac arrest or unstable postresuscitation conditions. This "D" of the secondary survey helps the team leaders refocus their thoughts and think in terms of "what caused or precipitated this arrest?" and "why have they not responded to our treatment?" Many patients will have responded to defibrillation. Patients in non–VF rhythms or those people who have not responded early present a more complicated challenge and require resuscitation teams to think of specific causes and possible corrective actions.

> The ABCD mnemonics for the secondary survey could have used "D" for drugs. As an aid to memory, however, we think cardiac medications (or "drugs") should be included under "C" for "circulation." "D" works better as a mental link to "differential diagnosis." Thinking about the "differential diagnosis" leads the resuscitation team to perform an important review of the causes of the original arrest and to review whether they should take other actions besides a narrow "rhythm-drug" response. The algorithms for asystole and PEA provide examples of the causes and cause-specific interventions that personnel must consider.

Additional Key Points to Remember About Defibrillation

1. As part of the primary survey and the ABCD approach you will deliver up to three "stacked" defibrillations (assuming persistent VF or VT). These three shocks are delivered consecutively, one after the other. You do not perform CPR between these shocks. You do not perform ventilations. You do not spend a long time feeling for a pulse after each shock. You do not take the paddles away from the chest if you are using defibrillators with conventional paddles.
2. You should recharge immediately after each shock. Push the charge control as soon as the first and second shock are delivered. Immediately look at the monitor screen (while recharging) to check for persistent VF.
3. If you see a non-VF rhythm, remove the paddles from the chest, disarm the defibrillator, and check for a pulse.
4. If you see persistent VF, keep the paddles on the chest and deliver the second (or third) shock.
5. Consider the "hunt for VF" one of your highest priorities during a resuscitative attempt. While the ABCs and CPR should not be neglected, there should always be a strong sense of urgency to attach the defibrillator and deliver the shock if the rhythm is VF.
6. A dead defibrillator means a dead patient. Learn about the proper care and maintenance of your defibrillators.
7. Never meet your defibrillator for the first time at a code! Learn about the location and controls of your defibrillator before you need to use it. Many code attempts go awry because personnel have not learned or do not remember the basic operational steps of a conventional defibrillator. Manufacturing standards have produced excellent devices with standardized controls and functions. Many locations, however, particularly code carts, have older devices that have been in place and seldom used for over 10 years! It is your obligation to learn to operate and maintain the defibrillators used in all locations where you have clinical responsibility.
8. Learn whether there are separate controls for the monitor and for the defibrillator. On most devices you can turn on the monitor independently of the defibrillator. If you then want to defibrillate the patient, you have to press separate "Power On" controls for the defibrillator portion. Most modern devices will automatically turn on the monitor screen if you press the defibrillator on first but not vice versa. Ask to see the defibrillator instruction manuals and the operator maintenance checksheets. Remember, this is *your* responsibility, not the responsibility of the engineering department or the manufacturer.
9. Learn how to attach the monitor cables correctly and without having to read the labels. Remember: "white goes to right, red goes to ribs, color left over goes to left shoulder."
10. Learn where the defibrillation gel or, even better, the adhesive defibrillation pads are kept.
11. Learn and always use the "clearing chant" to ensure safe defibrillation.

Note that remote defibrillation through adhesive patches and cable connections are available for many conventional defibrillators and all AEDs. Clinical experiences suggest that remote defibrillation is much safer for the operator, though you must still use the clearing chant.

Reasons for the Secondary Survey

At the simplistic level, the secondary ABCD survey translates into "tube 'em, start an IV, then try to remember which drug goes with which rhythm." Concentration on the ABCD paradigm, however, will help emergency personnel remember to always look at the whole patient and at what is going on with the entire resuscitative attempt.

Note that the assessments and actions of the secondary survey should be performed almost simultaneously. The roles of the team members should be defined *before* cardiac arrests occur. With proper planning the code leader should not even have to direct people to secure the airway with endotracheal intubation and to gain IV access through a large-gauge antecubital vein.

A problem may arise if personnel who can perform these advanced tasks are not available. In this case the team leader must step forward to perform the most essential next step. While airway and breathing always remain the highest priority, it may not be necessary to rush toward endotracheal intubation if the noninvasive ventilatory adjuncts (oropharyngeal airway, bag-valve mask, or the pocket face mask) appear to provide adequate oxygenation and ventilation or if regurgitation does not appear imminent (eg, absence of severe gastric distention). The AHA now recommends endotracheal intubation before gaining IV access. Stated unambiguously: *airway control and ventilation support is more important than medications.* Definitive scientific evidence to support the value of IV medications in full cardiac arrest is lacking. However, common sense should prevail: it is acceptable to gain IV access before endotracheal intubation *if* ventilation, oxygenation, and airway protection appear satisfactory.

