This overview is a summary of the Guidelines for CPR and ECC and is not meant to replace the textbooks or other supplemental material. It is meant to be used as a study adjunct

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Basic Cardiac Life Support

Advanced Cardiac Life Support

Yes, the American Heart Association is changing everything again! New information, new books, new classes and new tests! How can everything keep changing?? The answer is simple: SCIENCE! If it wasn’t for changes you and I would still be riding donkeys to and from work because training a horse just isn’t possible. Without change progress is stagnant at best.

The 2010 Guidelines are evidence based and involved 356 resuscitation experts from 29 countries over 3 years of scientific review. They produced 411 scientific evidence reviews on 277 topics in resuscitation and Emergency Cardiac Care. If medicine is to continue to succeed and grow, we must let go of the comfortable hand rail and take a step forward.

In 1960 14 patients survived cardiac arrest following closed chest cardiac massage. That same year the Maryland Medical Society in Ocean City, MD introduced the combination of rescue breaths and chest compressions. In 1962, direct-current, monophasic waveform defibrillation was described.

The goal of resuscitation is an outcome beyond return of spontaneous circulation (ROSC). Return to a prior quality of life and functional state of health is the ultimate goal of a resuscitation system of care. Return to quality of life is dependent upon high quality CPR.

Emergency Medical Systems

There is evidence of considerable differences in rates of survival and outcome with cardiac arrest within the United States. Studies have demonstrated improved outcome from out of hospital cardiac arrest, particularly from shockable rhythms, and have reaffirmed the importance of a stronger emphasis on compressions of adequate rate and depth, allowing complete chest recoil, minimizing interruptions and avoiding excessive ventilation.

Lay Person Response

Studies show an undoubtedly positive impact of bystander CPR on survival after out of hospital cardiac arrest. For most adults with out of hospital cardiac arrest, bystander CPR with chest compressions only (Hands Only CPR) have similar outcomes to conventional CPR.

For children, conventional CPR is superior to hands only because of children’s dependency on airway and the fact that many cardiac arrests in children are caused by airway or ventilation issues.

Minimizing the amount of time between the end of compressions and defibrillation improves the outcome of the shock. Compressions should be continued until just before the shock is delivered.

Devices and Drugs

There is insufficient data to demonstrate that any drugs or mechanical CPR devices improve long term outcome after cardiac arrest.
Post Resuscitation

Optimizing hemodynamic, neurologic and metabolic function may improve survival to hospital discharge among patients who have ROSC. Therapeutic hypothermia is one intervention that has shown to improve outcome for comatose adult victims of witnessed out of hospital cardiac arrest when the presenting rhythm was ventricular fibrillation.

Educational Recommendations

More frequent renewal of skills is needed. Retraining should not be limited to two year intervals. Commitment to maintenance of certification similar to that embraced by many healthcare credentialing organizations.

Ethics

*2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: Laurie J. Morrison, Chair; Gerald Kierzek; Douglas S. Diekema; Michael R. Sayre; Scott M. Silvers; Ahamed H. Idris; Mary E. Mancini

The goals of resuscitation are to preserve life, restore health, relieve suffering, limit disability, and respect the individual’s decisions, rights, and privacy. Decisions about CPR efforts are often made in seconds by rescuers who may not know the victim of cardiac arrest or whether an advance directive exists.

Respect for Autonomy

The principle of respect for autonomy is an important social value in medical ethics and law. The principle is based on society’s respect for a competent individual’s ability to make decisions about his or her own healthcare. Informed consent requires a three step process:

1) The patient receives and understands accurate information about his or her condition, prognosis, the nature of any proposed interventions, alternatives, and risks and benefits.
2) The patient is asked to paraphrase the information to give the provider the opportunity to assess his or her understanding and to correct any misimpressions
3) The patient deliberates and chooses among alternatives and justifies his or her decision.

When the individual’s preferences are unknown or uncertain, emergency conditions should be treated until further information is available.

Advanced Directives, Living Wills and Patient Self-Determination

- More than ¼ of elderly patients require surrogate decision making at the end of life.
- Advanced directives ensure that when the patient is unable, the preferences that the individual established in advance can guide care
- These decisions are associated with less aggressive medical care near death, earlier hospice referrals for palliation, better quality of life, and caregiver’s bereavement adjustment

Healthcare Directive – legally binding document that is based on the Patient Self Determination Act. Advanced directives can be verbal or written and may be based on conversations, written directives, living wills, or durable power of attorney for healthcare.
Living Will may be referred to as a “medical directive” or directive to physicians. It provides written direction to healthcare providers about the care that the individual approves should he or she become terminally ill and be unable to make decisions. A living will constitutes evidence of the individual’s wishes, and in most areas it can be legally enforced.

Durable Power of Attorney – legal document that appoints an authorized person to make healthcare decisions (not limited to end of life decisions). A durable power of attorney accounts for unforeseen circumstances.

Comprehensive Healthcare Advance Directive – combines the living will and the durable power of attorney for healthcare into one legally binding document.

Do Not Attempt Resuscitation is an order given by a licensed physician or alternative authority as per local regulation, and it must be signed and dated to be valid. Allow Nature Death (AND) is becoming a preferred term to replace DNAR, to emphasize that the order is to allow natural consequences of a disease or injury, and to emphasize ongoing end of life care.

Principle of Futility

Patients or families may ask for care that is highly unlikely to improve health outcomes. Providers are not obliged to provide such care when there is scientific and social consensus that the treatment is ineffective. If the purpose of a medical treatment cannot be achieved, the treatment can be considered futile.

Withholding resuscitation and the discontinuation of life sustaining treatment during or after resuscitation are ethically equivalent. In situations when prognosis is uncertain, a trial of treatment may be initiated while further information is gathered to help determine the likelihood of survival, the patient’s preferences, and the expected clinical course.

Withholding and Withdrawing CPR in Out of Hospital Cardiac Arrest (OHCA)

All trained rescuers should immediately begin CPR without seeking consent, because delay in care dramatically decreases the chances of survival. Withholding CPR may be appropriate in a few situations.

- Attempts to perform CPR would place the rescuer at risk of serious injury or mortal peril
- Obvious clinical signs of irreversible death
- A valid, signed, and dated advanced directive indicating that resuscitation is not desired, or a valid, signed and dated DNAR order

OHCA DNAR Orders

The ideal Out of Hospital DNAR order is portable and can be carried on the person. Delayed or token efforts such as so-called “slow codes” (knowingly providing ineffective resuscitation efforts) are inappropriate. It compromises the ethical integrity of healthcare providers, uses deception to create a false impression, and may undermine the provider patient relationship. The practice of pseudo resuscitation was self reported by paramedics to occur in 27% of cardiac arrest.

Termination of BLS Efforts

1. Arrest was not witnessed by EMS provider or first responder
2. No return of spontaneous circulation after 3 rounds of AED analysis
3. No AED shocks were delivered
The BLS termination of efforts can reduce the transport of cardiac arrest to 37% without compromising the care of potentially viable patients. The rule should be applied BEFORE moving to the ambulance for transport.

Implementation of the rule includes real time contacting of medical control when the rule suggests termination.

ALS Out of Hospital System

Resuscitation efforts could be terminated in patients who do not respond to 20 minutes of ALS care. All of the following criteria should be met.

1. Arrest was not witnessed
2. No bystander CPR provided
3. No ROSC after full ALS care in the field
4. No AED shocks delivered

*Field termination reduces unnecessary transport to the hospital by 60% with the BLS rule and 40% with the ACLS rule reducing associated road hazards that put the provider, the patient and public at risk.

Criteria for Not Starting CPR

- Few criteria predict futility of resuscitation
- All should have resuscitation attempted unless obvious signs of death
- Valid DNAR order in place

CPR is initiated without a physician order based on implied consent. A licensed physician’s order is necessary to withhold CPR in the hospital setting. Studies have shown that terminally ill patients fear abandonment and pain more than death. DNAR orders carry no implications about other forms of treatment and other aspects of the treatment plan should be documented and followed. DNAR should outline the type of treatment that is acceptable, for example, will accept vasopressors or antibiotics but will not accept intubation or CPR. A DNR order must be reviewed before surgery by the anesthesiologist, attending surgeon and patient or surrogate to determine their applicability in the operating suite and during the immediate post op recovery period. Normally a DNAR order is not valid within an operating suite or procedural area such as a catheterization laboratory.

