PURPOSE:

Treatment of: Cardiac Arrest: VF, VT, Asystole, and PEA [Adult]

Aliases

Heart attack, arrest, cardiac arrest

ABBREVIATIONS:

- VT - Ventricular Tachycardia
- VF - Ventricular Fibrillation
- ROSC - Return of Spontaneous Circulation
- EMS - Emergency Medical Services
- AED - Automated External Defibrillator
- IV - Intravenous
- IO - Intraosseous
- BVM - Bag Valve Mask
- ETT - Endotracheal Tube
- NRB - Non-Rebreather

PROTOCOL:

Patient Care Goals

1. Return of spontaneous circulation (ROSC)
2. Preservation of neurologic function
3. High-quality chest compressions with minimal interruption from recognition of cardiac arrest until confirmation of ROSC or field termination of care

Patient Presentation

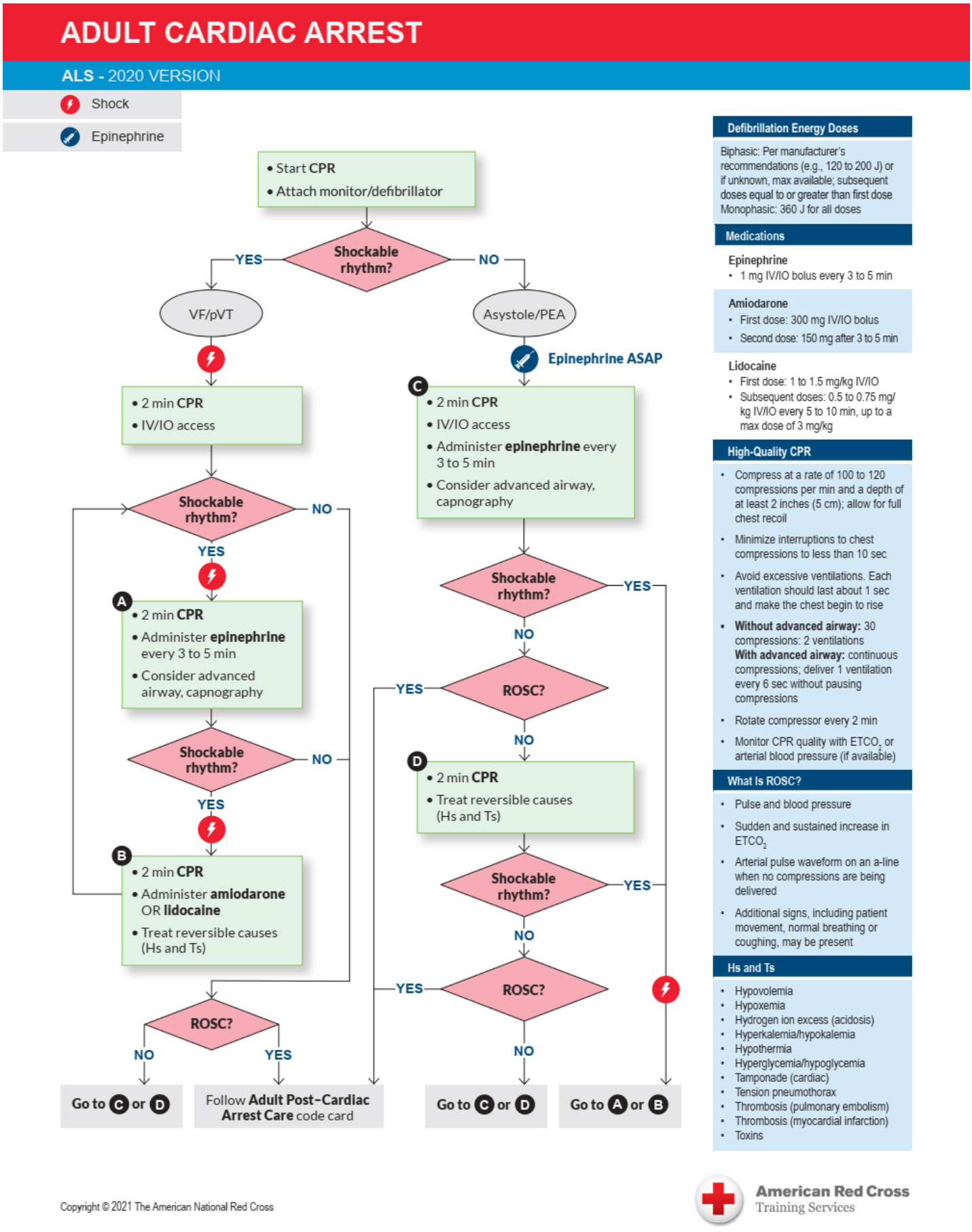
- **Inclusion Criteria**
    - Patients with cardiac arrest
- **Additional Considerations**
    - Patients suffering cardiac arrest due to severe hypothermia [see Hypothermia/Cold Exposure guideline]
    - Patients with identifiable Do Not Resuscitate (or equivalent such as POLST) order [see Do Not Resuscitate Status/Advance Directive/Health Care Power of Attorney (POA) Status guideline]
    - Patients in arrest due to traumatic etiology [see General Trauma Management guideline and Cardiac Arrest-Traumatic Considerations]

