CARDIAC ARREST CARE: HOW IS IT CHANGING?

Bound Tree University

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This special Bound Tree University guide brings together three articles to help EMS personnel understand the evolving care for patients in cardiac arrest.

Though the 2015 AHA Guidelines for CPR and Emergency Cardiac Care didn’t significantly change the prehospital treatment of cardiac arrest, the guidelines did offer fine tuning based on the most recently published resuscitation research. Increasingly we hear from EMS agencies that have increased cardiac arrest survival in their communities by adopting new guidelines as they become available, regularly training on and practicing high-performance CPR and focusing on the application of interventions that are most likely to improve survival — neurologically intact survival to hospital discharge.

Read and share this E-Book to make sure your EMS agency, through collaboration with its medical director and receiving hospitals, as well as bystanders is rapidly recognizing and treating cardiac arrest. High-quality chest compressions and rapid defibrillation continue to be the key determinants to survival. Both interventions can be and need to be performed by police officers, firefighters, teachers, business owners, high school students and other friends and family. The emergency medical dispatcher, helping callers recognize cardiac arrest and provide CPR instructions, is a critical component in patient survival.

While affirming the importance of BLS procedures through research, resuscitation investigators are also examining the efficacy of ACLS drugs. The Amiodarone vs. Lidocaine vs. Plain Saline (ALPS) trial, conducted by Resuscitation Outcomes Consortium, wanted to know if antiarrhythmics improved survival following out-of-hospital cardiac arrest. Read about their findings and what the ALPS trial means for EMS providers.

As EMS personnel renew their BLS and ACLS certifications one of the top messages is the importance of consistent, uninterrupted chest compressions. The EMS personnel available for cardiac arrest response varies widely based on agency’s staffing model and utilization. Review the benefits of mechanical chest compression devices as your agency determines the best way to insure sudden cardiac arrest victims receive high-quality CPR.

**Editors Note:**

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Survival from sudden cardiac arrest (SCA) is zero percent if external chest compressions (CPR) are not performed. Since the 1950s, when Dr. Peter Safar first described the modern technique of pushing on the chest to create blood flow, researchers have worked to optimize manual compression depth and rate while trainers have trained millions of people worldwide in CPR.

Along with automated external defibrillators and basic airway management, CPR is considered a fundamental component of basic life support (BLS) in cardiac resuscitation.

BACKGROUND

From the 1970s to the late 90s, much attention was given to advance life support (ALS). It was thought that medications and ALS procedures such as intubation would help to increase survival rates.

However, in one study after another it became clear that these more complex and complicated techniques were not improving survival rates. It became increasingly obvious that effective BLS in the form of high quality chest compressions was crucial in resuscitation efforts.

In 2005, the American Heart Association recommended that the management of cardiac arrest revolved around minimally interrupted chest compressions of adequate depth and sufficient rate to adequate blood pressure in the cardiovascular system, while ensuring that full recoil off the chest was achieved to allow blood flow through the coronary arteries. In subsequent updates to the AHA CPR guidelines the emphasis on high-quality compressions continued.

MANUAL CPR

Historically, chest compressions have been delivered manually, with the rescuer kneeling upright next to the victim, using two outstretched arms placed over the sternum, and bending at the hips to create a downward force.

The rescuer returns back to an upright position, releasing all pressure off the chest. This “duty cycle” is repeated at a rate faster than 100 times per minute but slower than 120 times per minute, interrupted every 30 compressions to deliver a small volume of air to ventilate the lungs.

There are many challenges to achieving continuous, high-quality compressions. First, the rescuer must be of
sufficient size and weight in order to generate adequate compressions. It is thought that late middle school children may be the minimum age to learn and deliver CPR.

Second, the training must be simple enough to acquire quickly and retain. Performing CPR is a task that is seldom practiced in real life by the lay public; even professional rescuers perform CPR at a much lower frequency than other procedures, such as measuring blood pressure or gaining intravenous access.

Given that mandatory retraining occurs usually on an annual or biannual basis, it becomes difficult to deliver compressions accurately.

Third, fatigue during CPR is a major factor. Studies show that the rescuer’s ability to deliver effective chest compressions decreases significantly in as little as a minute after initiation. It is for this reason that the AHA recommends that rescuers be rotated out of providing compressions every two minutes during a cardiac arrest.

Finally, trying to deliver effective manual chest compressions during patient extrication and transport is extremely difficult and dangerous for unrestrained EMS personnel who attempt to perform chest compressions in the patient care compartment of a moving ambulance. Maintaining body and arm position while in motion is impractical and can harm the rescuer.

**CONSISTENT, UNINTERRUPTED COMPRESSIONS**

Given the challenges of trying to perform human-powered CPR, it’s no surprise that biotechnology has been working on mechanically-driven devices that tirelessly deliver accurate chest compressions in virtually any situation.

As early as the 1960s, the “Thumper” made by Michigan Instruments used an oxygen-powered piston on an adjustable arm to deliver compressions.