Termination of Resuscitation Efforts in In Hospital Cardiac Arrest (IHCA)

Noninitiation of resuscitation and discontinuation of life sustaining treatment during or after resuscitation are ethically equivalent, and clinicians should not hesitate to withdraw support when functional survival is highly unlikely. The responsible clinician should stop the resuscitative attempt if there is a high degree of certainty that the patient will not respond to further advanced life support.
Advanced Cardiac Life Support Guidelines Overview

CPR OVERVIEW

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Andrew H. Travers, Co-Chair; Thomas D. Rea, Co-Chair; Bentley J. Bobrow; Dana P. Edelson; Robert A. Berg; Michael R. Sayre; Marc D. Berg; Leon Chameides; Robert E. O’Connor; Robert A. Swor

350,000 people/year (half of them in hospital) experience cardiac arrest and receive attempted resuscitation. This does not include those who experience cardiac arrest, but do not received attempted resuscitation. Twenty five percent of out of hospital cardiac arrest present with a Pulseless ventricular arrhythmia. Victims who present with Ventricular Fibrillation (VF) or Pulseless Ventricular Tachycardia (VT) have a substantially better outcome compared with those who present with Asystole or PEA.

Emergency systems that can effectively implement the chain of survival can achieve witnessed VF cardiac arrest survival rates of almost 50%.

1. Immediate Recognition and Activation of the EMS System
2. Early CPR with emphasis on chest compressions
3. Rapid Defibrillation
4. Effective Advanced Life Support
5. Integrated Post Cardiac Arrest Care

Rescuer and victim characteristics may influence the optimal CPR delivery:

Rescuer – application of CPR will depend on the rescuer’s training, experience and confidence. All rescuers should provide chest compressions to all cardiac arrest victims.

- Initial intervention for all victims should be chest compressions for victims of all ages.
- Rescuers who are able to add ventilations to chest compressions, should.
- Highly trained rescuers should work together to perform compressions and ventilations simultaneously without interruption.
Victim

- Most arrests in adults are sudden, resulting from a primarily cardiac cause, circulation from compressions is paramount.
- Arrest in children is most often asphyxia, which requires both ventilations and chest compressions for optimal results.
- Therefore rescue breathing may be more important for children than for adults in cardiac arrest.
RECOGNITION AND ACTIVATION OF EMERGENCY RESPONSE

- Agonal gasps are common early after sudden cardiac arrest
- Can be confused with normal breathing
- Pulse detection is unreliable, even when performed by trained rescuers
- CPR should be started immediately if adult victim is unresponsive and not breathing normally
- Look, Listen and feel to aid recognition is not longer recommended

CHEST COMPRESSIONS

- Adequate rate – at least 100/min
- Adequate depth
  - Adults: at least 2 inches
  - Infants and Children: at least 1/3 anterior-posterior diameter of the chest
- Allow complete chest recoil after each compression
- Minimizing interruptions in compressions
- Avoiding excessive ventilation
- If multiple rescuers – rotate tasks every 2 minutes.

AIRWAY AND VENTILATION

- Opening the airway and providing ventilation can be challenging and require interruptions of chest compressions for the lone untrained rescuer
- The untrained rescuer should perform Hand Only CPR (compressions only)
- If the lone rescuer is able he/she should open the airway and give rescue breaths with chest compressions
- Once an advanced airway is in place the healthcare provider will delivery ventilations at a rate of one breathe every 6-8 seconds and chest compressions can be delivered without interruption.

DEFIBRILLATION

- Chance of survival decreases with increased interval between arrest and defibrillation
- Defibrillation remains the cornerstone therapy for VF and VT.
- Community and hospitals should aggressively work to decrease interval between arrest and defibrillation
- One determinant of successful defibrillation is effectiveness of chest compressions.
- Improved outcome with shorter time between stopping of compressions and shock delivery

Quality Assurance consists of three parts;
1. Systematic evaluation of resuscitation care and outcome
2. Benchmarking with stakeholder feedback and
3. Strategic efforts to address identified deficiencies
Adult Basic Life Support
2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Robert A. Berg, Chair; Robin Hemphill; Benjamin S. Abella; Tom P. Aufderheide; Diane M. Cave; Mary Fran Hazinski; E. Brooke Lerner; Thomas D. Rea; Michael R. Sayre; Robert A. Swor
Key Changes and Emphasis Include:

- Immediate recognition of Sudden Cardiac Arrest (SCA) based on assessing unresponsiveness and absence of normal breathing
- Look, Listen and Feel removed from the BLS algorithm
- Encouraging Hands Only CPR for the untrained lay-rescuer
- Sequence change to chest compressions before rescue breaths (CAB rather than ABC)
- Healthcare providers continue effective chest compressions until return of spontaneous circulation or termination of resuscitative efforts
- Increased focus on methods to ensure that high-quality CPR is performed. Compressions of adequate rate and depth, allowing full chest recoil between compressions, minimizing interruptions in chest compressions and avoiding excessive ventilation.
- Continued de-emphasis on pulse check for healthcare providers
- A simplified adult BLS algorithm is introduced with the revised traditional algorithm
- Recommendation for simultaneous, coreographed approach for chest compressions, airway management, rescue breathing, rhythm detection and shocks by an integrated team of highly trained rescuers in appropriate settings.

IMMEDIATE RECOGNITION

- Survival rates following cardiac arrest due to VF vary from approximately 5% to 50% in both out of hospital and in hospital settings. This variation in outcome underscores the opportunity for improvement in many settings.
- Once layperson recognizes that the victim is unresponsive, the bystander must immeditely activate (or send someone) the EMS system. After activation, rescuers should immediately begin CPR.
- Early CPR can improve the likelihood of survival and yet CPR is often not provided until the arrival of professional rescuers
- Chest compressions should have the highest priority
- “Push hard and Push fast” emphasizes some of the critical components of chest compressions
- High quality CPR is important not only at onset but throughout resuscitation
- Defibrillation and advanced care should be interfaced in a way that minimizes any interruption of CPR

ACTIVATING THE EMERGENCY RESPONSE SYSTEM

- Dispatcher CPR instructions substantially increase the likelihood of bystander CPR performance and improve survival from cardiac arrest, all dispatchers should be appropriately trained to provide telephone CPR instructions
- Bystanders often misinterpret agonal gasps or abnormal breathing as normal breathing. This information can result in failure by 911 dispatchers to instruct bystanders to begin CPR Dispatchers should inquir about a victim’s absence of consciousness and quality of breathing (not presence of breathing)
- Generalized seizures may be the first manifestation of cardiac arrest. Dispatchers should recommend compressions for unresponsive patients who are not breathing normally because most are in cardiac arrest and serious injury from chest compressions in the nonarrest group is very low.
- Because it is easier for rescuers receiving telephone instructions to perform Hands Only CPR, dispatchers should instruct untrained rescuers in this method unless it is an adult or pediatric patient with a high likelihood of asphyxial cause of arrest (drowning, choking, etc)
PULSE CHECK
- The lay rescuer should not check for a pulse and should assume arrest is present if patient is unresponsive and not breathing normally
- The healthcare provider should not take more than 10 seconds to assess a pulse and if one is not DEFINATELY felt within that time period, start chest compressions

CHEST COMPRESSIONS
- Forceful rhythmic application of pressure over the lower half of the sternum which create blood flow by increasing intrathoracic pressure and directly compressing the heart.
- Effective chest compressions are essential for providing blood flow during CPR.
- Rate of AT LEAST 100 per minute (This is not the number of compressions in a minute, but the speed at which they are delivered)
- At least a depth of 2 inches
- Allow the chest to completely recoil after each compression so that heart can fill and the coronary arteries can be fed.
- Minimize the frequency and duration of interruptions of compressions for any reason.

RESCUE BREATHS
- Initiate compressions prior to ventilations
- Chest compressions can be started immediately and positioning of the head, achieving a seal and getting a bag mask apparatus for rescue breathin all take time.
- Beginning CPR with 30 compressions (CAB)
- Deliver each breath over 1 second
- Give a sufficient tidal volume to produce visible chest rise
- Use a compression to ventilation ratio of 30 chest compressions to 2 ventilations

EARLY DEFIBRILLATION
- After activating the Emergency Response System, the lone rescuer should retrieve an AED, return to the victim to attach and use the AED
- Turn the AED on
- Follow the AED prompts
- Resume chest compressions immediately after the shock

UNTRAINED RESCUER
- Bystander should provide Hands Only CPR with emphasis on push hard, push fast or follow the instructions of the dispatcher

TRAINED RESCUER
- Should at a minimum provide chest compressions. The trained lay rescuer is able to perform rescue breaths at a ratio of 30 compressions to 2 breaths

HEALTHCARE PROVIDER
- Provide chest compressions and rescue breaths
- 30:2 Ratio
- After advanced airway placement ventilations every 6-8 seconds (Hyperventilation should be avoided)
• Tailor the sequence of rescuer’s actions to the most likely cause of arrest. (For example if a drowning, emphasis should be placed on ventilations, if sudden arrest, emphasis should be placed on getting an AED)

**Adult BLS for Healthcare Providers**

**Healthcare provider in a healthcare setting rarely respond alone** and so emphasis is placed on response as a team. Therefore multiple interventions can happen simultaneously. For example, compressions are started, the defibrillator readied and the airway managed by three different people at the same time.