Patient Management

Assessment

- The patient in cardiac arrest requires a prompt balance of treatment and assessment
- In cases of cardiac arrest, assessments should be focused and limited to obtaining enough information to reveal the patient is pulseless
- Once pulselessness is discovered, treatment should be initiated immediately and any further history must be obtained by bystanders while treatment is ongoing

Treatment and Interventions



The most important therapies for patients suffering from cardiac arrest are prompt cardiac defibrillation for shockable rhythms and minimally interrupted effective chest compressions.

1. Initiate chest compressions in cases with no bystander chest compressions or take over

compressions from bystanders while a second rescuer is setting up the AED or defibrillator.
    - If adequate, uninterrupted bystander CPR has been performed or if the patient arrests in front of the EMS clinicians, immediately proceed with rhythm analysis and defibrillation, if appropriate
    - For adults and children with unwitnessed cardiac arrest or for whom an AED is not immediately available, it is reasonable that CPR be initiated while the defibrillator equipment is being retrieved and applied and that defibrillation if indicated, be attempted as soon as the device is ready for use
2. Chest compressions should resume immediately after defibrillation attempts with no pauses for pulse checks for 2 minutes, regardless of the rhythm displayed on the cardiac monitor.
3. All attempts should be made to prevent avoidable interruptions in chest compressions, such as pre-charging the defibrillator and hovering over the chest rather than stepping away during defibrillation.
4. If feasible, IV or IO access should be obtained [AEMT]. Administer epinephrine during the first or second round of compressions. Prioritize early administration of epinephrine for non-shockable rhythms [PARA]
5. Airway Management Considerations
    - The airway management strategy should not interrupt compressions.
    - Passive ventilation:
        - High flow oxygen is applied via a non-rebreather mask with an oropharyngeal airway [EMR-O; EMT-R].
        - Some oxygen will be entrained with each decompression of the chest.
        - This may be applied for the first 3–4 compression cycles (6–8 minutes), after which one may consider BVM ventilation or placement of an advanced airway.
    - BVM ventilation
        - Continuous: BVM ventilation at 10 breaths per minute (1 breath every 10 compressions), applied during the upstroke between compressions, without interrupting the compressions [EMR]. **OR**
        - Intermittent: BVM ventilation with 30:2 ventilation to compression ratio: Each 30 compressions, the compressions are paused briefly to allow 2 BVM ventilations, then compressions immediately resumed.
    - Advanced airway placement:
        - Either a supraglottic airway or an endotracheal tube may be placed without interruption of compressions [non-visualized
        - Ventilations are provided at 10 breaths/minute for adults.

6. Consider reversible causes of cardiac arrest which include the following:
    - Hypovolemia: Additions to above care include normal saline 2 L IV ***[AEMT]***
    - Hypothermia: Additions to care include attempts at active rewarming [see Hypothermia/Cold Exposure guideline].
    - The dialysis patient/known hyperkalemic patient: Additions to the above care include the following:
        - **Calcium (gluconate preferred) *[PARA]***
            - **1grams IV/IO push**
            - May repeat up to a total of 3g for ongoing symptoms
        - **Sodium bicarbonate *[PARA]* 1mEq/kg IV/IO, max 50 Eq bolus**
    - Tricyclic antidepressant overdose: Additions to the above care include sodium bicarbonate ***[PARA]* 1mEq/kg IV/IO max 50 Eq bolus**
    - If the patient is intubated at the time of arrest, assess for tension pneumothorax and misplaced ETT
    - If tension pneumothorax is suspected, perform needle decompression ***[PARA]***.
    - Assess ETT, if misplaced, replace ETT
7. If there is ongoing (refractory) ventricular fibrillation or tachycardia, consider Double Sequential Defibrillation (see Double Sequential Defibrillation procedure)
8. If at any time during this period of resuscitation, the patient regains return of spontaneous