The ZOLL AutoPulse delivers chest compressions using a load-distributing band that is wrapped around the victim’s chest and tightened rhythmically by a battery-powered electrical motor.

Physio Control’s LUCAS is powered by compressed air. The LUCAS 2 is battery powered. Both devices compress the chest with a piston in a more compact configuration.

The Resuscitation International ROSC-U Miniature Chest Compressor uses a chest compression component, attached to the patient’s chest, that is powered by a battery-control unit.

While the design of each device varies, the benefits to the resuscitation team are consistent, uninterrupted chest compressions. Mechanical chest compression devices can reduce the number of rescuers needed to perform CPR at a cardiac arrest, since the machines do not tire.

Properly applied and adjusted, the devices can deliver consistent, continuous compressions throughout the arrest phase. Studies have shown that using chest compression devices does promote coronary blood flow, higher coronary perfusion pressures and can increase the chances of return of spontaneous circulation (ROSC).

Given these findings, it would appear that chest compression devices are superior to providing manual CPR.

Yet large-scale scientific studies have not shown whether these devices are effective in improving the primary measurement of resuscitation success — survival to discharge from hospital.

**SUMMARY**

At this point, the available evidence does not establish a preference for mechanical compression devices. We can expect researchers will continue to investigate the efficacy of the devices. Meanwhile EMS agencies should continue to train, monitor and improve manual and mechanical chest compressions as part of a team approach to sudden cardiac arrest resuscitation.

Also keep in mind that a mechanical chest compression device is described in the 2015 AHA CPR guidelines as “a reasonable alternative to conventional CPR in specific settings where the delivery of high-quality manual compressions may be challenging or dangerous for the provider.” Those settings or situations are limited rescuers available to respond to a cardiac arrest call, prolonged CPR when guided by local protocols, CPR administered to patient who severely hypothermic and when a patient’s cardiac arrest cause and potential survivability may warrant transport in a moving ambulance.
In October of 2015, the American Heart Association released the 2015 American Heart Association (AHA) Guidelines Update for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC). This publication represents the most current recommendations for improving survival from cardiac arrest. In many cases, the AHA did not significantly change previous recommendations but simply clarified meanings. However, in other cases, the AHA made recommendations that did not previously exist.

**CHAIN OF SURVIVAL: AFFIRMED YET REVISED**

The AHA continues to recognize the relevancy of the Chain of Survival; however, it recognizes the important differences between responding to a cardiac arrest in the out-of-hospital (OOH) environment and responding to an arrest that occurs inside the hospital. The role of the lay rescuer is significantly more important in the OOH setting where, ideally the patient receives CPR and defibrillation before the EMS team arrives on the scene. Without those early interventions, the chances of survival decrease.

Although early CPR and defibrillation still have value for cardiac arrest occurring in the in-hospital setting, those initial responders are often health care providers with some degree of professional training. In many of these cases, patients display clear warning signs of impending cardiac arrest. Prompt recognition of those warning signs and appropriate intervention could possibly prevent the cardiac arrest from occurring in the first place.

Multiple studies since the release of the 2010 AHA Guidelines demonstrate a decrease in the incidence of in-hospital cardiac arrest when hospitals implemented a system of medical emergency team (MET) responses to patients with signs of impending cardiac arrest. Thus, the 2015 recommendation is for hospitals to implement MET responses based on early warning signs.
In the OOH environment, the emergency medical dispatcher (EMD) plays a key role in the chain of survival once the bystander accesses the EMS system. The AHA states that after identification of an unconscious adult patient with abnormal or absent breathing, it is reasonable for the EMD to assume the patient is in cardiac arrest. The recommendation is for the EMD to provide compression-only instruction until EMS arrival.

RESUSCITATION: A CONCERTED EFFORT

Most of the sequential assessments and actions for CPR remain unchanged from the 2010 recommendations. Although one of the limitations of any patient care algorithm is the linear presentation of the steps, the AHA acknowledges that EMS responses rarely involve a single person. A team of responders can therefore accomplish multiple tasks simultaneously.

Approach the victim cautiously, making sure the scene is safe before proceeding. Upon contact with the victim, verify unresponsiveness and send someone to get an AED or manual defibrillator. Determine whether the patient is breathing normally. Unresponsive patients who are not breathing normally have a high likelihood of being in cardiac arrest.

Do not confuse gasping with normal breathing. Gasping occurs frequently in patients who develop sudden cardiac arrest, but rapidly disappears as time progresses. In one study, EMS responders witnessed gasping in about 20 percent of patients when the EMS response time was less than seven minutes. However, when the EMS response time was greater than nine minutes, only 7 percent of the patients were still gasping. Gasping is associated with increased survival to discharge rates.