Pulse checks for both lay persons and healthcare providers have been de-emphasized. The healthcare provider should take no longer than 10 seconds to check for a pulse.

The patient should be placed supine on a firm surface. There is insufficient evidence for or against the use of backboards in CPR. Air filled mattresses should be deflated when performing CPR.

• The chest should be depressed at least 2 inches over the lower half of the sternum
• Chest compression and chest recoil times should be approximately equal. Incomplete chest recoil is associated with lower coronary perfusion pressures and decreased ventricular filling. This can be improved by using CPR feedback devices. Manikin studies suggest that lifting the heel of the hand slightly, but completely, off the chest can improve chest recoil
• The compression rate refers to the speed of compressions, not the actual number of compressions per minute. The actual number of compressions delivered is determined by the rate and number as well as the duration of interruptions
• The rate should be at least 100/minute.
• Limit interruptions to no longer than 10 seconds for any reason
• Because of the difficulty in providing effective chest compressions while moving the patient during CPR, the resuscitation should generally be conducted where the patient is found.
• A ratio of 30:2 is reasonable until an advanced airway is in place. Once an airway is in place there is no pause for ventilations. Ventilations are delivered one every 6-8 seconds and compressions 100/minute.

**HANDS ONLY CPR**

• Only 20-30% of adults with out of hospital arrest receive any bystander COR.
• Hands only CPR substantially improves survival following arrest compared with no bystander CPR
• Similar survival rates among victims receiving Hands Only vs conventional CPR.
• May overcome the panic (which is common) and the hesitation to act
• Because the oxygen level in the blood remains adequate for the first several minutes, ventilation is not as important as compressions.
• Agonal gasps allows for some oxygenation and carbon dioxide elimination. If the airway is open, passive chest recoil during relaxation phase of chest compressions can provide some air exchange.
• No prospective study has demonstrated that lay person conventional CPR provides better outcomes than hands only CPR when provided before EMS arrival
• Conventional CPR with rescue breathing is recommended if the arrest is suspected to be aphyxial such as drowning, drug overdose.
MANAGING THE AIRWAY

CAB (Compressions – Airway – Breathing) helps clarify that airway maneuvers should be performed quickly and efficiently so that interruptions in chest compressions are minimized and chest compressions should take priority in the resuscitation of an adult.

The trained rescuer should open the airway using the head tilt chin lift method if no signs of head or neck trauma. Between 0.12 and 3.7% of victims with blunt trauma have a spinal injury and the risk of spinal injury is increased if the victim has craniofacial injury. Spinal immobilization devices may interfere with maintaining a patent airway but ultimately the use of such a device may be necessary to maintain spinal alignment during transport. Maintaining a patent airway and providing adequate ventilations are priorities, use the head tilt – chin lift maneuver if the jaw thrust does not adequately open the airway.

• Deliver each breath over 1 second
• Give a sufficient tidal volume to produce visible chest rise
• Use a compression to ventilation rate of 30 compressions to 2 ventilations.
• With an advanced airway – 1 breath every 6-8 seconds without a pause in compressions

During CPR cardiac output is 25-33% of normal, so oxygen uptake from the lungs and CO2 delivery to the lungs are also reduced. As a result, a low minute ventilation can maintain effective oxygenation and ventilation. Patients with poor lung compliance may require high pressures to be properly ventilated.

MOUTH TO MOUTH – give 1 breath over 1 second with the rescuer taking a regular breath rather than a deep breath. This prevents the rescuer from getting dizzy and over inflation of the patient’s lungs.

MOUTH TO BARRIER DEVICE – the risk of disease transmission through mouth to mouth ventilation is very low and it is reasonable to initiate rescue breathing with or without a barrier device. When using a barrier, the rescuer should not delay compressions while setting up the device.

BAG VALVE MASK – provides positive pressure ventilation without an advanced airway; therefore it may produce gastric inflation and its complications. A bag valve mask should have;

• Non jam inlet valve
• No pressure relief valve or one that can be bypassed
• Standard fittings
• Oxygen reservoir to allow deliver of high oxygen concentrations
• A non rebreathing outlet valve that cannot be obstructed with foreign material
• Transparent mask
• Not the recommended ventilation method for a lone rescuer.
• Should be used by two trained rescuers – one seals the mask and the other compresses the bag

SUPRAGLOTTIC AIRWAY

Devices such as the LMA, esophageal tracheal combitube and the King airway are currently within the scope of BLS practice in a number of regions. Ventilations with a bag through these devices provide an acceptable alternative to bag mask ventilation.
CRICOID PRESSURE

- Can prevent gastric inflation and reduce risk of regurgitation and aspiration but it may also impede ventilations
- Training in the maneuver is difficult for both expert and non expert providers
- Not recommended for use during cardiac arrest ventilation
- May be used in a few special circumstances such as to aid in viewing the vocal cords during intubation.

AED DEFIBRILLATION

All Basic Life Support providers should be trained to provide defibrillation. VF is a common and treatable initial rhythm of cardiac arrest in adults. Chest compressions should be performed while another rescuer gets a defibrillator.

There is insufficient evidence to recommend for or against delaying defibrillation to provide a period of CPR for patients in VF out of hospital cardiac arrest. The rescuer should use the defibrillator as soon as it is available and ready.

RECOVERY POSITION – There is no single position for all victims. The position should be stable, near true lateral, with the head dependent and with no pressure on the chest to impair breathing.

DROWNING

Rescuers should provide CPR; particularly rescue breaths, as soon as possible. The lone healthcare provider should give 5 cycles (about 2 minutes) of CPR before leaving the victim to activate EMS. There is no evidence that water acts as an obstructive foreign body. Heimlich maneuvers may cause harm (aspiration).

ELECTRICAL THERAPY

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care
Mark S. Lin, Chair; Dianne L. Atkins; Rod S. Passman; Henry R. Halperin; Ricardo A. Samson; Roger D. White; Michael T. Cudnik: Marc D. Berg; Peter J. Kudenchuk; Richard E. Kerber

For every minute that passes between collapse and defibrillation survival decreases 7-10%.
- With CPR decrease in survival is 3-4% per minute. That means you have twice the amount of time to provide defibrillation with the possibility of success.
- Survival rates are greatest if defib occurs in 4-5 minutes from collapse
- CPR prolongs VF and delays the onset of Asystole which has a poor prognosis.

Defibrillation should occur as soon as the AED is available and ready to shock. CPR should be done until the defibrillator is readied.

When EMS call to arrival time was 4-5 minutes or longer 1 ½ to 3 minutes of CPR prior to defibrillation increased the rate of initial resuscitation, survival to discharge, and 1 year survival when compared with immediate defibrillation. With in hospital arrest there is insufficient evidence to support or refute CPR before defibrillation. The time to defibrillation from collapse in a hospital facility should not be longer than 3 minutes.
SINGLE SHOCK – evidence from two studies suggested significant survival benefit with the single shock defibrillation protocol compared with the 2 stacked shock protocol. First shock efficacy for biphasic defibrillators is comparable or better than 3 monophasic shocks.

After shock delivery the rescuer should immediately begin compressions. There should be no pulse or rhythm check at this time. Most post defibrillation rhythms are either PEA or hypoperfused. All will benefit from increased coronary perfusion pressures. If the defib was unsuccessful, then it is better perfusion, not more electricity that is needed.

The second and subsequent shocks should be done at the same; or higher energy levels may be considered if available.

Paddle/Pad Placement – anterior-left infrascapular, anteroposterior, and anterior right infrascapular are equally effective to treat atrial or ventricular arrhythmias. Ten studies have indicated that the larger pad/paddle size (8-12 cm diameter) lowers transthoracic resistance.

DEFIBRILLATION WITH IMPLANTED CARDIOVERTER DEFIBRILLATOR

If the patient has an ICD that is delivering shocks, wait 30-60 seconds to allow the ICD to complete the treatment cycle before attaching the AED. Occasionally, the analysis and shock cycles of automatic ICDs and AEDs will conflict. There is the potential for pacemaker or ICD malfunction after defibrillation when pads are placed near the device. Pacemaker spikes with unipolar pacing may confuse AED software and may prevent VF detection. The anteroposterior and anterolateral locations are acceptable. It might be reasonable to avoid placing the pads or paddles over the device.

- The largest electrode or pad works best. 8-12 cm is acceptable. Smaller electrode size may result in myocardial necrosis and therefore be harmful.

AED programs in Airports, casinos, and first responder programs with police officers have shown survival rates of 41-74% from out of hospital witnessed VF arrest when immediate bystander CPR is provided and defibrillation occurs within about 3-5 minutes of collapse.

