# Cardiopulmonary Resuscitation and Advanced Cardiac Life Support: Common Errors and Current Techniques

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Competence in the techniques of Advanced Cardiac Life Support is essential for physicians who are in frequent contact with patients at high risk for cardiac arrest. The methods utilized are complex and rapidly changing. However, a consistent pattern of errors in fundamental concepts or methods emerges. These can be characterized as (1) errors in the general management of patients, (2) errors in basic cardiopulmonary resuscitation (CPR) techniques, (3) mistakes in the use or omission of appropriate drugs, (4) errors in the associated necessary techniques which require some technical skills, and (5) errors in management of the patient subsequent to the cardiac arrest. Attention to these details may increase success in management of patients with cardiac arrest.

An extensive and extremely well-developed training program in cardiopulmonary resuscitation (CPR) for the public has been very well received. The program is effective in teaching fundamental resuscitation techniques to large numbers of paramedical or non-medically trained individuals.[1,2] The skills, once mastered, need regular review to maintain a satisfactory level of competence. This training is directed primarily toward out-of-hospital cardiac arrest and resuscitation. It follows a simple standard decision tree (Figure 1) and ends when the patient enters into a system of advanced cardiac life support (ACLS), the hospital emergency room, or the intensive care unit.

In marked contradistinction to the basic cardiopulmonary resuscitation, the training of physicians and nurses regularly involved in advanced cardiac life support is excellent but is frequently informal and unstructured, often neglected, and highly variable. There are very few physicians who have been adequately trained in the complexities of advanced cardiac life support, and fewer still who retain this competence without regular exposure to patients in need of advanced life support. Competence requires mastering the subtle aspects of (a) complex electrocardiography, (b) cardiac pharmacology, (c) team management, (d) technical procedures including the insertion of venous cutdowns, pulmonary artery balloon catheters, and temporary pacemakers, and (e) electrical cardioversion and defibrillation.

Despite the wide variation in training and experience of physicians and nurses, it is apparent that the same errors, the same misconceptions, and the same inadequacies occur during advanced cardiac life support with surprising regularity at all levels of training and experience. During the observation of over 500 in-hospital resuscitation efforts, the most common mistakes and the inadequacies which are most flagrant or potentially most serious were identified. This paper outlines currently rec-

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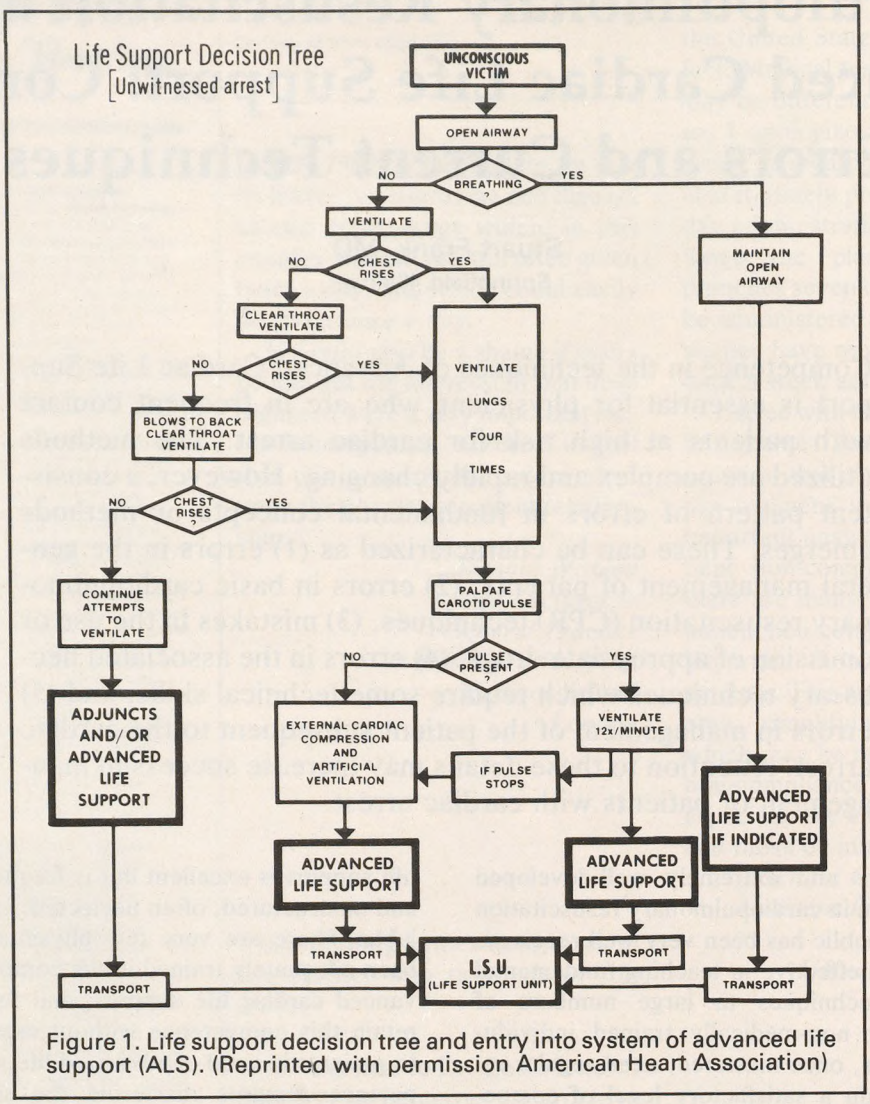