Simultaneously during the breathing assessment, check the patient’s carotid artery to verify pulselessness. Because health care providers often have difficulty determining whether a pulse is present, withhold chest compressions only when absolutely sure the pulse is present. In many instances, health care providers also take too long to make a decision. Do not spend more than 10 seconds checking for a pulse. If the pulse is absent or you are unsure if the pulse is present, begin chest compressions.

CHEST COMPRESSION RECOMMENDATIONS

The original recommendation for where to place the hands when performing chest compressions comes from canine studies extrapolated to humans. Over the years, recommendations for hand positioning when performing chest compressions have migrated from two fingers above the tip of the xiphoid process to the lower half of the breastbone. Two studies since the 2010 AHA Guidelines failed to identify an optimal alternative hand placement position for closed chest massage in adults. Therefore, the 2015 Guidelines do not change hand placement recommendations made in 2010.

The original recommendation for chest compression depth in the average adult called for the rescuer to push the sternum to a depth of 3 or 4 centimeters (about 1.0 - 1.5 inches) towards the vertebral column. Since that original recommendation, researchers have searched for the optimal chest compression depth. In the 2010, the AHA recommended a chest compression depth greater than previously recommended. Although more recent evidence does not contradict this statement, there is some evidence to suggest that compression depths greater than 2.4 inches may result in an increase in patient injuries.
In response the AHA now recommends that health care providers compress the chest to a depth of at least two inches, but no deeper than 2.4 inches. In order to hit this narrow target, the AHA recommends the use of audiovisual feedback devices that allow real time corrections to poor compression technique.

After compressing to the proper depth, the AHA recommends health care providers allow full recoil of the chest before delivering the next compression (32). Animal studies suggest that incomplete recoil, also known as rescuer leaning, can negatively impact cerebral and coronary perfusion. Other studies suggest leaning is common among health care providers. So, despite the lack of conclusive evidence associating leaning with worsened clinical outcomes, the AHA recommends health care providers avoid leaning on the patient’s chest while performing chest compressions.

One important determinate of Return of Spontaneous Circulation (ROSC) and neurologically intact survival is the actual number of chest compressions health care providers deliver to the patient during each minute of the resuscitation period. An in-hospital study demonstrated improved outcomes with the delivery of 80 chest compressions per minute (46) and an out-of-hospital observational study found improved outcomes when EMS personnel delivered 68-89 compressions per minute (47). To compensate for the compression interruptions that occur with defibrillation attempts, ventilation, or to switch chest compressors, the 2010 Guidelines recommended a chest compression rate of at least 100 compressions per minute.

Although this recommendation clarifies the minimum number chest compressions per minute, the recommendation did not indicate a maximum number of compressions beyond which survival outcomes could be negatively affected. Since 2010, two studies suggest the optimal chest compression rate likely lies between 100 and 120 chest compressions per minute. This forms the bases for the 2015 recommendation.

The 2015 Guidelines also includes a recommendation to continue to provide 30 chest compressions followed immediately by two ventilations. This recommendation remains unchanged from the 2010 Guidelines and is based on consensus opinion rather than definitive evidence.

**ALL ABOUT THE BEAT**

A caveat to the standard 30:2 compression ventilation ratio is that rescuers must minimize interruptions in chest compressions. This is true for both the potentially therapeutic pauses that accompany ventilation and defibrillation, and the non-therapeutic pauses, such as moving the patient to the ambulance. To illustrate the importance of minimizing interruptions, the AHA defined a new metric, chest compression fraction (CCF), that did not exist in 2010.

The CCF represents the proportion of time during the resuscitation attempt that someone is actually pushing on the patient’s chest. Minimizing interruptions in chest compressions allows rescuers to spend more time compressing the sternum, which results in higher CCF. Higher CCF increases the likelihood of survival. Although an expert panel consensus found a CCF of 80 percent achievable, the 2015 recommendation calls for rescue teams to achieve a CCF of at least 60 percent.

An alternative to the standard 30:2 compression/ventilation ratio gaining traction in the out-of-hospital environment is a continuous chest compression model, either with active asynchronous ventilation delivered without interrupting compressions or with passive ventilation in the early stages of the resuscitation attempt.

**VENTILATION RECOMMENDATIONS**

The 2010 Guidelines recommended asynchronous ventilation with continuous chest compression, but only after the insertion of an advanced airway. A newborn manikin model of cardiac arrest demonstrated higher minute ventilation when breaths were delivered asynchronously via bag-mask with continuous chest compressions compared to coordinated ventilations and compressions.

Animal studies of asynchronous ventilation during continuous chest compression could find no difference in outcome compared to standard CPR. A recent large cluster-randomized trial with crossover involving more than 23,700 patients suffering OOH cardiac arrest could find no survival advantages associated with continuous chest compressions and asynchronous ventilation compared to standard CPR.