- 80% of cardiac arrests occur in private residential settings, however survival was not improved in homes of high risk individuals equipped with AEDs, compared to homes where only CPR training was provided.

In-Hospital Use of Automated External Defibrillators

Evidence from two retrospective and one historical study indicated higher rates of survival to hospital discharge when AEDs were used to treat adult VF or Pulseless VT in the hospital. Defibrillation may be delayed when arrest occurs in unmonitored hospital beds and in outpatient and diagnostic facilities. AEDs may be considered for the hospital setting as a way to facilitate early defibrillation. The goal of hospital defibrillation is that it should occur within 3 minutes of collapse especially in areas where staff have no rhythm recognition skills or defibrillators are used infrequently.

SYNCHRONIZED CARDIOVERSION

- Timed with the QRS complex to avoid shock delivery during the relative refractory portion of the cardiac cycle when it would most likely produce VF.
- Recommended to treat SVT due to reentry, atrial fibrillation, atrial flutter and atrial tachycardia
- Recommended to treat monomorphic VT with pulses.
Not recommended for junctional tachycardia or multifocal atrial tachycardia

PACING
- Not recommended for patients in asystolic cardiac arrest.
- No improvement in the rate of admission to hospital or discharge when paramedics or physicians attempted to provide pacing in Asystole.
- Has a negative effect as it may delay chest compressions.

CPR TECHNIQUES AND DEVICES
Diana M. Cave, Chair; Raul J. Gaxmuri; Charles W. Otto; Vinay M. Nadkarni; Adam Cheng; Steven C. Brooks; Mohamud Daya; Robert M. Sutton; Richard Branson; Mary Fran Hazinski

High Frequency Chest Compressions
- Compressions greater than 120/min have provided mixed results
- Hemodynamics were marginally improved however there was no change in clinical outcome

Open Chest Compression
- Small case studies reported survivals with mild or no neurological deficit when treated with thoracotomy and open chest CPR. All had penetrating or blunt chest trauma
- Insufficient evidence to recommend for or against
- May be useful if cardiac arrest develops during surgery when the chest or abdomen is already open.

Interposed Abdominal Compressions – CPR
- 3 rescuer technique (an abdominal compressor plus the chest compressor and the rescuer providing ventilations) that includes conventional chest compressions combined with alternating abdominal compressions
- May be considered during in hospital resuscitation when sufficient personnel trained in its use are available.
- Insufficient evidence to recommend for or against the use in out of hospital setting or in children

Cough CPR
- Episodically increases intrathoracic pressure and can generate systemic blood pressures higher than those usually generated by conventional chest compressions allowing patients to remain conscious for a brief arrhythmic interval up to 92 seconds documented in humans.
- Should not be taught to lay rescuers
- Useful in specialized areas such as the cardiac catheterization laboratory where the response is immediate, the patient can be coached to practice ahead of time

Prone CPR
- If the patient cannot be placed in the supine position it is reasonable to provide CPR in the prone position, particularly in hospitalized patients with an advanced airway in place.

Precordial Thump
- Two large studies found that the thump was ineffective (79/80 cases & 153/155 cases) in malignant ventricular tachycardia.
- Documented complications such as sternal fracture, osteomyelities, stroke and triggering of malignant arrhythmias
- Not used for unwitnessed out of hospital arrest
• May be considered for patients with witnessed monitored, unstable ventricular tachycardia if a defibrillator is not immediately available

**CPR Devices**

• No devices including Piston devices, phased thoracic-abdominal devices, load distributing band CPR and impedance threshold devices have shown any improvement in survival to discharge from the hospital
• May cause harm as they tend to delay or interrupt conventional CPR for placement

**Automatic and Mechanical Transport Ventilators**

• The use of an ATV may provide ventilation and oxygenation similar to that possible with the use of a manual resuscitation bag, while allowing the EMS team to perform other tasks

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**ADULT ADVANCED CARDIOVASCULAR LIFE SUPPORT**

Robert Neumar, Chair; Charles W. Otto; Mark S. Link; Steven L. Kronick; Michael Shuster; Clifton W. Callaway; Peter J. Knudenchuk; Josephee P. Ornato; Bryan McNally; Scott M. Silvers; Rod S. Passman; Roger D. White; Erik P. Hess; Wanchun Tang; Daniel Davis; Elizabeth Sinz; Laurie J. Morrison

**SUMMARY**

• Continuous quantitative waveform capnography is recommended for confirmation and monitoring of endotracheal tube placement
• Cardiac arrest algorithms are simplified and redesigned to emphasize the importance of high quality CPR
• Atropine is no longer recommended for routine use in the management of Pulseless Electrical Activity/Asystole
• There is an increased emphasis on physiologic monitoring to optimize CPR quality and detect ROSC
• Chronotropic drug infusions are recommended as an alternative to pacing in symptomatic and unstable bradycardia
• Adenosine is recommended as a safe and potentially effective therapy in the initial management of stable undifferentiated regular monomorphic wide complex tachycardia

**Adjuncts for Airway Control and Ventilation**

The purpose of ventilation during CPR is to maintain adequate oxygenation and sufficient elimination of carbon dioxide. Because both systemic and pulmonary perfusion are substantially reduced during CPR, normal ventilation perfusion relationships can be maintained with a minute ventilation that is much lower than normal. During CPR with an advanced airway in place; a lower rate of rescue breathing is needed to avoid hyperventilation.

Oxygen delivery during CPR is limited by blood flow rather than by arterial oxygen content. During the first few minutes, the lone rescuer should not interrupt compressions for ventilation. Advanced airway placement in cardiac arrest should not delay initial CPR and defibrillation for VF cardiac arrest.

**Oxygen during CPR**

Empirical use of 100% inspired oxygen during CPR optimizes arterial oxyhemoglobin content and in turn, oxygen delivery, therefore, use 100% oxygen as soon as it becomes available during resuscitation.
Passive Oxygen Delivery During CPR

In the out of hospital setting, passive oxygen delivery via mask with an opened airway during the first 6 minutes of CPR provided by emergency medical services personnel was part of the protocol of bundled care interventions (including continuous compressions) results in higher survival. However, at this time there is insufficient evidence to support the removal of ventilations from CPR performed by ACLS providers.

Bag Valve Mask Ventilation

Is an acceptable method of providing ventilation and oxygenation during CPR but is a challenging skill that requires practice. It is not recommended for a lone provider. When ventilations are performed by a lone rescuer, mouth to mouth or mouth to mask are more efficient.

Cricoid Pressure

May impede ventilation and interfere with placement of a supraglottic airway or intubation. The routine use of cricoid pressure in cardiac arrest is not recommended.

Nasopharyngeal Airways

Useful in patients with airway obstruction or risk of obstruction particularly when conditions such as clenched jaw prevent placement of an oral airway. Airway bleeding can occur in up to 30% of patients following insertion.

ADVANCED AIRWAYS

All healthcare providers should be trained in delivering effective oxygenation and ventilation with a bag and mask. ACLS providers should also be trained and experienced in the insertion of an advanced airway.

There are no studies directly addressing the timing of advanced airway placement and outcome during resuscitation from cardiac arrest.

- Intubation is frequently associated with interruption of compressions for many seconds
- Placement of a supraglottic airway is a reasonable alternative to endotracheal intubation and can be done successfully without interrupting compressions
- Earlier time to invasive airway was not associated with improved 24 hour survival
- If airway placement will interrupt chest compressions, providers may consider deferring insertion of the airway until the patient fails to respond to initial CPR and defibrillation attempts or demonstrates ROSC
- For a patient with perfusing rhythm, pulse oximetry and ECG status should be monitored continuously during airway placement
- Should have a secondary strategy for airway management and ventilation if they are unable to establish the first choice airway adjunct
- Continuous waveform capnography is recommended in addition to clinical assessment as the most reliable method of confirming and monitoring correct placement of an endotracheal tube.
- Waveform capnography should be utilized to confirm placement in the field, in the ambulance and on arrival at the hospital as well as after any patient transfer to reduce risk of unrecognized tube misplacement or displacement.
- Once an airway is in place compressions do not have to be paused to deliver breaths. The provider should ventilate every 6-8 seconds (8-10 times per minute).
Supraglottic Airways

- Does not require visualization of the glottis, so both initial training and maintenance of skills are easier
- The following airways have been studied in cardiac arrest; laryngeal mask airway (LMA), esophageal-tracheal tube (Combitube) and the laryngeal tube (king LT)
- Can provide ventilation that is as effective as that provided with a bag and mask or an endotracheal tube
- No evidence that any advanced airway measures improve survival in out of hospital arrest
- During CPR the use of a supraglottic airway is a reasonable alternative to bag mask ventilation

Combitube

- Similar advantages to endotracheal tube; isolation of the airway, reduced risk of aspiration, and more reliable ventilation than BVM.
- Providers of all level of experience were able to insert the Combitube and deliver ventilations
- No difference in outcome when compared with intubation

King LT

- More compact and less complicated to insert (the tube can only go into the esophagus).
- Study of trained paramedics the tube was inserted successfully 85% of the time and ventilation was effective
- Another study showed a 97% success rate when inserted by trained paramedics

LMA

- More secure and reliable than BVM
- Does not ensure absolute protection from aspiration, but less likely than with BVM
- Successful ventilation during CPR reported in 72-97% of cases
- Does not require visualization, training is simpler than endotracheal intubation
- Has advantages over endotracheal intubation when access to the patient is limited by location or position
- Acceptable alternative to endotracheal intubation

ENDOTRACHEAL INTUBATION

Endotracheal intubation was once thought to be the gold standard of airway management both in and out of the hospital. However, complications such as trauma, interruptions of compressions and hypoxemia from prolonged attempts have made other airway adjunctions come to the fore front. Frequent experience or retraining is essential for providers who perform intubation. EMS systems that perform intubation should provide a program of ongoing quality improvement to minimize complications.