Figure 1. Life support decision tree and entry into system of advanced life support (ALS). (Reprinted with permission American Heart Association)

ommended principles for management of cardiac arrest; these principles are derived from common errors of omission or commission.

## General Management

*Someone must take charge,* to assign, coordinate, and oversee; to avoid omissions and duplication of effort; and to ensure that everything is done in a reasonably coordinated and proper sequence. This will often, but not necessarily, be the patient's personal physician but he may not be early on the scene and the coordinator should be the senior or most experienced individual present. The responsibility can and should be assumed by anyone competent if he is there first or when no one else has assumed control.

*Someone must review the patient's history* or consult with the patient's family relatively early and continue communications as frequently as possible. This should ideally, but not necessarily, be the patient's personal physician. Sometimes the decision not to resuscitate is obvious, but often it is not, and occasionally aggressive efforts are mandated despite apparent contraindications.[3]

*Clear the room* of unnecessary furniture, additional patients, and curious spectators. A successful resuscitation often demands quick action, and rapid access to complex bulky equipment. Working with curtains drawn around a bed to ensure

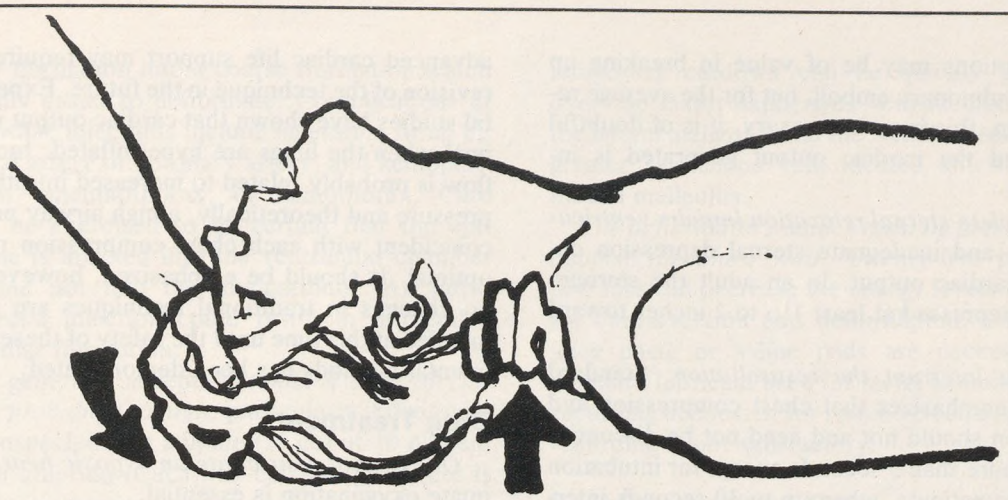

Figure 2. Hyperextension of neck to obtain open airway. (Reprinted with permission American Heart Association)

privacy is futile. It is often easier to move other beds and patients out.