circulation, treat per Adult Post-ROSC Care guideline

9. If resuscitation remains ineffective, consider termination of resuscitation [see Termination of Resuscitative Efforts guideline]

Patient Safety Considerations

- Performing manual chest compressions in a moving vehicle may pose a provider safety concern.
- In addition, manual chest compressions during patient movement are less effective in regards to hands-on time, depth, recoil, and rate.
- Ideally, patients should be resuscitated as close to the scene as operationally possible.
- Risks and benefits should be considered before patient movement in cardiac arrest situations.

Notes and Educational Pearls Key Considerations

1. Effective chest compressions and defibrillation are the most important therapies to the patient in cardiac arrest. Effective chest compressions are defined as:
    - A rate of greater than 100 and less than 120 compressions/minute.
    - Depth
        - Adults and children–at least 2 inches (5 cm) and less than 2.4 inches (6cm);
        - Infants– or 1.5 inches (4 cm);
        - Adolescents– patients who have entered puberty should receive the same depth of chest compressions as an adult
    - Allow for complete chest recoil (avoid leaning).
    - Minimize interruptions in compressions.
    - Avoid rescuer fatigue by rotating rescuers at least every 2 minutes. Some EMS pit crew approaches use a provider on either side of the chest, alternating compressions every minute or every 100 compressions to avoid fatigue.
2. Avoid excessive ventilation and consider delayed airway management. If no advanced airway, consider:
    - Passive ventilation using an NRB with 3–4 cycles of uninterrupted chest compressions (for arrests of suspected cardiac etiology). Consider BVM ventilation or advanced airway after 3–4 cycles.
    - BVM ventilation every 10–15 compressions with cycles of uninterrupted chest compressions. Upstroke ventilation between compressions. 30:2 ventilation to compression ratio for adults, and 15:2 for children when 2 rescuers are present.
    - If an advanced airway is placed, ventilations should not exceed 10 breaths/minute (1 breath every 6 seconds or 1 breath every 10 compressions) in adults.
3. Quantitative end-tidal CO_2 should be used to monitor effectiveness of chest compressions.
    - If $ETCO_2$ less than 10 mmHg during the initial phases of resuscitation, attempt to improve chest compression quality.
    - Consider additional monitoring with biometric feedback which may improve compliance with suggested Resuscitation section guidelines.Chest compressions are usually the most rapidly applied therapy for the patient in cardiac arrest and should be applied as soon as the patient is noted to be pulseless. If the patient is being monitored with pads in place at the time of arrest, immediate defibrillation should take precedence over all other therapies, however, if there is any delay in defibrillation (for instance, in order to place pads), chest compressions should be initiated while the defibrillator is being applied. There is no guidance on how long these initial compressions should be applied; however, it is reasonable to either complete between 30 seconds and 2 minutes of chest compressions in cases of no bystander chest compressions **or** to perform defibrillation as soon as possible after chest compressions initiated in cases of witnessed arrest.
4. Chest compressions should be re-initiated immediately after defibrillation as pulses, if present, are often difficult to detect and rhythm and pulse checks interrupt compressions.
5. Continue chest compressions between completion of AED analysis and AED charging.
6. Effectiveness of chest compressions decreases with any movements.
    - Patients should therefore be resuscitated as close to the point at which they are first