Indications:
1. Inability of the provider to ventilate the unconscious patient adequately with the BVM and
2. The absence of airway protective reflexes (coma or cardiac arrest)

Guidelines

- Interruptions in chest compressions should be no more than 10 seconds
- Interruptions are not necessary at all when utilizing a supraglottic airway adjunct.
- Intubation has been associated with a 6-25% incidence of unrecognized tube misplacement or displacement. This risk increases when the patient has to be moved as in the out of hospital setting. Both clinical and confirmation devices must be used to verify tube placement immediately after insertion and again after the patient is moved.
Confirming Tube Placement

• Clinical
  o Visualizing bilateral chest rise
  o Bilateral lung sounds

• Waveform Capnography should be used anytime a patient has been intubated both to verify placement and to monitor for displacement. 100% sensitivity and 100% specificity in identifying correct endotracheal tube placement has been identified.
  o Most reliable method of confirming and monitoring placement

• Colormetric CO2 detectors can be used when waveform capnography is not available, however the accuracy of these devices does not exceed that of auscultation and direct visualization for confirming position in victims of cardiac arrest.

VENTILATION AFTER AIRWAY PLACEMENT

• Ventilation increases intrathoracic pressure and may reduce venous return and cardiac output especially in patients with COPD or hypovolemia.
• Slower ventilations are associated with increased survival rates
• 6-12 breaths per minute are associated with improved hemodynamic parameters and short term survival
• Because cardiac output is reduced during arrest, the need for ventilation is reduced.
• 8-10 breaths per minute without pausing compressions

Automatic Transport Ventilators

• ATV’s can be useful for ventilation of adult patients in non cardiac arrest with an advanced airway in place
• During prolonged resuscitation efforts the use of an ATV may allow the EMS team to perform other tasks while providing adequate ventilation and oxygenation.

ADULT CARDIAC ARREST

PRIORITIES OF CARE

CPR

• Push hard (> 2 inches) and push fast >100/min and allow complete chest recoil
• Minimize interruptions in compressions
• Avoid excessive ventilations
• Rotate compressor every 2 minutes
• If no advanced airway 30:2 compression ventilation ratio
• Quantitative waveform capnography
  o If PETCO <10mmHg attempt to improve CPR quality
• Intra-arterial pressure
  o If relaxation phase (diastolic) pressure <20mmHg, attempt to improve CPR quality

RETURN OF SPONTANEOUS CIRCULATION (ROSC)

• Pulse and Blood Pressure
• Abrupt sustained increase in PETCO (typically >40mmHg
• Spontaneous arterial pressure waves with intra-arterial monitoring
SHOCK ENERGY
- Biphasic – manufacturer’s recommendation (120 – 200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered
- Monophasic – 306 joules

DRUG THERAPY
- **Epinephrine** IV/IO Dose: 1mg every 3-5 minutes
- **Vasopressin** IV/IO Dose: 40 units can replace first or second dose of Epinephrine
- **Amiodarone** IV/IO Dose: First Dose 300mg; Second Dose 150mg (VT or VF only)

ADVANCED AIRWAY
- Supraglottic advanced airway or endotracheal intubation
- Waveform capnography to confirm and monitor placement
- 8-10 breaths per minute with continuous chest compressions

REVERSIBLE CAUSES
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo or hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

General Principles
Survival from cardiac arrest requires both BLS and a system of ACLS with integrated post cardiac arrest care. ACLS interventions other than defibrillation, such as medications and advanced airways, although associated with an increased rate of ROSC have not been shown to increase the rate of survival to hospital discharge.

It remains to be seen if improved rates of ROSC may translate into improved survival to discharge with better implementation of good quality CPR techniques. Algorithms have been simplified and redesigned to emphasize the importance of high quality CPR in all cardiac arrest rhythms. Vascular access, drug deliver and advanced airway placement should not cause significant interruptions in chest compression or delay defibrillation. There is insufficient evidence to recommend a specific timing or sequence of drug administration and advanced airway placement during cardiac arrest.

Understanding the importance of diagnosing and treating the underlying cause of cardiac arrest is fundamental to management.

In patients with ROSC it is important to begin post cardiac arrest care immediately to avoid re-arrest and optimize the patient’s chance of long term survival with good neurologic function.
Physiologic Parameters
Cardiac arrest is the most critically ill condition, but is typically monitored by ECG and pulse checks. Many studies indicate that the monitoring of PETCO2, coronary perfusion pressure, and central venous oxygen saturation provides valuable information on both the patient’s condition and response to therapy.

Pulses
Providers frequently try to palpate arterial pulses during compressions to assess the effectiveness of compressions. No studies have shown the validity or clinical utility of checking pulses during ongoing CPR. Because there are no valves in the inferior vena cava, retrograde blood flow into the venous system may produce femoral venous pulsations. Palpation of pulses when chest compressions are paused is a reliable indicator of ROSC but is potentially less sensitive than other physiologic measures.

Pulse Oximetry
Typically does not provide a reliable signal because pulsatile blood flow is inadequate in peripheral tissue beds. But the presence of a pleth waveform on pulse oximetry is potentially valuable in detecting ROSC.

Arterial Blood Gases
During CPR is not a reliable indicator of the severity of tissue hypoxemia, hypercarbia, or tissue acidosis. Therefore routine measurement is not indicated.

Access for Medications During Cardiac Arrest
Drug administration is of secondary importance. After CPR and attempted defibrillation providers can establish IV or IO access. This should be done without interrupting compressions. In one study the interval from first shock to administration of an antiarrhythmic drug was a significant predictor of survival. Although time to drug treatment appears to have importance, there is insufficient evidence to specify exact time parameters or precise sequence with which drugs should be administered. Peripheral drugs should be followed by a 20ml bolus of IV fluid to ensure delivery to central circulation during cardiac arrest.

IO cannulation provides access to a non-collapsible venous plexus, enabling drug delivery similar to that achieved by peripheral venous access at comparable doses. Although virtually all ACLS drugs can be given IO in the clinical setting without ill effects, there is little information on the efficacy and effectiveness of such administration in clinical cardiac arrest during ongoing CPR. It is reasonable to establish IO access if IV access is not readily available.

Trained providers may consider the placement of a central line. Drug concentrations are higher and drug circulation times are shorter. In addition a central line extending into the SVC can be used to monitor Scvo2 and estimate coronary perfusion pressure during CPR.

There are no data regarding ET administration of drugs. It is not recommended except as an ABSOLUTE last resort.

MEDICATIONS

VASOPRESSORS: To date no placebo controlled trial have shown that administration of any vasopressors agent at any stage during management of VF, Pulseless VT, PEA or Asystole increases the rate of neurologically intact survival to hospital discharge. There is evidence however that the use of vasopressors is associated with an increased rate of ROSC.
Epinephrine produces alpha receptor properties which can increase coronary perfusion pressure and cerebral perfusion pressure during CPR. The value and safety of the beta effects of epinephrine are controversial because they may increase myocardial workload and reduce subendocardial perfusion. A retrospective study of patients with and without Epinephrine found improved ROSC with epinephrine but no difference in long term survival between the treatment groups. Epinephrine should be administered in 1mg doses every 3-5 minutes during resuscitation. Higher doses may be indicated to treat specific issues such as beta blocker overdose or when guided by hemodynamic monitoring such as arterial diastolic pressure or CPP.

Vasopressin is a non-adrenergic peripheral vasoconstrictor that also causes coronary and renal vasoconstriction. Trials demonstrated no difference in outcomes with vasopressin vs epi as first line vasopressor in cardiac arrest. One dose of vasopressin 40 units may be given in place of the first or second dose of Epinephrine during resuscitation.