*Someone must decide when to discontinue reasonable resuscitation efforts.* This decision should be made in consultation with the patient's personal physician and with the patient's family if they are immediately available. Currently accepted guidelines state, "The decision to terminate advanced cardiac life support based on the findings of cardiovascular unresponsiveness is equivalent to defining that the heart has died, and there is no purpose to be served in evaluating the status of the brain."[2] The use of large doses of barbiturates to minimize central nervous system damage and cerebral edema is still experimental and is not routinely recommended at this time.[4]

## CPR Techniques

*Do not forget to hyperextend the neck* (Figure 2). Resuscitation of a patient with his head comfortably on a pillow is doomed to failure. The tongue drops back to occlude the airway and adequate oxygenation is impossible.

*Do not forget the precordial thump.*[2,5] A sharp vigorous blow to the chest delivers about 5 or 10 watt seconds of energy which may be enough to convert ventricular tachycardia or ventricular fibrillation to sinus rhythm. Current recommendations indicate that the precordial thump should be used for "monitored arrest" only, since it has been shown to produce ventricular fibrillation or asystole on rare occasions.

*Do not massage the mattress.* If the crash cart does not have a bed board, almost anything flat and rigid will do. Cardiac massage without rigid support under the patient delivers most of the energy to the mattress and springs. Moving the patient carefully onto the floor is an alternative but is rarely necessary and makes it difficult to perform some procedures such as intubation.

*The hands and body must be in the proper position.* Fracture of the xiphoid, and hepatic laceration may result if massage is too low on the sternum, but more important is the resulting inefficient massage with incomplete compression of the ventricles. Do not press the fingers into the ribs or costochondral junctions during cardiac massage. The fingers should be hyperextended with the pressure delivered with the heel of both hands. The resuscitater should be properly positioned with his shoulders directly over the sternum, his elbows straight, and his knees at the level of the mid chest. Proper cardiac massage is difficult to perform optimally standing next to the bed, although it is sometimes necessary. The ideal position may sometimes require getting one's knees wet and dirty. Improper position promotes early and excessive fatigue and vastly diminishes efficiency.

*The cardiac massage must be smooth and rhythmic* with a goal of 50:50 downstroke: upstroke ratio.[2,6,7] Avoid short unsustained "jabs" which may eject small spurts of blood, and may generate a peripheral pulse but results in minimal blood flow. Some experts feel that these spas-

modic motions may be of value in breaking up massive pulmonary emboli, but for the average resuscitation, this is not necessary, it is of doubtful value, and the cardiac output generated is inadequate.

*Incomplete sternal relaxation impairs ventricular filling* and inadequate sternal depression decreases cardiac output. In an adult the sternum must be depressed at least 1 1/2 to 2 inches toward the spine.

*Do not interrupt the resuscitation.* Standard teaching emphasizes that chest compression and respiration should not and need not be discontinued for more than 5 seconds except for intubation or moving patients, when up to 30 seconds interruption is permitted. Practical considerations sometimes mandate otherwise.

A. It is often necessary to stop cardiac massage for a brief interval to eliminate artifact in the electrocardiogram and determine what intrinsic rhythm is present. These periods of asystole should be kept to a minimum. During this and all other necessary interruptions, it probably is wise to hyperoxygenate the patient just prior to temporary interruption of cardiac massage.

B. It is sometimes necessary to interrupt cardiac massage briefly to insert an endotracheal tube. If this is necessary, it is best to have all equipment ready and checked, and personnel properly positioned prior to discontinuation of massage, so as to facilitate the intubation and permit as brief a period of asystole as possible.

C. Although intracardiac injections are rarely necessary, an injection usually can not be performed safely unless cardiac massage is temporarily discontinued.

D. Current teaching and experience has demonstrated that cardiac massage can be successfully continued while moving a patient. Practical experience has indicated that massage sometimes must be briefly discontinued when moving a patient up or down stairs or through a narrow passageway. In some instances it may be wiser not to move the patient if this will require interrupting the resuscitation efforts.

E. It is not necessary to interrupt the cardiac massage to change personnel.

*The chest inflations should be synchronized with the cardiac massage.* The early part of inflation is best timed with sternal relaxation. This aspect of both cardiopulmonary resuscitation and advanced cardiac life support may require some revision of the technique in the future. Experimental studies have shown that cardiac output is maximal when the lungs are hyperinflated. Increased flow is probably related to increased intrathoracic pressure and theoretically, a high airway pressure coincident with each chest compression may be optimal. It should be emphasized, however, that no changes in traditional techniques are recommended at this time until the safety of these experimental methods has been demonstrated.

## Drug Treatment

*One cannot resuscitate an hypoxic heart.* Adequate oxygenation is essential.