In the passive ventilation approach, EMS providers generally deliver three cycles of 200 continuous chest compressions with a rhythm analysis and defibrillation attempt.
after every two hundred compressions and ventilation occurs passively through elastic recoil of the patient’s chest. In many of the agencies, rescuers maintain airway patency with an oropharyngeal airway and then place an oxygen mask over the patient’s face to allow passive oxygen delivery. Despite the fact that some suggest that passive ventilation created by compression only CPR cannot generate tidal volumes adequate for effective gas exchange, the 2015 Guidelines considers continuous chest compression with delayed ventilation to be a reasonable approach to the early management of a witnessed OOH arrest with a presenting rhythm of ventricular fibrillation or pulseless ventricular tachycardia (VF/pVT).

In the first published report on the use of passive oxygen insufflation in the management of OOH cardiac arrest, researchers found lower arterial carbon dioxide partial pressures and higher pH and partial pressure of arterial oxygen in the passively ventilated patients compared to the patients receiving traditional ventilation. Subsequently, in a larger study of OOH cardiac arrest, researchers could not find a difference in ROSC, survival to hospital admission, or survival to ICU discharge rate between patients passively oxygenated and those receiving conventional oxygenation and ventilation techniques.

However, in both of these studies, passive insufflation occurred through specially modified endotracheal tubes thereby limiting generalization of the results to passive insufflation through an oxygen mask. A retrospective analysis of a statewide OOH cardiac arrest database found that passive ventilation using an OPA and an oxygen mask improved neurologically intact survival after witnessed VF/pVT when compared to bag-valve-mask ventilation.

For unwitnessed VF/pVT and non-shockable rhythms, survival was similar. Until more clinical data is available, the AHA does not recommend the routine use of passive ventilation during conventional CPR.

**DEFIBRILLATION RECOMMENDATIONS**

Another strategy common in the EMS environment is to deliver a period of CPR, typically 1.5 – 3 minutes, before administering a defibrillation attempt. This approach is colloquially known as priming the pump. Twelve studies of varying complexity have failed to show any outcome advantages offered by up to 180 seconds of chest compressions before delivery of the first defibrillation attempt. For patients being monitored, defibrillate as quickly as possible after the patient develops VF/pVT. For patients in cardiac arrest who are not being monitored, perform CPR while someone retrieves the defibrillator and applies the pads. As soon as the defibrillator is ready, deliver a shock and resume CPR beginning with chest compressions.

**NALOXONE ADMINISTRATION RECOMMENDATIONS**

In 2014, the U. S. Food and Drug Administration approved for sale a naloxone autoinjector for use by the general public. Almost immediately, the AHA Training Network asked for guidance on how to incorporate this device into current training programs. The International Liaison Committee on Resuscitation (ILCOR) attempted to review research relevant to the question of whether naloxone administration to patients suspected of having opioid toxicity in addition to CPR provided any survival benefits compared to standard CPR alone but could not find any.
Despite the lack of evidence, the consensus opinion was that it is reasonable for appropriately trained health care providers to administer intramuscular or intranasal naloxone to patients who are not breathing normally and are suspected of overdosing on opioids. For patients in cardiac arrest with a known or suspected opioid overdose, health care providers can consider administering naloxone, but only after initiating CPR.

**OXYGEN — HOW MUCH?**

Over the past few years, researchers and clinicians began questioning the value of administering high-concentration oxygen to patients who suffer cardiac arrest, especially once the patient achieves ROSC. An observational OOH cardiac arrest study utilizing high-concentration oxygen administration during the resuscitation period found that increases in PaO2 levels correlated with increased rate of survival to hospital admission with a non-significant trend toward improved neurological outcome. On the other hand, several studies have demonstrated increased mortality and poor neurologic status associated with higher levels of the maximum measured PaO2 during the post-resuscitation period. Other studies have been unable to demonstrate this harm.

Thus, the AHA recommends that EMS providers deliver high-concentration oxygen via bag-mask during the resuscitation attempt when CPR is in progress. However, once the patient achieves ROSC and the health care team can reliably measure oxyhemoglobin saturation, the AHA states it is reasonable to titrate oxygen delivery to achieve a saturation value of at least 94 percent.

**ADVANCED AIRWAY RECOMMENDATIONS**

At the advanced level, one issue that remains controversial is whether EMS personnel should insert an advanced airway during the resuscitation attempt. Although many studies demonstrate worsened outcomes with ventilation through an advanced airway compared to bag-mask ventilation, the results of these studies may actually demonstrate the effects of other variables rather than the type of airway used. For example, patients who do not respond to CPR and the initial defibrillation attempt likely have more profound metabolic derangements than those who respond early. The AHA recommends EMS personnel provide oxygenation and ventilation with either a bag mask or with an advanced airway. The decision on what specific advanced airway (endotracheal or supraglo- tic) should be based on the training and skill level of the responders. There are no recommendations on the optimal timing for the insertion.