ANTIARRHYTHMICS – there is no evidence that any antiarrhythmic drug given routinely during human cardiac arrest increases survival to discharge from the hospital.

Amiodarone may be considered in the treatment of VF and Pulseless VT. Paramedic administration of 300mg of amiodarone improved hospital admission rates when compared with administration of placebo or 1.5mg/kg Lidocaine. Additional studies documented improvement in termination of arrhythmias when amiodarone was given to humans or animals with VF or hemodynamically unstable VT. An initial dose of 300mg can be followed by 1 dose of 150mg. There is limited experience with Amiodarone when given IO.

Lidocaine there is inadequate evidence to recommend the use of Lidocaine in patients with VT/VF. Lidocaine is an alternative of long standing and widespread familiarity with fewer immediate side effects but has no proven short or long term efficacy in cardiac arrest. It can only be considered if Amiodarone is not available. It is given at 1.5mg/kg doses with the second dose at 0.75mg/kg.

Magnesium Sulfate can facilitate termination of torsades de pointes associated with prolonged QT interval. Not likely to be effective terminating in patients with a normal QT interval.

INTERVENTIONS NOT RECOMMENDED DURING CARDIAC ARREST

ATROPINE – no prospective controlled clinical trials have examined the use of atropine in Asystole or bradycardic PEA cardiac arrest. Available evidence suggests that routine use of atropine during PEA or Asystole is unlikely to have a therapeutic benefit and is not recommended. It has been removed from the cardiac arrest algorithm.

SODIUM BICARBONATE – Tissue acidosis and resulting acidemia during cardiac arrest and resuscitation are dynamic processes resulting from no blood flow and low flow during CPR. Rapid ROSC are the mainstays of restoring acid base balance during cardiac arrest. The majority of studies demonstrated no benefit or found a relationship with poor outcome. Bicarbonate may compromise CPP by reducing systemic vascular resistance. It can create extracellular alkalosis that will shift the oxyhemoglobin saturation curve and inhibit oxygen release. In some special situations such as preexisting metabolic acidosis, hyperkalemia or tricyclic antidepressant overdose, bicarbonate can be beneficial. Routine use of bicarbonate during arrest is not recommended.

FIBRINOLYSIS – Two large clinical trials have failed to show any benefit in outcome with fibrinolytic therapy during CPR. One showed an increased risk of intracranial bleeding associated with the routine use. When pulmonary embolism is known to be the cause of arrest fibrinolytic therapy can be considered.
**IV FLUIDS** – Normothermic fluid, hypertonic and chilled fluids have been studied in animal and small human studies without a survival benefit. If cardiac arrest is associated with extreme volume loss, such as in hypovolemic PEA, intravascular volume should be promptly restored. However, routine fluid boluses should not be administered.

**PACING** – is not effective in cardiac arrest and no studies have observed a survival benefit from pacing. Electrical pacing is not recommended for routine use in cardiac arrest, and is considered possibly harmful (Class III).

**PRECORDIAL THUMP** – is not recommended in the out of hospital setting. May be considered for termination of witnessed monitored unstable ventricular tachycardia when a defibrillator is not immediately ready for use.

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**Treatment of Adult Bradycardia**

![Treatment of Adult Bradycardia Diagram]

Bradycardia is defined as a heart rate of less than 60 however when bradycardia is the cause of symptoms, the rate is generally less than 50 and that is the definition used by AHA. Hypoxia is a common cause of bradycardia. Evaluation of the patient with bradycardia should pay particular attention to signs of increased work of breathing and provide supplementary oxygen. The patient should be evaluated for blood pressure and have IV access. If possible a 12-lead ECG should be completed to determine the rhythm.

**VERY IMPORTANT:** the provider must identify signs and symptoms of poor perfusion and determine if THOSE SIGNS ARE LIKELY TO BE CAUSED BY THE BRADYCARDIA! If the signs and symptoms are not caused by the bradycardia, then the
underlying issue must be found and treated. If the bradycardia is suspected to be the cause of acute altered mental status, ischemic chest discomfort, acute heart failure, hypotension or other signs of shock, the patient should receive immediate treatment.

Atrioventricular (AV) blocks are classified as first, second and third degree. Blocks may be caused by medications or electrolyte disturbances, as well as structural problems resulting from AMI or other myocardial diseases.

- First Degree = prolonged PR interval (> .20)
  - Usually benign
- 2nd Degree Mobitz Type I
  - The block is at the AV node
  - Often transient and asymptomatic
- Mobitz II
  - The block is usually below the AV node within the Purkinje system
  - Often symptomatic with the potential to progress to complete AV block
- Third Degree AV Block
  - May occur at the AV node, bundle of His or bundle branches
  - No impulses pass between the atria and ventricles
  - Can be permanent or transient depending on the underlying cause

Atropine – remains the first line agent for acute symptomatic bradycardia. Studies show that atropine improved heart rate, symptoms and signs associated with bradycardia.

- Reverses cholinergic mediated decreases in heart rate and should be considered a temporary measure while preparing a pacemaker for patients with block at the AV node or sinus arrest
- Dose 0.5mg IV every 3 – 5 minutes to a total dose of 3mg
- Use cautiously in patients with acute coronary ischemia or MI as increased heart rate may worsen ischemia or increase infarction size
- Not likely to work in patients with Type II or Third Degree heart block. These are better treated with beta drugs or pacemakers

Transcutaneous Pacer

- May be useful in the treatment of symptomatic bradycardia
- Study compared Dopamine and TCP, no differences were observed between treatment groups in survival to hospital discharge
- TCP at best is a temporizing measure
- Painful in conscious patients
- It is reasonable to use in unstable patients in whom atropine has failed

Dopamine

- Both alpha and beta
- Can be titrated to more selectively target heart rate or vasoconstriction
- May be used for patients with symptomatic bradycardia especially associated with hypotension

Epinephrine

- Beta and alpha actions
- May be used for patients with bradycardia especially if hypotensive
ADULT TACHYCARDIA (WITH A PULSE)

1. Assess whether the tachycardia is causing the symptoms. (rarely the case if the heart rate is less than 150/min)
   If the tachycardia is compensatory, i.e., for fever, hypovolemia, congestive heart failure, treat the underlying cause. If the heart rate is lowered in those patients, the patient will decompensate.

2. Maintain patent airway and administer oxygen if the patient is hypoxic.

3. Cardiac monitor, blood pressure and pulse oximetry

4. If the patient is:
   a. Hypotensive
   b. Acutely altered mental status
   c. Signs of shock
   d. Ischemic chest discomfort
   e. Acute heart failure

   **Consider sedation and immediate cardioversion: if narrow complex consider Adenosine**

5. If not unstable evaluate for QRS >.012seconds. If yes;
   a. IV access and 12-Lead ECG
   b. Consider adenosine only if regular and monomorphic
   c. Consider antiarrhythmic infusion
   d. Consider expert consultation

6. If not unstable and QRS less than 0.12seconds
   a. IV access and 12 – Lead ECG
   b. Vagal Maneuvers
   c. Adenosine (if regular)
   d. Beta Blocker or Calcium Channel Blocker
   e. Consider expert consultation

**Note:** If the etiology of the rhythm cannot be determined, the rate is regular, and the QRS is monomorphic, recent evidence suggests that IV adenosine is relatively safe for both treatment and diagnosis. However, adenosine should not be given for unstable or for irregular or polymorphic wide complex tachycardia as it may cause deterioration into ventricular fibrillation.
Most deaths following cardiac arrest occur within 24 hours. A comprehensive, structured, multidisciplinary system of care should be implemented in a consistent manner for the treatment of post arrest patients. Patients who are victims of out of hospital arrest who have ROSC should be transported to a facility with this type of post arrest care.

**Induced Hypothermia:** for protection of the brain and other organs, hypothermia is a helpful therapeutic approach in patients who remain comatose after ROSC. One randomized trial reported improved neurologically intact survival to discharge when comatose patients with out of hospital ventricular fibrillation arrest were cooled to 32 degrees Centigrade for 12-24 hours beginning minutes to hours after ROSC. Hypothermia has not been studied in non ventricular fibrillation arrest.

- No single method of cooling has been shown superior
- Cooling starting in the field has not shown any advantage to cooling after arrival in the hospital and may delay transfer to a multidisciplinary facility
- Complications include coagulopathy, arrhythmias, and hyperglycemia. Hypothermia impairs coagulation and any ongoing bleeding should be controlled before temperature is decreased.

