TAKE HEART AMERICA: THE 2017 BUNDLE OF CARE

The Bundle of Care – No single intervention is effective in the treatment of cardiac arrest. Due to the highly complex nature of cardiac arrest, multiple treatments and devices are needed to resuscitate and sustain patients. The elements of this Bundle of Care are synergistic: when the entire bundle is available, and implemented using quality measures, survival rates from cardiac arrest soar.

Box 1: Public and Lay Response

Public Awareness and Education

Public awareness and education are critical to recognizing and treating cardiac arrest. The level of public awareness necessary to increase survival rates is established through support of local and state governments, community mobilization, and educational initiatives. Examples include CPR in school programs, social media and billboard campaigns, AEDs located in government buildings and public places, networking in companies and places of worship, and media involvement. At present, 33 states mandate CPR education and training prior to high school graduation. (1) View the map here: http://cpr.heart.org/AHAECC/CPRAndECC/Programs/CPRInSchools/UCM_475820_CPR-in-Schools-Legislation-Map.jsp

Widespread CPR by the Lay Public

Lay rescuers, defined as the non-medically trained general public, must perform CPR on as many patients as possible and as quickly as possible. When lay rescuer CPR is performed, survival rates increase 2-3 fold. (2) The general public needs to know how to perform CPR and feel comfortable using it. Chest compression-only CPR is easier to teach and learn than CPR that includes mouth-to-mouth cycles. The general public is encouraged to learn and perform CPR with mouth-to-mouth ventilation where access to rapid emergency care is limited. The percentage of lay rescuers who perform CPR varies widely from 20% to >50%, depending on the region and location type. When available, an AED is used by lay rescuers in accompaniment with CPR ensuring rapid defibrillation.

<u>Automatic External Defibrillator (AED) Use</u>

Public Access Defibrillation (PAD) programs provide access to AED's for the general public's use in administering lifesaving defibrillation. (3) PAD programs can save lives. Approximately 30% of patients in cardiac arrest present with an initial rhythm of ventricular fibrillation (VF), which can be treated with a defibrillator. For every minute of untreated VF, the chances for survival decrease by 10%. The public must be made aware of the closest AEDs, and then must be encouraged to use them. Available programs and cell phone applications are used to track AED locations and provide cell-phone users and EMS dispatchers with information on AED locations. Access to this information helps save more lives. (4-9) These programs are key to ensuring lay rescuers have access to and use of AEDs. In most states fewer than 5% of the lay rescuers use AEDs. The primary reason that the general public, or lay rescuers, do not perform CPR or use an AED, is fear of doing something wrong and lack of recent training. (1, 10-13)

<u>911 Dispatcher Assist CPR and AED Use</u>

Starting chest compressions as soon as possible saves more lives. When the 911-dispatcher coaches the caller to identify when a person is in need of immediate CPR, and instructs that person on how to perform CPR, more lives are saved. "No, no, go" is one recent program that has helped simplify dispatcher assisted CPR. The dispatchers determine if CPR is needed by asking: 'is the person conscious – yes/no; is the person breathing normally – yes/no"? If both answers are 'no', then they instruct the caller to start chest compressions immediately. Widespread use of rapid dispatcher-assisted CPR is a significant advance in the field of resuscitation. (14-22)

Box 2: First Responder CPR

Rapid Response

Efforts to decrease the time between when a dispatcher receives a 911 call-for-help, to arrival-on-scene and the start of CPR by first responders, save lives. Every minute that passes without CPR reduces the chances of survival by 10%. First responders include volunteers, police, and fire fighters. Every EMS system should regularly assess their "911-first responder at scene time interval" to ensure it is as short as possible. (23)

Start CPR immediately

When first responders arrive on scene and confirm a cardiac arrest, CPR should be continued if lay rescuer CPR was initiated, or started immediately if it was not. Without CPR there is no blood flow to the brain. Every minute without CPR reduces the chances of surviving by up to 10%. (24, 25) An AED is used in conjunction with high quality CPR.

High quality CPR

For manual closed chest CPR to be effective it needs to be delivered correctly. (26) The compression rate is 100-110 per minute (not faster), depth of 2 inches in adults and 1.5 inches in infants, and the chest must fully recoil after each compression. An AED is used in conjunction with high quality CPR. First responders use a compression:ventilation ratio of 30:2, a 2-handed facemask technique, bag-valve-ventilation with a tidal volume of 500-600 cc, and deliver each breath over <1 second, until more advanced forms of airway management are placed. Chest compressions should NOT be stopped for airway management. Rescuers should rotate no less than every minute 2 minutes with minimal interruptions. Each of these recommendations related to compression rate, depth, recoil, and compression:ventilation ratio is closely linked to increased survival with good brain function. (27-38) When an advanced airway is placed then the compression:ventilation ratio is changed to 10:1 with asynchronous ventilations.