encountered and should only be moved if the conditions on scene are unsafe or do not operationally allow for resuscitation.
    - Chest compressions are also less effective in a moving vehicle.
    - It is also dangerous to EMS providers, patients, pedestrians, and other motorists to perform chest compressions in a moving ambulance.
    - For these reasons and because in most cases the care provided by EMS providers is equivalent to that provided in emergency departments, resuscitation should occur on scene.
7. The maximum setting on the defibrillator should be used for initial and subsequent defibrillation attempts. Defibrillation dosing should follow manufacturer's recommendation in the case of biphasic defibrillators.
8. Place IV or IO access without interrupting chest compressions.
9. Administer epinephrine during the first or second round of compressions.
10. At present, the most effective mechanism of airway management is uncertain, regardless of the airway management style, consider the following principles:
    - Airway management should not interrupt chest compressions.
    - Carefully follow ventilation rate and prevent hyperventilation.
    - Consider limited tidal volumes.
    - There is uncertainty regarding the proper goals for oxygenation during resuscitation:
        - Current recommendations suggest using the highest flow rate possible through NRB or BVM.
        - This should not be continued into the post-resuscitation phase in which the goal should be an oxygen saturation of greater than 93%.
    - In addition, conventional CPR is preferred in children, since it is associated with better outcomes when compared to compression-only CPR.
11. Special Circumstances in Cardiac Arrest
    - Trauma: Treat per the General Trauma Management guideline.
    - Pregnancy
        - The best hope for fetal survival is maternal survival.
        - Position the patient in the supine position with a second rescuer performing manual uterine displacement to the left in an effort to displace the gravid uterus and increase venous return by avoiding aorto-caval compression.
        - If manual displacement is unsuccessful, the patient may be placed in the left lateral tilt position at 30°. This position is less desirable than the manual uterine displacement as chest compressions are more difficult to perform in this position.
        - Chest compressions should be performed slightly higher on the sternum than in the non-pregnant patient to account for elevation of the diaphragm and abdominal contents in the obviously gravid patient.
        - Defibrillation should be performed as in non-pregnant patients.
    - Arrests of respiratory etiology (including drowning): In addition to the above, consider early management of the patient's airway. Passive ventilation with a NRB is not indicated for these patients.
12. Application of the "pit crew" model of resuscitation
    - Ideally, providers in each EMS agency will use a "pit crew" approach when using this protocol to ensure the most effective and efficient cardiac arrest care. Training should include teamwork simulations integrating first responders, BLS, and ALS crew members who regularly work together. High-performance systems should practice teamwork using "pit crew" techniques with predefined roles and crew resource management principles. For example (the Pennsylvania State EMS Model for Pit Crew):
        - Rescuer 1 and 2 set up on opposite sides of patient's chest and perform continuous chest compressions, alternating after every 100 compressions to avoid fatigue.
        - Use a metronome or CPR feedback device to ensure that compression rate is 100–120/minute.
        - Chest compressions are only interrupted during rhythm check (AED analysis or manual) and defibrillation shocks. Continue compressions when AED/ defibrillator is charging.

- Additional rescuer obtains IV/O access and gives epinephrine. For IO access:
    - The proximal humerus is the preferred site for adults.
    - The tibial site is preferred for infants and children.
- During the first four cycles of compressions and defibrillation, (approximately 10 minutes) avoid advanced airway placement.
- One responding provider assumes code leader position overseeing the entire response.
- Use a CPR checklist to ensure that all best practices are followed during CPR.

Quality Improvement

Associated NEMSIS Protocol(s) (eProtocol.01)

- 9914011—Cardiac Arrest-Asystole
- 99014013—Cardiac Arrest-Hypothermia-Therapeutic
- 9914015—Cardiac Arrest-Pulseless Electrical Activity
- 9914017—Cardiac Arrest-Ventricular Fibrillation/Pulseless Ventricular Tachycardia)
- 9914055—General-Cardiac Arrest
- 9914087—Injury-Cardiac Arrest

Key Documentation Elements

- Should be tailored to any locally utilized data registry but may include as a minimum the following elements:
    - Resuscitation attempted and all interventions performed
    - Arrest witnessed
    - Location of arrest
    - First monitored rhythm
    - CPR before EMS arrival
    - Outcome
    - Any ROSC
    - Presumed etiology
        - Presumed cardiac
        - Trauma
        - Submersion
        - Respiratory
        - Other non-cardiac
        - Unknown

Performance Measures

- Time to scene
- Time to patient
- Time to first CPR
- Time to first shock
- Time of ROSC
- Review of CPR Quality
    - Compression Fraction
    - Average and longest peri-shock pause
    - Rate and depth of compressions

REFERENCES:

1. Atkins DL, Berger S, Duff JP, et al. Part 11: Pediatric Basic Life Support: 2015 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care.