**VASOPRESSOR USE DURING CARDIAC ARREST**

Another controversial subject is whether the administration of vasopressors during the resuscitation attempt offers any survival advantages for the patient. Since 2010, one randomized control trial (RCT) and one large observational trial found patients who received epinephrine were more likely to achieve ROSC in the field compared to patients who did not receive epinephrine. However, the RCT study was stopped early and was therefore unable to evaluate whether epinephrine provided any long-term survival advantages. The observational trial found that epinephrine administration was associated with a decreased chance of survival to one-month after discharge with good functional outcome.

Another observational trial could not demonstrate any improvements in ROSC, survival to hospital admission, survival to hospital discharge, or good neurological recovery.

The only study to compare exclusive vasopressin administration to exclusive epinephrine administration could find no differences in the rates of ROSC, 24-hour survival or survival to hospital discharge between the two groups.

Another study randomized patients to receive either vasopressin to epinephrine. If the patients did not respond to the initial drug, all patients received epinephrine from that point forward. Adding vasopressin to the standard management of cardiac arrest did not improve survival to hospital discharge rates.

As a result, the AHA continues to recommend epinephrine as the vasopressor of choice for the management of cardiac arrest. The AHA has removed vasopressin from the cardiac arrest algorithm.

**WHEN TO ADMINISTER EPINEPHRINE?**

Now that the AHA has simplified the cardiac arrest algorithm by removing one of the vasopressors, one should consider the issue of timing. The 2010 Guidelines recommended vasopressor administration after the second defibrillation attempt for shock-refractory rhythms. Without any new evidence to support a change, the AHA continues to recommend that strategy for shockable rhythms.
However, the recommendation for when to administer the first dose of epinephrine in non-shockable rhythms is different. Three studies suggest improved outcomes with earlier (rather than later or not at all) administration of epinephrine. Thus, after initiating CPR, it is reasonable for EMS providers to administer epinephrine as early as possible when patients are in a non-shockable rhythm.

ANTIARRHYTHMIC RECOMMENDATIONS

The other group of medications routinely administered during a resuscitation attempt is the antiarrhythmics. Two trials demonstrated that amiodarone provided short-term survival advantages compared to lidocaine in patients who suffered an OOH cardiac arrest and presented in Vf/pVT. Amiodarone continues to be the recommended first-line antiarrhythmic agent in shock refractory cardiac arrest rhythms. Lidocaine remains an acceptable alternative. For patients with hypomagnesemia or torsades do pointes, the AHA recommends substituting magnesium sulfate for amiodarone.

CORTICOSTEROID USE IN CARDIAC ARREST

It is worth mentioning a recommendation that applies exclusively to the in-hospital environment. An animal study demonstrated that corticosteroid administration reverses the vasopressin hyporesponsiveness often seen in septic shock. In vitro studies of human arteries found that corticosteroid administration inhibits the endotoxin-mediated contractile depression response to norepinephrine during septic shock. Other researchers have demonstrated that cardiac arrest produces a sepsis-like syndrome during the post-resuscitation period leading to speculation that corticosteroids may enhance the cardiovascular effects of epinephrine and result in higher survival rates following cardiac arrest.

A small RCT of OOH cardiac arrest could not demonstrate any survival advantages associated with corticosteroid administration. In a small prospective, non-randomized trial, patients arriving in the emergency department with CPR in progress received either a corticosteroid during the resuscitation attempt or an injection of plain saline. Patients who received the corticosteroid had significantly higher ROSC rates compared to those who received the plain saline. Moreover, if the corticosteroid was administered within six minutes of the patient’s arrival in the emergency department, the difference in ROSC rates was even more striking. However, there was no difference in survival to hospital discharge or 1- and 7-day survival rates between the two groups. The exact role of steroids in the management of OOH cardiac arrest remains unclear.

However, for patients who develop cardiac arrest as an in-patient in the hospital, two RCTs found improved survival to hospital discharge associated with the administration of a combination of vasopressin, epinephrine, and methylprednisolone administered after achieving ROSC if the patient developed shock. Although the AHA does not recommend this drug combination for OOH resuscitation, hospital personnel may consider administering the drugs.
MANAGING HYPOTENSION
EMS personnel should continue to place a high priority on identifying and correcting hypotension (defined as a systolic blood pressure less than 90 mm Hg or a mean arterial pressure (MAP) less than 65 mm Hg) during the post cardiac arrest phase. During the period, if the rescue team can reliably measure oxyhemoglobin saturation, the team can begin titrating oxygen administration to achieve a saturation value of at least 94 percent.

THE USE OF ANTIARRHYTHMIC INFUSIONS
For patients who achieve ROSC after presenting in a shockable rhythm, many EMS providers administer an antiarrhythmic infusion in an effort to prevent the patient from re-arresting. The 2010 Guidelines acknowledged that although patients could receive antiarrhythmics during this time, there was no evidence to support or refute the continued use of any prophylactic antiarrhythmic agent during the post-resuscitation period.