Rapid AED use

AEDs are used as soon as possible. When there are adequate personnel at the scene, efforts are made to perform chest compressions without interruption by one rescuer as the second rescuer positions and uses the AED. (39-42)

CPR feedback tools

High quality CPR is difficult to perform without real time guidance. (43) Feedback tools that assist in the delivery of high quality CPR (correct rate, depth, recoil) are available, are often linked to defibrillators, and have been shown to improve CPR quality. High quality CPR is closely associated with better survival rates. (44) Multiple devices are available for this purpose.

Impedance Threshold Device (ITD)

An impedance threshold device (ITD) is an adjunct that lowers intrathoracic pressure during the chest recoil phase of CPR, drawing more blood back into the heart and lowering intracranial pressures. This technology contributes to the increase in survival with good brain function when an ITD is used with high quality CPR. (45-50) Without high quality CPR the benefits of the ITD cannot be assured. (51)

Active compression decompression (ACD) CPR and an impedance threshold device (ITD) (ACD+ITD)

The combination of active compression decompression (ACD) CPR and an impedance threshold device (ITD) provides 2-3 times more blood flow to the heart and the brain than traditional manual CPR. (52) This device combination has been shown to increase the likelihood of survival by 50% when compared with conventional manual CPR. (45, 48) ACD+ITD CPR can be used by first responders (police and fire), and advanced life support (ALS) EMS personnel. When an ITD is used with a facemask, a 2-handed technique is needed to maintain a seal between the mask and the skin at all times. ACD+ITD CPR can be performed with a 30:2 or 10:1 compression:ventilation ratio depending upon whether BLS or ALS is performed. An ITD has a timing light that flashes 10x per minute to guide the ventilation rate during ALS. Training is needed to teach proper ACD+ITD technique. (48)

Collect performance data

Critical CPR quality metrics and time intervals are measured to monitor field activity and assure proper care is provided in a timely manner. Data is collected on all cases related to receipt of the 911-call-for-help and the multiple subsequent actions taken by the care providers including time from dispatch to the scene, time from 911 call to start of CPR, time to AED placement and use, duration of CPR, the quality of CPR performed, the number of personnel at the scene, the method of airway management, use of the ITD and other CPR adjuncts, and the method(s) of CPR used. Multiple EMS programs are available for tracking these important data elements.

Communication with the base hospital

Recent advances in cell phone app technology allow first responders and EMS personnel to communicate rapidly with base hospital physicians and support staff. This rapid communication ensures early medical oversight resulting in to improved care at the scene and facilitates more timely plans for transport to an appropriate cardiac receiving center.

Box 3: EMS

High Quality CPR

EMS personnel continue to focus on high quality uninterrupted chest compressions, as described above, throughout the resuscitation effort.

Advanced Airway Management

A 2-handed facemask technique is used initially and when staffing allows. (49) Advanced airway devices reduce the likelihood of aspiration and facilitate patient ventilation, especially during transport. They have not been shown to increase survival rates. A variety of advanced airway devices, including endotracheal tubes and supraglottic airway adjuncts. (53-57)

Intra-osseous (IO) drug delivery

IO delivery of fluids and drugs can generally be initiated more rapidly than intra-venous access and are recommended when in cardiac arrest patients. (58, 59)

ACD+ITD CPR
(see above for ACD+ITD CPR).

Mechanical CPR

Automated mechanical CPR devices have been found to be equivalent to high quality manual conventional CPR. Multiple devices are available and they can be particularly effective when insufficient personnel are available on scene. (60-62) During transport, automated CPR devices are used rather than manual conventional CPR. Performance of manual CPR during transport should be avoided as it is dangerous for rescue personnel and the patient. (63)

Continuous End tidal CO2 (ETCO2) monitoring

End tidal CO2 is a non-invasive indicator of circulation during CPR. In general, the higher the ETCO2, the better the circulation. (64, 65) There are no ideal non-invasive measures of adequate circulation but

ETCO2 can be a useful guide to therapy and a first indicator of loss of perfusing circulation. (66)

Cerebral Oximetry

Recently, newer technologies to non-invasively measure blood oxygen content to the brain have become available. Brain oxygen content shows promise as a way to determine both the amount of oxygen delivered to the brain and the likelihood of recovery after resuscitation (67-69).