**Hyperthermia** – can impair brain recovery and should be treated aggressively in any post arrest patient.

**Pulmonary System** – dysfunction is common after cardiac arrest. Essential testing includes

- Chest x-ray
- Arterial blood gas measurement
- Mechanical ventilator support to reduce the work of breathing as long as the patient remains in shock

Ventilation with 100% oxygen has been associated with increased brain lipid peroxidation, increased metabolic dysfunctions, increased neurological degeneration and worsen short term functional outcome when compared with ventilation with room air or an inspired oxygen fraction titrated to a pulse oximeter reading between 94% or 96%. Once ROSC is achieved adjust the Fio2 to the minimum concentration needed to achieve arterial oxyhemoglobin saturation of 94% or greater with the goal of avoiding hyperoxia.

Post cardiac arrest patients are at risk of acute lung injury (ARDS), but hypoxemia is not a frequent mode of death after cardiac arrest. There is no reason to recommend hyperventilation and “permissive hypercapnia (hypoventilation) for these patients, and normocapnia should be considered the standard.

**Cardiovascular System** - acute coronary syndrome is a common cause of cardiac arrest. Because it is impossible to determine neurological function of patients in the first hours after cardiac arrest aggressive treatment of ST elevation MI should begin immediately. Emergent coronary angiography may be reasonable even in the absence of STEMI. Percutaneous coronary intervention (PCI) alone or bundled with other care is associated with improved myocardial function and neurological outcome. Therapeutic hypothermia can be safely combined with primary PCI after cardiac arrest caused by acute myocardial infarction.
Vasoactive Drugs

May be administered after ROSC to support cardiac output, especially blood flow to the heart and brain. Drugs may be used to improve heart rate, myocardial contractility or arterial pressure.

Death due to multi-organ failure is associated with a persistently low cardiac index during the first 24 hours after resuscitation. Vasodilation may occur from loss of sympathetic tone and from metabolic acidosis. Drug choices include:

- Epinephrine
- Norepinephrine
- Phenylephrine
- Dopamine
- Dobutamine
- Milrinone

Glucose Control

The post arrest patient is likely to develop metabolic abnormalities such as hyperglycemia that may be detrimental. Higher glucose levels are associated with increased mortality or worse neurological outcomes. Target should be 144-180 in adult patients with ROSC following cardiac arrest.

Steroids

Have an essential role in the physiological response to severe stress, including maintenance of vascular tone and capillary permeability. The value of administering corticosteroids following ROSC is currently unknown.
Advanced Cardiac Life Support Guidelines Overview

ACUTE CORONARY SYNDROMES

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Robert E. O’Connor, Chair; William Brady; Steven C. Brooks; Deborah Diercks; Jonathan Egan; Chris Ghaemmaghami; Venu Menon; Brian J. O’Neil; Andrew H. Travers; Demetris Yannopoulos

Prehospital Management

Prompt diagnosis and treatment offers the greatest potential benefit for myocardial salvage in the first hours of STEMI; and early, focused management of unstable angina and NSTEMI reduces adverse events and improves outcome.

Potential delays occur in three areas;
1. Patient recognition
2. Prehospital transport
3. Emergency department

Initial Care

- Half the patients who die of ACS do so before reaching the hospital. VF or Pulseless VT is the cause of most of these deaths. Rapid access to an AED and CPR is paramount. Dispatchers should be educated in the provision of CPR instructions.
- Dispatchers should instruct patients with no history of aspirin allergy and without signs of active recent GI bleeding to chew an aspirin (160mg to 325mg) while awaiting the arrival of EMS
- Oxygen therapy is indicated only if oxygen saturation is less than 94% or the patient is short of breath or has obvious signs of heart failure
- Aspirin (160-325mg) should be administered (if not already done by dispatch)
- Nitroglycerin at intervals of 3-5 minutes to a total of 3 doses. Nitrates are contraindicated with systolic blood pressure less than 90 or right ventricular infarction. For that reason extreme caution should be used in patients with STEMI from inferior wall infarction.
- Morphine can be used in patients still having pain after NTG who are having an MI. Caution should be used in patients with unstable angina as it is associated with an increase in mortality in a large registry study.
- 12-Lead ECG speeds the diagnosis, shortens the time to reperfusion. All patients with signs and symptoms of ACS should have a 12-Lead and it should be either transmitted for remote interpretation by a physician or screened for STEMI by properly trained paramedics.

Triage and Transfer

- 40% of patients with MI, the EMS provider establishes first medical contact
- Direct triage from the scene to a PCI capable hospital may reduce the time to definitive therapy and improve outcome. In a large historically controlled clinical trial the mortality rate was significantly reduced (8.9% vs 1.9%) when transport time was less than 30 minutes.
- If PCI is the chosen method of reperfusion for the Prehospital STEMI patient, it is reasonable to transport patients directly to the nearest PCI facility bypassing closer EDs as necessary, in systems where the time intervals between first medical contact and balloon times are <90 minutes and transport times are relatively short (<30 minutes.)
- In patients presenting within 2 hours of symptom onset when delays to PCI are anticipated, fibrinolytic therapy is recommended

Prepared by Judy Haluka
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Note: In systems where the Emergency Department physician activates the STEMI reperfusion protocol, including the cardiac catheterization laboratory team, significant reduction in time to reperfusion are seen and the rate of “false positive” activations are infrequent ranging from 0 to 14%.

Inter-facility Transfer – ED protocols should clearly identify critiera for expeditious transfer of patients to PCI facilities. Patients who are ineligible for fibrinolytic therapy or who are in cardiogenic shock should depart within 30 minutes of arrival.

Emergency Department Evaluation and Risk Stratification

The evaluation should focus on chest discomfort, associated signs and symptoms, prior cardiac history, risk factors for ACS and historical features that may preclude the use of fibrinolytics or other therapies. A 12 Lead ECG should be completed within 10 minutes of arrival. All providers must focus on minimizing delays at this level. ED evaluation constitutes 25-33% of the time to treatment delay in ACS patients. Patients are divided into three groups:

1. ST segment elevation or presumed new LBBB. ST segment elevation in 2 or more contiguous leads is classified as STEMI.
2. Ischemic ST depression or dynamic T wave inversion with pain or discomfort is classified as Unstable Angina/NSTEMI
3. Non diagnostic ECG with either normal or minimally abnormal T wave changes. This category of ECG is considered non diagnostic.

Cardiac Biomarkers

- Troponin is the preferred marker and is more sensitive than creatine kinase isoenzyme (CK-MB)
- Elevated level of Troponin correlates with an increased risk of death and greater elevations predict greater risk of adverse outcome
- In patients with STEMI, reperfusion therapy should not be delayed pending results of biomarkers, they are insensitive during the first 4-6 hours of presentation unless continous persistent pain as been present for 6-8 hours.

STEMI

- The primary goal of initial treatment is early reperfusion therapy through administration of fibrinolytics or PCI.

UNSTABLE STABLE ANGINA AND NON STEMI

- Unstable angina and NSTEMI are difficult to distinguish initially. These patients usually have a partially or intermittently occluding thrombus.
- These patients can be treated with early invasive strategies or with more conservative approaches depending upon physician and patient preference and various risk factors.

Normal or Non Diagnostic ECG

- The majority of patients with normal or non diagnostic ECGs do not have acute coronary syndrome. Patients in this category are most often at low or intermediate risk.

INITIAL THERAPY

1. Oxygen should be administered if the patient is short of breath, signs of heart failure, shock or saturation less than 94%. If none of those are present, oxygen is NOT necessary.
2. Aspirin – has been associated with decreased mortality rates in several clinical trials
   a. Non-enteric coated
Advanced Cardiac Life Support Guidelines Overview

b. Produces a rapid clinical antiplatelet effect with near total inhibition of thromboxane A2 production.
c. Reduces coronary re-occlusion and recurrent ischemic events after fibrinolytic therapy
d. Recommended dose: 160-325mg. Chewable or soluble aspirin is absorbed more quickly than swallowed tablets

3. NSAIDS are contraindicated and should be discontinued in patients who are taking them. Should not be administered during hospitalization for STEMI because of increased risk of mortality, re-infarction, hypertension, heart failure and myocardial rupture associated with their use.

4. Nitroglycerin causes dilation of coronary arteries, peripheral arterial bed and venous capacitance vessels.
   a. Treatment benefits are limited, however and no conclusive evidence supports routine use in AMI
   b. Carefully considered especially with low blood pressure or when their use would preclude the use of other agents known to be beneficial such as ACE inhibitors
   c. Relief of chest discomfort with NTG is neither sensitive or specific for ACS; gastrointestinal etiologies as well as other causes of chest discomfort can respond to NTG administration.