For the 2015 Guidelines, the AHA reexamined this issue. One prehospital observational study of OOH cardiac arrest patients found conflicting results. Using one method of data analysis found an association between prophylactic lidocaine administration during the post cardiac arrest period and reduced odds of re-arrest from either VF/pVT or non-shockable rhythms, improved survival to hospital admission rates, and improved survival to hospital discharge rates. A second method of data analysis could only demonstrate a reduction in re-arrest from VF/pVT following lidocaine administration. Therefore, the AHA changed the previous recommendation to state that health care providers can consider administering lidocaine once the patient achieves ROSC following VF/pVT.

BETA BLOCKER USE AFTER ROSC?
The AHA also looked at another class of antiarrhythmic medications not commonly used for cardiac arrest in the OOH environment. An observational study of in-hospital cardiac arrest found that either oral or intravenous administration of beta-blocking agents within the first 72 hours of the post resuscitation period was associated with survival to hospital discharge. The AHA now recommends that hospital personnel consider administering either oral or intravenous beta-blockers within 72 hours of admission following cardiac arrest due to VF/pVT. This recommendation does not extend to the OOH environment.

TARGETED TEMPERATURE MANAGEMENT — HOW COLD?
The AHA made several modifications to the existing recommendations concerning targeted temperature management (TTM). In 2010, the strength of recommendation for initiating therapeutic hypothermia varied depending on cardiac arrest rhythm and location of the arrest. The current guidelines upgrade the strength of the recommendation for TTM to the highest level for all comatose patients who achieve ROSC regardless of the presenting rhythm or whether the arrest occurred in the OOH or hospital environment.

The previous guidelines recommended that health care providers achieve a temperature of 32 C to 34 C. Since publication of those guidelines, one RCT compared the outcomes between patients cooled to 33 C and those cooled to 36 C. There was no difference in mortality or neurologic function between the two groups suggesting that cooler temperatures conferred no outcome advantages. As a result, the AHA expanded the target range for hypothermia to temperature of 32 C to 36 C.

The AHA no longer recommends the prehospital use of chilled saline as a method of inducing hypothermia. Five RCTs using chilled IV fluids following ROSC, one trial using chilled IV fluids during the resuscitation attempt, and one trial using intra-nasal cooling could find no survival or neurological recovery benefits offered by prehospital cooling. In one of the chilled saline trials, initiating cooling in the field actually increased the risk of re-arrest and post resuscitation pulmonary edema.

DESTINATION CRITERIA FOR POST CARDIAC ARREST?
The AHA attempted to answer the question of whether transport to a facility that specializes in the care of a patient who has suffered an OOH cardiac arrest improves the outcome. Although the data is limited, there is one prospective study that indirectly addressed the question. Researchers found that transport to a critical care facility improved neurologically favorable one-month mortality compared to transport to a non-critical care facility, even when the patient did not achieve ROSC in the field. Thus the AHA recommends that EMS agencies collaborate with key stakeholders in the community and approach the problem of OOH cardiac arrest from a system perspective rather than from an individual agency standpoint. Part of this approach is the consideration of transport to specialized cardiac arrest hospitals.
TERMINATION OF RESUSCITATION BY EMS PROVIDERS
The AHA recommends EMS personnel consider terminating the resuscitation efforts when the team is unable to achieve an ETCO2 reading greater than 10 mm Hg 20 minutes after intubation. However, the AHA does not recommend using ETCO2 readings as the sole criterion for making that decision. Additionally, the AHA advises against using any ETCO2 value as a criterion for making a decision to terminate resuscitation in non-intubated patients.

EXPECT CONTINUED UPDATES TO THE GUIDELINES
Overall, changes in the 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care are relatively minor. The publication represents the culmination of years of work by the most respected resuscitation researchers in the world. This publication also marks the beginning of a new era in resuscitation guidelines as the American Heart Association transitions away from a five-year periodic update to a web-based format that will allow continuous updates. This should help minimize the inconsistencies that sometimes occur when EMS Medical Directors update system protocols and treatment guidelines with new science between the five-year official updates made by the American Heart Association.

REFERENCES AVAILABLE ONLINE
Rescue 46 and Engine 13 respond to an unconscious person at a high school football game. Dispatch reports an off-duty firefighter on the scene performing CPR.

Upon arrival, Engine 13 confirms the absence of a pulse and takes over CPR using a metronome to assist in maintaining the appropriate rate. After application of the AED pads, the device recommends a shock, which firefighters deliver immediately. The engine crew resumes high-quality CPR at a 30:2 compression/ventilation ratio.

Rescue 46 arrives and plugs the AED pads into the manual defibrillator, which displays ventricular fibrillation. Paramedic Davis delivers the second shock on time and the crew begins the next two-minute period of CPR.

Paramedic Davis asks the paramedic intern to establish an IV, which she easily does. After securing the IV, the intern administers epinephrine. While waiting for the next rhythm check, the intern asks if she should get the amiodarone ready. Davis quickly explains this particular EMS agency does not administer antiarrhythmics during a resuscitation attempt.

