Resuscitation

Cardiac Arrest (VF/VT/Asystole/PEA)

Aliases

Heart attack, arrest, full arrest

Patient Care Goals

1. Return of spontaneous circulation (ROSC)
2. Preservation of neurologic function
3. High-quality chest compressions/CPR 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

Exclusion Criteria

1. Patients suffering cardiac arrest due to severe hypothermia [see Hypothermia/Cold Exposure guideline]
2. Patients with identifiable Do Not Resuscitate (or equivalent such as POLST) order [see Do Not Resuscitate Status/Advance Directive/Healthcare Power of Attorney (POA) Status guideline]
3. Patients in arrest due to traumatic etiology [see General Trauma Management guideline]

Patient Management

Assessment

1. The patient in cardiac arrest requires a prompt balance of treatment and assessment
2. In cases of cardiac arrest, assessments should be focused and limited to obtaining enough information to reveal the patient is pulseless
3. 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 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
    a. If adequate, uninterrupted bystander CPR has been performed or if the patient arrests in front of the EMS providers, immediately proceed with rhythm analysis and defibrillation, if appropriate
    b. It is realistic for EMS providers to tailor the sequence of rescue actions to the most likely cause of arrest
    c. There is insufficient evidence to recommend for or against delaying defibrillation to provide a period of CPR for patients in VF/pulseless VT out-of-hospital cardiac arrest

    d. For adults and children with unmonitored 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. 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. If the manufacturer's recommendation is unknown, use highest setting possible. In the case of monophasic devices, the setting should be 360 J (or 4 J/kg for children)
3. 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
4. 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 defibrillations
5. If feasible, IV or IO access should be obtained. Administer epinephrine during the first or second round of compressions
6. Continue the cycle of chest compressions for 2 minutes, followed by rhythm analysis and defibrillation of shockable rhythms; during this period of time, the proper strategy of airway management is currently not defined and many options for airway management exist – Regardless of the airway management and ventilation strategy, consider the following principles:
    a. The airway management strategy should not interrupt compressions
    b. Successful resuscitation from cardiac arrest depends primarily on effective, minimally-interrupted chest compressions and prompt defibrillation; airway management is of secondary importance and should not interfere with compressions and defibrillation – Options for airway management include:
        i. Passive ventilation:
            1. High flow oxygen is applied via a non-rebreather mask with an oropharyngeal airway
            2. Some oxygen will be entrained with each decompression of the chest
            3. 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 (as below).
        ii. BVM ventilation at 10 breaths per minute (1 breath every 10 compressions), applied during the upstroke between compressions, without interrupting the compressions
        iii. 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
            1. **Pediatric Consideration:** For multiple rescuer CPR in children, 15:2 is the recommended compression to ventilation ratio. (30:2 for single rescuer).
            2. **Pediatric Consideration:** For neonates, 3:1 is the recommended compression to ventilation ratio.
        iv. Advanced airway placement:
            1. Either a supraglottic airway or an endotracheal tube may be placed without interruption of compressions
            2. Ventilations are provided at 10 breaths/minute for adults

3. **Pediatric Consideration:** for children, 1 breath every 3-5 seconds is recommended (12-20 breaths/minute)

c. **Pediatric Consideration:** deliver volume needed to achieve chest rise

7. Consider use of antiarrhythmic for recurrent VF/Pulseless VT
   a. The principal objective of antiarrhythmic drug therapy in shock-refractory VF and pulseless VT is to facilitate the restoration and maintenance of a spontaneous perfusing rhythm in concert with the shock termination of VF/VT; some antiarrhythmic drugs have been associated with increased rates of ROSC and hospital admission, but none have yet been proven to increase long-term survival or survival with good neurologic outcome
      i. Amiodarone (5 mg/kg IV, max of 300 mg) may be considered for VF/pulseless VT that is unresponsive to CPR, defibrillation, and a vasopressor therapy
      ii. Lidocaine (1 mg/kg IV) may be considered as an alternative to amiodarone for VF/pulseless VT that is unresponsive to CPR, defibrillation, and vasopressor therapy
      iii. The routine use of magnesium for VF/pulseless VT is not recommended in adult patients
   b. There is inadequate evidence to support the routine use of lidocaine and beta blockers after cardiac arrest by EMS – There is insufficient evidence to recommend for or against the routine initiation or continuation of other antiarrhythmic medications after ROSC from cardiac arrest
   c. For torsades de pointes, give magnesium sulfate 2 g IV (or 25-50 mg/kg for **pediatrics**). There is insufficient evidence to recommend for or against the routine administration during cardiac arrest
8. Consider reversible causes of cardiac arrest which include the following:
   a. Hypothermia – additions to care include attempts at active rewarming [see Hypothermia/Cold Exposure guideline]
   b. The dialysis patient/known hyperkalemic patient – Additions to care include the following:
      i. Calcium gluconate 10% 1 g IV (for **pediatrics** the dose is 100 mg/kg) OR
      ii. Calcium chloride 10% 10ml IV (for **pediatrics**, the dose is 20 mg/kg which is 0.2 mL/kg)
      iii. Sodium bicarbonate 1 mEq/kg IV
   c. Tricyclic antidepressant overdose - Additions to care include sodium bicarbonate 1 mEq/kg IV
   d. Hypovolemia - Additions to care include normal saline 2 L IV (or 20 mL/kg, repeated up to 3 times for **pediatrics**)
   e. If the patient is intubated at the time of arrest, assess for tension pneumothorax and misplaced ETT
   f. If tension pneumothorax suspected, perform needle decompression. Assess ETT, if misplaced, replace ETT
9. If at any time during this period of resuscitation the patient regains return of spontaneous circulation, treat per Adult Post-ROSC Care guideline
10. If resuscitation remains ineffective, consider termination of resuscitation [see Termination of Resuscitative Efforts guideline]