Pediatric and Adult Drug Algorithms

The determination of the correct dose of cardiac medications can be challenging especially in infants and small children. One size fits all medication references require that providers calculate dosages rapidly and lead to a significant increase in medication errors. (70) Recent data has demonstrated a 49% medication discordance between the length based tape and standard EMS protocols. (71) Customized dosing guides (printed or mobile app) are now available to assist in determining the correct dose of a variety of medications to avoid mistakes and improve outcomes. Age-based resuscitation drug protocols are as effective as the length-based tape and allows providers to determine dosing *prior* to arrival on scene. (72-74)

Extended scene times and ongoing CPR to the hospital

Newer CPR methods that enhance circulation as well as automated CPR devices that provide high quality CPR have helped increase the chances for survival. In some systems CPR is performed for >30 minutes at the scene to increase the chances for survival. Recently some EMS systems have started to transport patients with ongoing automated CPR to Cardiac Arrest Centers for advanced cardiovascular care (see ECMO below) if they present with VF and cannot be resuscitated after ~15 minutes of CPR in the field. There are multiple reports of patients surviving with full brain function even after > 1 hour of CPR in the field. (75)

Start therapeutic temperature management

Targeted Temperature Management (TTM) improves outcome in selected comatose survivors of cardiac arrest. (76, 77). The intensity of the intervention is currently a topic of ongoing research. (78) Consideration should be given to preferential transport of cardiac arrest victims to facilities that have TTM programs. Prehospital cooling is controversial and has not been shown to improve outcome. Prehospital intravascular cooling with chilled saline has not been shown to improve outcomes when initiated after ROSC and there is concern that intravascular cooling given prior to ROSC may negatively affect outcomes. (79) EMS decisions to initiate TTM should be based upon transport times and ability to reliably measure temperatures in the field and should use external methods such as ice packs. The 2015 AHA Guidelines recommend against routine use of prehospital cooling with rapid infusion of large volumes of cold IV fluid immediately after ROSC. (80-82)

Collect performance data

As described above for first responders, measurement of CPR performance and outcome data (e.g. ETCO2) are key to improving outcomes with favorable brain function during EMS–guided CPR. (83, 84)

Box 4: Hospital (Resuscitation Receiving Hospitals)

Similar to the concepts underlying Level 1 Trauma centers, hospitals with expertise directed towards cardiac arrest patients have the best outcomes. (46, 85-87) When possible, EMS personnel should direct patients to those hospital centers specializing in comprehensive cardiac arrest care management. Specialized centers should have capacity for taking patients directly to the cardiac catheterization laboratory for percutaneous coronary interventions (PCI), temperature management, specialized ICU care, cardiac electrophysiological evaluation and treatment and extracorporeal membrane oxygenation (ECMO) when available.

Cardiac/PCI catheterization ASAP

EKG should be performed immediately after ROSC and patients demonstrating STEMI should be taken emergently to percutaneous coronary intervention (PCI). Selected NSTEMI patients may benefit from an early invasive cardiac strategy after cardiac arrest as well. Preferred receiving centers should have a demonstrated history of early PCI for resuscitated cardiac arrest patients. Additionally, these centers should be prepared and willing to take patients for PCI even in the setting of ongoing cardiac arrest, particularly in the setting of refractory VF, using mechanical CPR and circulatory adjuncts such as ECMO. (88) If the patient is still in cardiac arrest in the catheterization laboratory, automated CPR can be useful to maintain some perfusion during the PCI procedure prior to return of spontaneous circulation. (89) Pre-arrival notification and coordination between EMS and the emergency department personnel and cardiology teams increases the likelihood of survival with good brain function after cardiac arrest. (90)

Targeted Temperature Management

If a patient is comatose after cardiac arrest and/or cannot respond to questions, therapeutic temperature management improves the likelihood of full neurological recovery. (76, 77) The sooner a comatose patient is cooled, the better the outcome. (91) Cooling can be started outside the hospital, as described above. (92) The target temperature is somewhat controversial due to a recent publication showing similar outcomes when patients were cooled to either 33° C or 36° C for 24 hours but with either temperature target, active cooling strategy was used. The target temperature should be tightly controlled. It has been shown that fevers in the post-resuscitation timeframe can lead to a worse neurological outcome. Most experts recommend a gradual rewarming at a rate of 0.5° C per hour. (76, 77, 93) Both invasive and non-invasive methods to accomplish TTM are effective. (82)

Specialized ICU care

After cardiac arrest, patients who are unconscious or hemodynamically unstable require specialized ICU care. Efforts are taken to deliver patients to tertiary care centers as quickly as possible after cardiac arrest. Board certified specialists should care for this extraordinarily sick patient population.