During the next six minutes, the patient receives two additional shocks and one additional milligram of epinephrine. At the next rhythm check, the patient has organized complexes and a palpable pulse. The patient remains comatose, does not breathe on his own and has a blood pressure of 104/72 mmHg.

During transport, the patient has another episode of ventricular fibrillation and the medics resume CPR. On arrival in the emergency department, the patient remains in cardiac arrest. The ED staff provides a thirty-minute resuscitation attempt. Without any response, the ED physician terminates the attempt.

Back at the station, the intern asks why the agency does not use an antiarrhythmic during a resuscitation attempt. She explains her school taught her to give amiodarone, which helps improve survival rates. Davis explains the local medical director removed the amiodarone from the ambulances last year stating there was no evidence it was effective.
STUDY REVIEW

Researchers with the Resuscitation Outcomes Consortium conducted a placebo-controlled investigation of antiarrhythmic administration for patients who suffered an out-of-hospital (OOH) cardiac arrest. Although not the official name, the investigation was known as the Amiodarone vs. Lidocaine vs. Plain Saline (ALPS) Trial.

The primary purpose of the ALPS investigation was to determine if amiodarone or a plain saline placebo resulted in greater survival to hospital discharge regardless of the neurological status of the patient — primary outcome variable, although the researchers collected data on a number of other outcome variables. The secondary purpose of the investigation was to compare lidocaine to a placebo and compare amiodarone to lidocaine. This hierarchy of comparisons highlights where the researchers expected to find the greatest differences in outcome measures.

Although this investigation utilized the same formulation of lidocaine used in resuscitation for decades, the type of amiodarone used was new. The standard formulation of amiodarone used in many early studies contained two chemicals that helped keep the drug dissolved in the liquid. Both of these chemicals are independently known to reduce the force of myocardial contraction and produce hypotension. These effects may be responsible for the lack of long-term survival seen in earlier trials of the drug.

The present study used a new formulation of amiodarone that did not contain the harmful stabilizers. The new captisol-enabled formulation of IV amiodarone keeps the drug dissolved in liquid but does not produce the harmful side effects associated with the earlier formulation.

The study drugs were packed in sealed boxes that paramedics would open after determining patient eligibility. Each ambulance had one kit, which was carried to the scene along with all other resuscitation equipment.

Each kit had three identical glass syringes marked with labels that read 1A, 1B, or 2. The contents of the three syringes in each kit were identical; each syringe contained 150 mg of amiodarone, 60 mg of lidocaine, or plain saline.

Paramedics, research staff and hospital staff were unaware of the contents of each individual kit — double blinded. If the patient received the contents of all three syringes, the total dose of drugs administered during the resuscitation attempt was 450 mg of amiodarone or 180 mg of lidocaine.

Patients received CPR according to the 2010 AHA Guideline recommendations. During this trial, the ROC was also conducting a comparison study on the effectiveness of continuous chest compressions versus interrupted chest compressions that followed the traditional 30:2 compression/ventilation ratio.

Patients in the ALPS study may also have been enrolled in the chest compression study. A summary of the chest compression study results can be found here.

CPR quality measures were closely monitored and strictly enforced during the study period. For continued participation in the study, EMS personnel in each participating agency had to meet certain CPR quality measures related to rate, depth, and chest compression fraction. In addition, the agencies had to meet other quality benchmarks such as completeness of patient care records, submission of ECG reports and timeliness of interventions.

After beginning chest compressions and providing bag mask ventilation, paramedics performed advanced life support interventions according to local protocol. In some cases, the first defibrillation attempt occurred before arrival of ALS personnel. In other cases, ALS personnel delivered the first shock immediately upon identifying a shockable...
rhythm (analyze early) or after delivering two minutes of high quality CPR (analyze later). During the two-minute period after the first shock, paramedics attempted to gain intravenous access, either through a peripheral venous or intraosseous site but did not administer any medications.

Patients who did not require subsequent shocks beyond the first defibrillation were not eligible for inclusion in this study. Among other eligibility criteria, the adult patient had to receive at least two shocks in the field.

After delivery of the second shock, the paramedics administered the first dose of epinephrine and opened the ALPS kit, which enrolled the patient into one of the three treatment arms. If the paramedic estimated the patient’s weight to be over 100 pounds, the paramedic administered the 1A and 1B syringes. If the patient weighed less than 100 pounds, the paramedic only administered the 1A syringe.

If the patient remained in a shockable rhythm after two additional minutes of high-quality CPR, the crew delivered a third shock. After resuming CPR, the paramedic delivered a second dose of epinephrine and the contents of the ALPS syringe with the label 2 regardless of the weight of the patient. All subsequent care followed agency specific protocols and may have included additional epinephrine, vasopressin, sodium bicarbonate, beta-blockers, procainamide or magnesium.

The study protocol is summarized in Figure 1.