*One cannot resuscitate an acidotic heart.*[8] Administration of bicarbonate and frequent evaluation of arterial blood gases is necessary.

Although *prophylactic use of lidocaine* after a myocardial infarction is controversial, most experienced cardiologists would agree that lidocaine 100-200 mg intravenously should be given early during the resuscitation in a patient in ventricular tachycardia or fibrillation or a patient who has been electrically converted from these ventricular arrhythmias. Lidocaine may be hazardous in an infrequent patient whose arrest may be the result of asystole or associated with an idioventricular or junctional rhythm which might be abolished by this drug.

If an *adequate intravenous route* is not immediately available, rapid administration of lidocaine, epinephrine, or atropine can sometimes be accomplished by injection directly into the trachea via an endotracheal tube. Drugs should be administrated in a volume of at least 5 cc to enhance pulmonary distribution and uptake. The epinephrine dose is 1 mg (10 cc of 1:10,000 solution), the lidocaine dose is approximately 100 mg (5 cc of 20 mg/cc) and atropine should be given as 1 mg diluted to 10 cc.[9,10]

*Alkalosis is just as hazardous and detrimental as acidosis.*[11] It depresses the sensorium, promotes hypokalemia, and facilitates ectopic beats. Aggressive sodium bicarbonate administration results in an excessive sodium and volume load, both of which are undesirable in a marginally compensated patient.

*Intracardiac injections are seldom necessary* except perhaps to administer epinephrine for persistent asystole. Epinephrine can convert fine ven-

tricular fibrillation into a coarse fibrillation which is usually easier to defibrillate. Complications of intracardiac injections include laceration of an intercostal artery or coronary artery, and hemopericardium, pneumothorax, or hemothorax. Care should be exercised to be certain that the epinephrine is injected into the ventricular chamber itself and not into the myocardium. An intramyocardial injection could result in intractable ventricular fibrillation.

The generally accepted *standard dose of calcium is probably too high,* particularly if digitoxicity is suspected. An ampule (10 cc) of 10 percent calcium chloride ($CaCl_2$) or calcium gluconate is more than necessary and 5 cc is usually adequate.

## Associated Techniques

*Do not waste time with sterile techniques or unnecessary concern about hemostasis.*

*Do not ignore increasing gastric dilatation.* A distended stomach can significantly impair ventricular filling by elevating the diaphragm. Early insertion of a nasogastric tube can rapidly relieve already existing distention but a cuffed endotracheal tube should be inserted first to protect the airway. The use of an esophageal obturator airway[12,13] or an endotracheal tube can effectively prevent gastric distention. Recent experimental studies have shown that increased intra-abdominal pressure, which may be achieved with a tight abdominal binder, may increase cardiac output substantially.

*Do not spent too much time and effort inserting an endotracheal tube,* particularly if experienced personnel are not immediately available. Adequate oxygenation is often obtained using a mask properly positioned and supported. An esophageal obturator airway is easier to use and provides excellent oxygenation while decreasing the risks of vomiting and aspiration.[12,13]

It is generally wise to *avoid early insertion of an intravenous line into the subclavian or external jugular veins,* unless the operator is highly skilled and experienced. These routes, although ultimately satisfactory, may require unnecessary interruption of cardiac massage, are more likely to induce complications because of the trauma associated with the resuscitative efforts, and once inserted are often inaccessible or "in the way." Intravenous cutdowns in the arm are inconvenient or difficult because of the cardiac massage. An ideal temporary cutdown can be quickly performed over the lesser saphenous vein located between the lateral malleolus and the Achilles tendon or the greater saphenous vein located anterior to the medial malleolus.

*The defibrillator paddles must be pressed firmly against the chest wall.* Twenty-five pounds of pressure can decrease the energy levels necessary for cardioversion and defibrillation. Low resistance paste or saline pads are necessary. The standard lubricant used for rectal examination, for recording echoes, or for routine electrocardiogram recording is not satisfactory.

## Post-Resuscitation Care

After a successful resuscitation, do not forget:

To *order appropriate studies* to determine the etiology of the arrest.

To *order appropriate continuing medications.*

To *deal with post-resuscitation complications.*

In the excitement and enthusiasm after a successful resuscitation, the resuscitating team may neglect their responsibility to provide for continuing care until the primary physician responsible for the patient's care can be informed and can assume responsibility.

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