5. Analgesia should be administered for chest discomfort unresponsive to nitrates.
   a. Morphine is the drug of choice in STEMI patients
   b. Morphine is associated with increased mortality in patients with unstable angina and should be administered with caution

REPERFUSION THERAPIES

- Fibrinolysis restores normal coronary flow (TIMI 3) in 50-60% of subjects.
- PCI is able to achieve restored flow in >90% of subjects.
- PCI translates into reduced mortality and re-infarction rates as compared to fibrinolytic therapy making it the reperfusion strategy of choice in the elderly and those at risk for bleeding.
- Fibrinolysis can be used in patients who present within 12 hours on onset of symptoms and who lack contraindications to its use.
- The major determinants of myocardial salvage and long term prognosis are short time to reperfusion complete and sustained patency of the infarct related vessel with normal flow.
- The TRANSFER AMI trial supports the transfer of high risk patients who receive fibrinolysis in a non PCI center to a PCI center within 6 hours of presentation to receive routine early PCI.

COMPLICATED AMI

Cardiogenic Shock, LV Failure, Congestive Heart Failure – infarction of >40% of myocardium usually results in cardiogenic shock and carries a high mortality rate. Of those who develop shock, patients with ST segment elevation developed shock significantly earlier than those without elevation. Cardiogenic shock and congestive heart failure are not contraindications to fibrinolysis, but PCI is preferred if the patient is at a facility with PCI capabilities.

RV Infarction – or ischemia may occur in up to 50% of patients with inferior wall MI. The provider should suspect RV infarction in patients with inferior wall infarction, hypotension and clear lung sounds.
- Obtain an ECG with right sided leads. ST elevation in lead V4R is sensitive for RV infarction and is a strong predictor of increased in hospital complications and mortality
- The in hospital mortality rate of patients with RV dysfunction is 25-30%, and these patients should be routinely considered for reperfusion therapy.
ADJUNCTIVE THERAPIES FOR ACS AND AMI

**Clopidogrel (Plavix)** results in a reduction in platelet aggregation through a different mechanism than aspirin. Patients with ACS and a risk in cardiac biomarkers or ECG changes consistent with ischemia had reduced stroke and major adverse cardiac events if Plavix was added to aspirin and heparin within 4 hours of hospital presentation. Plavix given 6 hours or more before elective PCI for patients with ACS without ST elevation reduced adverse ischemic events at 28 days.

- **Loading dose:** 300mg PO
- **Maintenance:** 75mg q day

**Prasugrel (Effient)** – oral thienopyridine prodrug that irreversibly binds to the ADP receptor to inhibit platelet aggregation.

- Small improvement in major adverse cardiac events (MACE) when administered before or after angiography to patients with NSTEMI and STEMI
- 60mg oral loading dose may be substituted for clopidogrel after angiography in patients determined to have non ST segment elevation ACS or STEMI who are more than 12 hours after symptom onset prior to planned PCI.
- No evidence supporting use in ED or Prehospital setting.
- Not recommended in STEMI patients receiving fibrinolysis or NSTEMI patients prior to angiography

**Glycoprotein IIb/IIa Inhibitors** – use for treatment of patients with unstable angina and NSTEMI has been well established.

- Documented benefit in patients with elevated Troponin and a planned invasive strategy or specific patients with diabetes or significant ST depression on presenting ECG.

**Beta Adrenergic Receptor Blockers** – several studies have shown reduced mortality and decreased infarction size with early beta blocker administration.

- Recommend beta blockade within 24 hours of hospitalization
- Contraindicated in moderate to severe LV failure and pulmonary edema, bradycardia (<60) and hypotension (<100mmHg), poor peripheral perfusion or second or third degree heart block
- For STEMI there is no evidence to support the routine administration in the Prehospital environment or during the initial ED assessment.

**Heparins** – is an indirect inhibitor of thrombin that has been widely used in ACS as adjunctive therapy for fibrinolysis and in combination with aspirin and other platelet inhibitors for the treatment of non ST segment elevation ACS.

**ACE Inhibitors** – has improved survival rates in patients with AMI, particularly when started early after the initial hospitalization. The beneficial effects are most pronounced in patients with anterior infarction, pulmonary congestion or LV ejection fraction less than 40%. Although ACE inhibitors and ARB’s have been shown to reduce long term risk of mortality in patients suffering AMI, there is insufficient evidence to support the routine initiation of therapy in the Prehospital or ED setting.

**HMG Coenzyme A Reductase Inhibitors (Statins)** – there is little data to suggest that this therapy should be initiated within the ED; however early initiation (within 24 hours of presentation) of statin therapy is recommended in patients with an ACS or AMI. If patients are already on statin therapy is should be continued.
ADULT STROKE

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

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The D’s of Stroke Care are the major steps in diagnosis and treatment of stroke and identify the key points at which delays can occur:

- Detection – Rapid recognition of stroke symptoms
- Dispatch – Early activation and dispatch of emergency medical services by calling 911
- Delivery – Rapid EMS identification, management and transport
- Door – Appropriate triage to stroke center
- Data – Rapid triage, evaluation, and management within the emergency department
- Decision – Stroke expertise and therapy selection
- Drug – Fibrinolytic therapy, intra-arterial strategies
- Disposition – Rapid admission to stroke unit, critical care unit

The time sensitive nature of stroke care is central to the establishment of successful stroke systems.

GENERAL: The logic of having a multi-tiered system such as that provided for trauma works best. There will be primary stroke centers and comprehensive stroke centers and the new concept of a stroke prepared hospital can access stroke expertise via telemedicine.

Several states have passed legislation requiring Prehospital providers to triage patients with suspected stroke to designated stroke centers. The integration of EMS into regional stroke models is crucial for improvement of patients outcomes.

911 and Dispatch – provide education and training to 911 and EMS personnel to minimize delays in Prehospital dispatch, assessment and transport. High priority dispatch to patients with stroke symptoms

- Where ground transport to a stroke center is potentially long, air medical services may be used.

Assessment
The Cincinnati Prehospital Stroke Scale has a sensitivity of 50% and a specificity of 89% when scored by Prehospital providers. The provider first rules out other causes such as hypoglycemia and seizures and then evaluates three areas:

1. Facial droop
2. Arm Drift
3. Abnormal Speech

With education paramedics demonstrated a sensitivity of 61-66% for identifying patients with stroke.

Prehospital Management and Triage

- Must clearly establish time of onset of symptoms. Defined as the last time the patient was observed to be normal
- Supplemental oxygen if saturation less than 94% or shortness of breath
- Unless patient is hypotensive (systolic less than 90mmHg) no intervention for blood pressure is recommended.
• Should consider transporting a witness or family member with the patient to verify time of onset
• Pre-arrival hospital notification has been found to significantly increase the percentage of patients with acute stroke who receive fibrinolytic therapy
• Significantly larger percentages of patients receive rtPA when transported directly to stroke centers

A growing body of evidence indicates a favorable benefit from triage of stroke patients directly to designated stroke centers. EMS systems should establish a stroke destination preplan to enable EMS providers to direct patients with acute stroke to appropriate facilities. When multiple stroke hospitals are within similar transport distances, EMS personnel should consider triage to the stroke center with the highest capability of stroke care.

Multiple randomized clinical trials and meta analysis in adults document consistent improvement in one year survival rate, functional outcome and quality of life when patients hospitalized for stroke are cared for in a dedicated stroke unit by a multidisciplinary team experienced in management of stroke. When such a facility is available within a reasonable transport interval, stroke patients who require hospitalization should be admitted there. (Class I)

**In Hospital Care – Initial ED Assessment and Stabilization**

• Protocols should be used to minimize delay to definitive diagnosis and therapy
• Assessment should be complete within 10 minutes of arrival
• Obtain IV access, draw blood for baseline studies
• Identify and treat hypoglycemia
• Obtain a neurologic screening assessment
• Emergent CT scan of the brain
• Activate the stroke team or arrange consultation with a stroke expert
• 12 lead ECG does not take priority but can help identify recent infarction or arrhythmia as case of embolic stroke
• Cardiac monitoring during the first 24 hours of patients with ischemic stroke is recommended to detect atrial fibrillation and potentially life threatening arrhythmias

**Hypertension Treatment**

Management of hypertension in the stroke patient is dependent on the fibrinolytic eligibility. For patients potentially eligible for fibrinolysis, blood pressure must be <185mmHg systole and <110 mmHg diastolic to limit the risk of bleeding complications.

**Imaging** – CT should be completed within 25 minutes of arrival and interpreted within 45 minutes of ED arrival

**Fibrinolytic Therapy**

• Assess for exclusion criteria
• The major complication is intracranial hemorrhage. Occurred in 6.4% of 312 patient study and 4.6% of 1135 in another trial
• A higher likelihood of good to excellent functional outcome when rtPA is administered to adult patients with acute ischemic stroke within 3 hours of onset of symptoms
  • Treatment of CAREFULLY SELECTED patients with acute ischemic stroke with IV rtPA between 3 and 4.5 hours after onset of symptoms has also been shown to improve clinical outcome, although the degree of clinical benefit is smaller than that achieved with treatment within 3 hours.