RESULTS OF THE ALPS TRIAL

During the roughly 41-month trial, 35,889 patients in the areas served by the participating agencies had a non-traumatic out-of-hospital cardiac arrest. Of those, 7,051 had ventricular fibrillation or pulseless ventricular tachycardia at some point during the resuscitation attempt. After excluding a variety of patients who did not fully meet the inclusion criteria, data from roughly 3,026 patients underwent primary analysis.

Factors known to influence survival from OOH cardiac arrest were balanced over the three groups. This included factors such as whether the arrest occurred in a public place, whether the collapse was witnessed, whether bystanders performed CPR or delivered the first shock with an AED. The time it took for BLS and ALS responders to arrive on the scene were not different between the three groups.

In the primary analysis, 24.4 percent of the patients who received amiodarone, 23.7 percent of the patients who received lidocaine, and 21.0 percent of the patients who received placebo survived long enough to be discharged from the hospital. Although there was roughly a three percent absolute difference in survival between patients who received an antiarrhythmic and those who did not, the differences between the groups were not statistically significant and could have occurred simply as a matter of chance.
As often happens in clinical trials, the researchers and statisticians looked at treatment effects among various subgroups. This analysis provided some very interesting results. For example, if bystanders witnessed the cardiac arrest, survival to hospital discharge rates were about five percent higher if the patient received either amiodarone or lidocaine when compared to placebo. Additionally, if EMS personnel witnessed the collapse, survival was about 20 percent higher in patients who received amiodarone instead of placebo.

**WHAT THE ALPS TRIAL MEANS FOR EMS PROVIDERS**

For patients with refractory ventricular fibrillation or pulseless ventricular tachycardia, two previously conducted randomized control trials failed to find improved long-term survival rates associated with the intra-arrest administration of either amiodarone or lidocaine. In the ARREST trial, researchers found that amiodarone administration in the OOH environment was associated with improved return of spontaneous circulation rates when compared to a placebo, but was not associated with improved survival to hospital discharge.

Researchers in the ALIVE Trial found similar results in a comparison of amiodarone to lidocaine. The results of the ALPS Trial support the findings of both earlier trials.

The latest American Heart Association guidelines, released before publication of the ALPS Trial, note that recommendations for the use of antiarrhythmic medication in the treatment of cardiac arrest are based primarily on short-term survival benefits, not long-term survival benefits.

**STUDY LIMITATIONS**

Before changing treatment protocols and guidelines, one must carefully consider other factors that may have influenced the outcome of the study. One variable the researchers could not control is the care provided after the paramedics delivered the patient to the hospital. Some might argue this factor alone could be responsible for why the drugs, especially amiodarone, seemed to work well in the field but did not translate into increased long-term survival.

Although possible, this seems unlikely in this investigation. Hospital personnel were blinded to the experimental groups — meaning they did not know who received the lidocaine, who received the amiodarone, or who received a placebo. This helped prevent hospital staff from treating one group differently than the others.

The research staff also measured several aspects of the hospital care, such as whether patients received targeted temperature management, coronary catheterization within 24 hours of admission, an implanted cardiovascular defibrillator or withdrawn or limited care. With respect to these variables, there were no differences between the groups.

In this trial, it took paramedics, on average, about 19 minutes from the moment they arrived on the scene until they administered the study drugs. In two other randomized control trials, the drugs were not given until 21 and 25 minutes after ALS arrival on scene. One might argue the reason the drugs do not appear effective is they are given too late in the resuscitation attempt. Historically, a vasopressor is always the first medication administered during a resuscitation attempt. No one knows whether earlier administration of an antiarrhythmic would result in a different outcome.

Based on the results of two earlier trials, the ALPS researchers believed the administration of amiodarone would result in about a 6 percent increase in survival to hospital discharge. Using those numbers to perform a power analysis, the researchers determined they would need to enroll about 3,000 patients in the ALPS Trial to prove the survival increase really does exist (1000 people per group).

Since the actual survival to hospital discharge rate was only about three percent, the ALPS Trial was not sufficiently powered to demonstrate improved survival resulting from amiodarone. It could be that amiodarone actually is beneficial in increasing long-term survival rates, but this investigation would need about three times as many patients before being able to prove so.

**SUMMARY**

Although there is no evidence of harm, the routine administration of antiarrhythmic medication during a resuscitation attempt appears unnecessary. A subgroup of patients whose arrest episode is witnessed may derive a benefit from the drugs, however that benefit is still unproven. EMS agencies should continue to focus on training and providing high-quality CPR and early defibrillation.

REFERENCES AVAILABLE ONLINE
SUDDEN CARDIAC ARREST
350,000

46% Bystander CPR
12% Survivor Rate

Out-of-Hospital Incidents in 2016

Many EMS, law enforcement & laypeople utilize these solutions when responding to cardiac arrest:

- Smart CapnoLines
- Powerheart® G5 AED
- Curaplex® Defib Pads
- ROSC-U Automated CPR
- BlueSensor Electrodes
- Recertified Equipment

9 out of 10 victims don’t survive

* cpr.heart.org