Circulation. 2015;132(18 Suppl 2):S519-25.
2. Bobrow BJ, Clark LL, Ewy GA, et al. Minimally interrupted cardiac resuscitation by emergency medical services for out-of-hospital cardiac arrest. *JAMA*. 2008;299(10):1158-65.
3. Brooks, Anderdon ML, Bruder E, et al. Part 6: alternative techniques and ancillary devices for cardiopulmonary resuscitation: 2015 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;132(18 Suppl 2):S436-43.
4. de Caen R, Berg MD, Chameides L, et al. Part 12: Pediatric Advanced Life Support: 2015 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;132(18 Suppl 2)S526-42.
5. Dorian P, Cass D, Schwartz B, Cooper R, Gelaznikas R, Barr A. Amiodarone as compared with lidocaine for shock-resistant ventricular fibrillation. *N Engl J Med*. 2002;346(12):884-90
6. Ewy GA. The cardiocerebral resuscitation protocol for treatment of out-of-hospital primary cardiac arrest. *Scand J Trauma Resusc Emerg Med*. 2012;20:65.
7. Garza AG, Gratton MC, Salomone JA, Lindholm D, McElroy J, Archer R. Improved patient survival using a modified resuscitation protocol for out-of-hospital cardiac arrest. *Circulation*. 2009;119(19):2597-605.
8. Hinchey PR, Myers JB, Lewis R, et al. Improved out-of-hospital cardiac arrest survival after the sequential implementation of 2005 AHA guidelines for compressions, ventilations, and induced hypothermia: the Wake County experience. *Ann Emerg Med*. 2010;56(4):348-357.
9. Hopkins CL, Burk C, Moser S, Meersman J, Baldwin C, Youngquist ST. Implementation of pit crew approach and cardiopulmonary resuscitation metrics for out-of-hospital cardiac arrest improves patient survival and neurological outcome. *J Am Hear Assoc*. 2016;5.
10. Hostler D, Everson-Stewart S, Rea TD, et al. Effect of real-time feedback during CPR. *BMJ.* 2011;342:d512.
11. Huang CH, Yu PH, Tsai MS, et al. Acute hospital administration of amiodarone and/or lidocaine in shockable patients presenting with out-of-hospital cardiac arrest: a nationwide cohort study. *Int J Cardiol*. 2017;227:292-8.
12. Jacobs I, Hadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries. C*irculation.* 2004;110(21):3385-97.
13. Kleinman ME, Brennan EE, Goldberger ZD, et al. Part 5: Adult Basic Life Support: 2015 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;312(18 Suppl 2):S414-35.
14. Kronick SL, Kurz MC, Lin S, et al. Part 4: systems of care and continuous quality improvement: 2015 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;132(18 Suppl 2):S397- 413.
15. Kudenchuk PJ, Brown SP, Daya M, et al. Amiodarone, lidocaine, or placebo in out-of-hospital cardiac arrest. *N Engl J Med*. 2016;374(18):1711-1722.
16. Kudenchuk PJ, Cobb LA, Copass MK, et al. Amiodarone for resuscitation after out-of-hospital cardiac arrest due to ventricular fibrillation. *N Engl J Med*. 1999;341(12):871-878.
17. Lavonas EJ, Drennan IR, Gabrielli A, et al. Part 10: cardiac arrest in special situations: 2015 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;132(18 Suppl 2):S501-18.
18. Link MS, Berkow LC, Kudenchuk PJ, et al. Part 7: adult advanced cardiovascular life support: 2015 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;132(18 Suppl 2):S444-64.
19. Neumar RW, Shuster M, Callaway CW, et al. Part 1: executive summary: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;132(18 Suppl 2)S315-67.
20. Nichol G, Leroux B, Wang H, et al. Trial of continuous or interrupted chest compressions during CPR. *N Engl J Med*. 2015;373(23):2203-14.
21. Sporer K, Jacobs M, Derevin L, Duval S, Pointer J. Continuous quality improvement efforts increase survival with favorable neurologic outcome after out-of-hospital cardiac arrest. *Prehospital Emerg Care*. 2017;21(1):1-6.

SUPPORTING DOCUMENTATION:

- None

ADDENDUM:

- None

COMMITTEE APPROVALS:

- None