Patient Safety Considerations

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

Notes/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. A rate of greater than 100 and less than 120 compressions/minute
   b. Depth of at least 2 inches (5 cm) and less than 2.4 inches (6cm) for adults and children or 1.5 inches (4 cm) for infants; adolescents who have entered puberty should receive the same depth of chest compressions as an adult
   c. Allow for complete chest recoil (avoid leaning)
   d. Minimize interruptions in compressions
   e. 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:
   a. 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
   b. 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
   c. 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. **Pediatric Consideration:** For children with an advanced airway, 1 breath every 3-5 seconds is recommended (equivalent to 12-20 breaths/minute)
3. Quantitative end-tidal CO_2 should be used to monitor effectiveness of chest compressions
   a. If $ETCO_2$ less than 10 mmHg during the initial phases of resuscitation, attempt to improve chest compression quality
   b. Consider additional monitoring with biometric feedback which may improve compliance with suggested Resuscitation section guidelines
4. 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.

5. There is insufficient evidence to recommend the routine use of extracorporeal CPR (ECPR) for patients with cardiac arrest – In settings where it can be rapidly implemented, ECPR may be considered for select cardiac arrest patients for whom the suspected etiology of the cardiac arrest is potentially reversible during a limited period of mechanical cardiorespiratory support
6. Chest compressions should be reinitiated immediately after defibrillation as pulses, if present, are often difficult to detect and rhythm and pulse checks interrupt compressions
7. Continue chest compressions between completion of AED analysis and AED charging
8. Effectiveness of chest compressions decreases with any movements
    a. 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
    b. Chest compressions are also less effective in a moving vehicle
    c. It is also dangerous to EMS providers, patients, pedestrians, and other motorists to perform chest compressions in a moving ambulance
    d. 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
9. 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. If the manufacturer's recommendation is unknown, use highest setting possible. In the case of monophasic devices, the setting should be 360 J (or 4 J/kg for children)
10. IV or IO access without interrupting chest compressions
11. Administer epinephrine (0.1 mg/kg, maximum dose 1 mg) IV/IO during the first or second round of compressions
12. At present, the most effective mechanism of airway management is uncertain due to some systems managing the airway aggressively and others managing the airway with basic measures and both types of systems finding excellent outcomes. Regardless of the airway management style, consider the following principles:
    a. Airway management should not interrupt chest compressions
    b. Carefully follow ventilation rate and prevent hyperventilation
    c. Consider limited tidal volumes
    d. There is uncertainty regarding the proper goals for oxygenation during resuscitation
        i. Current recommendations suggest using the highest flow rate possible through NRB or BVM
        ii. This should not be continued into the post-resuscitation phase in which the goal should be an oxygen saturation of 94-98%
    e. **Pediatric Considerations**: Special attention should be applied to the pediatric population and airway management/respiratory support. Given that the most likely cause of cardiac arrest is respiratory, airway management may be considered early in the patient's care
        i. However, the order of Circulation-Airway-Breathing is still recommended as the order of priority by the American Heart Association for pediatric resuscitation in order to ensure timely initiation of chest compressions to maintain perfusion, regardless of the underlying cause of the arrest

ii. In addition, conventional CPR is preferred in children, since it is associated with better outcomes when compared to compression-only CPR

13. Special Circumstances in Cardiac Arrest
    a. Trauma, treat per the General Trauma Management guideline
    b. Pregnancy
        i. The best hope for fetal survival is maternal survival
        ii. 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
        iii. 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
        iv. 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
        v. Defibrillation should be performed as in non-pregnant patients
    c. 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.
14. Application of the "pit crew" model of resuscitation
    a. 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 crewmembers 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):
        i. 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
        ii. Use a metronome or CPR feedback device to ensure that compression rate is 100-120/minute
        iii. Chest compressions are only interrupted during rhythm check (AED analysis or manual) and defibrillation shocks – Continue compressions when AED/ defibrillator is charging
        iv. Additional rescuer obtains IO (or IV) access and gives epinephrine – For IO access:
            1. The proximal humerus is the preferred site for adults
            2. The tibial site is preferred for infants and children
        v. During the first four cycles of compressions/defibrillation (approximately 10 minutes) avoid advanced airway placement
        vi. One responding provider assumes code leader position overseeing the entire response
        vii. Use a CPR checklist to ensure that all best practices are followed during CPR
    b. For efficient "pit crew" style care, the EMS agency medical director should establish the options that will be used by providers functioning within the EMS agency. Options include establishing:
        i. The airway/ventilation management, if any, that will be used
        ii. The initial route of vascular access

15. The EMS agency must perform a QI review of care and outcome, overseen by the agency medical director, for every patient that receives CPR
    a. The QI should be coordinated with local receiving hospitals to include hospital admission, discharge, and condition information. This EMS agency QI can be accomplished by participation an organized cardiac arrest registry
    b. The QI should be coordinated with local PSAP/dispatch centers to review opportunities to assure optimal recognition of possible cardiac arrest cases and provision of dispatch-assisted CPR (including hands-only CPR when appropriate)

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

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