Post resuscitation O2 administration should be governed by the factors discussed above, regarding titrating 91-95%, with efforts to avoid insufficient and excessive amount of supplemental O2.

Hyperglycemia is common after cardiac arrest. Adequate control of blood glucose with insulin reduces hospital mortality rates in critically ill adults in a surgical ICU and may protect the central and peripheral nervous system for cardiac arrest patients as well. (94, 95)

Seizures, myoclonus, or both occur in 5%-15% of adult patients after cardiac arrest and 10%-40% of those who remain comatose. (96-99) Seizures increase cerebral metabolism by up to 3-fold. (100) Prolonged seizures should be treated promptly and effectively with benzodiazepines, phenytoin, sodium valproate, propofol, or a barbiturate. No studies have directly assessed the use of prophylactic anticonvulsant drugs after cardiac arrest in adults and, as such, the optimal choice is unknown. Each of these drugs can cause hypotension, and this must be treated accordingly. Clonazepam is the drug of choice for the treatment of myoclonus.

Efforts should be made to allow patients to wake up after rewarming: it can take over a week for some patients to wake up after cardiac arrest. (101)

Extracorporeal membrane oxygenation (ECMO)

Recent studies show that ECMO is effective in saving patients with ongoing CPR and refractory VF. (102, 103) ECMO can be placed in the emergency department or cardiac catheterization laboratory. (104) It can be used to maintain circulation, sometimes for many days, until the heart and brain recover. (102)

Pharmacological management of blood pressure and arrhythmias

Vasopressor and anti-arrhythmic support needs to be individualized on a patient-by-patient basis. Similarly, intravenous amiodarone is generally used as the first line anti-arrhythmic agent but other anti-arrhythmic drugs should be used as needed. Recent case reports suggest that Esmolol is effective in patients with refractory VF despite treatment with amiodarone and lidocaine and normalization of electrolytes. (107)

EP evaluation/ICD placement

Patients should be treated with an implantable cardioverter defibrillator (ICD) after cardiac arrest unless the cause of the arrest is completely reversible. (108-112) ICD placement after cardiac arrest prevents recurrence of lethal arrhythmias and allows the patient to take certain anti-arrhythmic drugs that would otherwise be considered potentially harmful without the ICD as a backup. In the subgroup of patients with a completely reversible cause of arrest, those with no prior warning should be considered ICD candidates as the risk of cardiac arrest recurrence is usually high enough to justify the risks and costs of the device.

Track and report outcomes

Without the ability to accurately measure outcomes, it is not possible to know how well any given system is doing, how the presence, absence, or timeliness of certain steps affects outcomes, and how to improve outcomes further. Multiple cardiac arrest registries exist, including the AHA's 'Get with the Guidelines' and the CDC's Cardiac Arrest Registry to Enhance Survival (CARES). (113) When these registries are implemented correctly, which includes assuring that the data collection and input process is comprehensive and thorough, they provide a means to assess outcomes on a consistent year-to-year basis and can be used to guide continuous quality improvement efforts. One of the most important outcome measures includes the total number of patients who have a cardiac arrest and the number of patients who survive with good brain function to hospital discharge.

Connect patients and/or loved ones with support and education services

Cardiac arrest is rare in any given community, but common nationwide. Only about 1% of all 911 calls involve a cardiac arrest and with <20% overall survival rate in the best of EMS systems, patients often find themselves alone and in need of support. (114) A number of local and national support groups have been developed to help patients assimilate back into their communities and help families link up to share the challenges of the recovery process (i.e. Sudden Cardiac Arrest Association, Heart Rescue, Life After SCA, Parent Heart Watch). These support systems provide a critical bridge for many patients and families, as the patients often have no recollection of the event and the event is extremely traumatic for the families and loved ones.

Predictive QI Algorithms for in-hospital arrests

It is estimated that 60% of all in-hospital cardiac arrests are preventable. (115) New predictive algorithms have been developed that, when implemented hospital-wide, reduce in-hospital cardiac arrest rates and save hospital resources. (116-119) Other new algorithms focus on multiple time-sensitive emergencies, including cardiac arrest, heart attack, stroke, trauma, and sepsis. This kind of approach can be used to improve in-hospital quality of care, reduce in-hospital mortality rate, and save hospital resources.

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