THE SECONDARY ABCD SURVEY: Details of Performance

Airway

- Verify that someone is preparing to perform endotracheal intubation (getting out a tube of proper size, checking the laryngoscope, preparing a suction method). Endotracheal intubation provides definitive airway management—there is no equivalent substitute. Rescuers can delay endotracheal intubation for other interventions, however, if noninvasive ventilation techniques appear temporarily adequate.
- Insert a nasal trumpet or nasopharyngeal airway if not already done.
- Continuous cricoid pressure may be all that is needed to prevent regurgitation into the hypopharynx and aspiration of gastric contents.
- Check that a suction device (electrically powered, or hand or foot powered) is available, operating properly, and ready to be used.

Breathing

- Check that ventilations with the pocket face mask, the bag-valve mask, and through the endotracheal tube or other device are causing the chest to rise.

- Check that the patient has bilateral breath sounds by listening at the midaxillary line on each side.
- Auscultate over the epigastrium.
- Order a stat portable chest x-ray after the intubation. This will confirm tube placement (which you should have already confirmed clinically and by one other method) and provide information on pulmonary conditions.
- Confirm endotracheal tube placement by some means in addition to bilateral breath sounds. These techniques include end-tidal CO_2 indicators and measurements, endotracheal tube aspiration,[24] and chest radiograph.
- If there is any doubt about correct tube placement, use direct visualization with a laryngoscope. Consider removing the tube and starting over.

Circulation

- The antecubital vein should be the first target for IV access.
- Normal saline rather than D_5W is now recommended as the IV fluid vehicle. Normal saline expands the intravascular volume better than dextrose; the theoretic problem of pushing people into pulmonary edema has not turned out to be a frequent problem. Some studies have observed an association between high postresuscitation glucose level and poor neurological outcomes.[25,26] In addition, normal saline has longer shelf life and is less expensive. Control administered volume with smaller size bags and volumetric units.
- Remember that rescuers can administer the following medications down the endotracheal tube: A-L-E (atropine, lidocaine, epinephrine).
- The recommended technique for endotracheal drug administration is
  - — Thread a long (35-cm) through-the-needle intracatheter rapidly down the inside of the endotracheal tube.
  - — Stop CPR chest compressions.
  - — Inject 2 to 2.5 times the normal dose of medication through the catheter.
  - — Follow with 10 mL normal saline flush down the catheter.
  - — Immediately attach the ventilation bag and forcefully ventilate 3 or 4 times. If an intracatheter is unavailable, it is possible to use a heparin lock with 20-gauge needle through the wall of the endotracheal tube to deliver and aerosolize medications during ventilations.[27]
- Be prepared to administer a 20- to 30-mL bolus of IV fluid and elevate the arm after each IV medication. This will enhance delivery of medications to the central circulation.

Differential Diagnosis

- The critical question that must be asked and answered is, what caused the arrest?
- The purpose of a differential diagnosis is to identify reversible causes—causes that have a specific therapy.
- Examine the rhythm. What is the rhythm? What could cause *this* rhythm? Each rhythm of arrest has many possible causes: VF/VT, asystole, PEA, severely symptomatic bradycardias, or tachycardias.
- The only possibility of successfully resuscitating a person may lie in searching for, finding, and treating reversible causes.
- Follow this same process for patients with *refractory cardiac arrests* that do not respond to the initial interventions. For example, transient postshock conversion rhythms in VF/VT may reveal an underlying bradycardia, in which case atropine can be added; or there may be a transient tachycardia, in which case a rapid-acting β blocker can be used.
- Follow this same process in the periarrest period for any severe cardiorespiratory emergency.

The Universal Algorithm for Adult ECC

The Algorithm Approach to Emergency Cardiac Care

For some years the AHA has used treatment algorithms as an educational tool. Table 1, "The Algorithm Approach to Emergency Cardiac Care," presents an overview of the algorithms and summarizes important points about their use.

Classification of Therapeutic Interventions in CPR and ECC

The 1992 National Conference on CPR and ECC used the following system of classifying interventions, based on the strength of the supporting scientific evidence.

Class I. — A therapeutic option that is usually indicated, always acceptable, and considered useful and effective.

Class II. — A therapeutic option that is acceptable, is of uncertain efficacy, may be controversial.

Class IIa. — A therapeutic option for which the weight of evidence is in favor of its usefulness and efficacy.

Class IIb. — A therapeutic option that is not well established by evidence but may be helpful and probably not harmful.

Class III. — A therapeutic option that is inappropriate, is without scientific supporting data, and may be harmful.