CARDIAC ARREST

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BASICS

DESCRIPTION

- The absence of effective mechanical cardiac activity
- This section is not a substitute for an AHA-approved Advanced Cardiac Life Support (ACLS) course and is intended only as a quick reference.
- Synonym(s): "Code" or "Code Blue" in many institutions

Geriatric Considerations

This condition has a low rate of survival and a poor long-term outcome. Discuss Do Not Resuscitate orders with patients at risk.

Pediatric Considerations

Bradycardia is linked to hypoxia. Bradycardia is the most common initial form of cardiac arrest in children and is often the response to hypoxia. Adequate oxygenation and ventilation are critical.

Pregnancy Considerations

- Displace the uterus to the left, either manually or by placing a rolled towel under the right hip. If the patient cannot be resuscitated within 5–15 minutes, consider an emergency C-section to relieve uterine obstruction and increase blood return to the heart. This may also be done to save the fetus if the fetus has reached gestational age of viability.
- Consider amniotic fluid embolism or eclampsia-related seizures as precipitating factors.

EPIDEMIOLOGY

- Predominant age: Risk increases with age.
- Predominant sex: Male > Female

Incidence

0.5–1.5/1,000 persons per year

ETIOLOGY AND PATHOPHYSIOLOGY

- Asystole (confirm in 2 leads)
- Ventricular fibrillation (VF)
- Pulseless ventricular tachycardia (VT)
- Pulseless electrical activity (PEA)
- Consider possible reversible causes (6 Hs and 5 Ts):
  - Hypoxia, hypovolemia, hyper- and hypokalemia, $[H^+]$ (acidosis), hypothermia, hypoglycemia
  - Cardiac tamponade, tension pneumothorax, thrombosis (pulmonary embolism, myocardial infarction [MI]), toxins (medications and overdoses), trauma

RISK FACTORS

- Male gender
- Advanced age
- Hypercholesterolemia
- HTN
- Cigarette smoking
- Family history of atherosclerosis
- Diabetes
- Cardiomyopathy
- Prolonged QT

COMMONLY ASSOCIATED CONDITIONS

- Coronary artery disease/acute coronary syndrome (ACS) (cardiac arrest may be presenting symptom)
- Valvular heart disease
- HTN
- Pulmonary embolism

DIAGNOSIS

- Loss of consciousness secondary to CNS hypoperfusion
- Absence of pulses in large arteries
- Apnea or agonal breathing

- Cyanosis or pallor

HISTORY

- Witnessed vs. unwitnessed
- Approximate downtime
- Initial resuscitation efforts and response
- History or risk factors
- Associated trauma
- Do Not Resuscitate (DNR)/Do Not Intubate (DNI) status

PHYSICAL EXAM

- Check for pulses.
- Check lungs (i.e., did patient have respiratory decline prior to cardiac decline?).
- Check for signs suggesting possible reversible causes:
  - Check for dialysis shunt: Patients on dialysis are at increased risk for an electrolyte imbalance that can cause arrest (especially hyperkalemia).
  - Check pupils: May indicate drug overdose (cannot interpret if patient has received atropine).
  - Check for obvious signs of trauma.

DIAGNOSTIC TESTS & INTERPRETATION

Laboratory results have limited value during initial resuscitation.

Initial Tests (lab, imaging)

- Fingerstick glucose
- ABG/VBG
- Chemistry and/or electrolyte panel
- Blood type and cross, if indicated
- Cardiac enzymes (troponin, CK, CK-MB)
- CBC with platelets
- Drug levels, if indicated (toxicology screen, acetaminophen/aspirin levels, history of specific medication (e.g., digoxin, antiepileptics)
- Consider:
  - RUSH (Rapid Ultrasound in SHock) exam to evaluate “the pump, tank, and pipes” to guide resuscitation (1)[C].

- Perform emergency echocardiogram for pericardial effusion, assessment of cardiac motion, presence of intraventricular clot.
- Chest x-ray for endotracheal tube (ET) placement, pneumothorax
- Once stabilized, consider a CT scan of the brain.

Diagnostic Procedures/Other

- Obtain access:
  - Peripheral IV as close to central circulation as possible (preferred)
  - Intraosseous if no venous access.
  - Consider central venous acces if unable to achieve alternative access; femoral approach preferred to minimize interruptions in CPR
  - Many medications may be administered by endotracheal tube if access is otherwise unobtainable (double dose and flush with saline).
- Airway management/intubation
- Needle decompression/chest tube for pneumothorax
- Pericardiocentesis for cardiac tamponade
- ECG

TREATMENT

- C-A-B (Circulation, Airway, Breathing). Use compressions 1st, then check airway and breathing.
- Prompt initiation of high-quality CPR, particularly chest compressions (at least 100 per minute, depth 2 inches in adults, allowing recoil after each compression), and immediate defibrillation (in witnessed VF and pulseless VT but not in PEA) are 1st priority (2)[A]:
  - In unwitnessed arrest, complete 2 minutes of CPR before attempting defibrillation (3)[A].
  - Capnography should be used to evaluate the efficacy of chest compressions (2)[A].
  - Avoid excessive ventilation (2)[A].
- Establishing IV access, intubation, and medications are 2nd priority.
  - Continue CPR for 1–2 minutes following the return of a potentially perfusing rhythm before stopping for a pulse check, except for

witnessed arrest with a prompt return of rhythm following defibrillation.

- Patients with a return of spontaneous circulation (ROSC) should have an ECG and be strongly considered for primary coronary intervention. If not available in your facility, then consider transfer to a hospital with this capacity. Early 12-lead ECG may not demonstrate MI, but this may develop late. Intervention should not be delayed in the appropriate setting.

GENERAL MEASURES

- Perform CPR: 100/min, allowing for chest wall recoil, with minimal interruptions (4)[B]
- Sequence should be:
  - CPR
  - Rhythm check
  - Resume CPR
  - Shock/Meds (charge defibrillator and administer drugs during CPR)
  - Continue CPR (after shocking) for 5 cycles before rechecking rhythm (repeat as needed) (4)[B]
- In VF/pulseless VT, 1 shock should be delivered, then continue sequence above (4)[B]:
  - Monophasic automatic external defibrillators (AEDs) initial and subsequent shocks at 360 J
  - Biphasic AEDs:
    - 150–200 J for biphasic truncated exponential waveform
    - 120 J for rectilinear biphasic waveform
    - If not specified on the biphasic defibrillator, use default of 200 J.
  - Subsequent shocks should be the same or higher energy.
  - Pediatric manual defibrillation energy should be initial dose of 2 J/kg for the 1st attempt, followed by 4 J/kg for the next attempt. Increase energy with subsequent attempts, but do not exceed 10 J/kg or maximum adult dose.
- Consider possible causes of VT/VF, including hypoxia, hyperkalemia, hypokalemia, preexisting acidosis, drug overdose, and hypothermia.
- Administer 100% oxygen by bag-valve-mask or ETT.

- IV and IO are the preferred methods of medication administration, followed by ET.
- Start IV lines as close to the heart as possible. Large-bore peripheral lines can deliver fluid more quickly than a triple-lumen catheter.
- Use an end-tidal CO_2 monitor to assess gas exchange, if available.

  Capnography is the test of choice to assess ET tube placement, as esophageal intubation will produce a very low end-tidal CO_2 and requires proper reintubation (2). The use of sodium bicarbonate will increase ET-CO_2 levels.
- Consider a termination of efforts if no reversible underlying cause is found. Consider patient's age, comorbid conditions, and length of downtime to help guide decision making.

MEDICATION

First Line

- Vascular access for medications: IV or intraosseous
- Consider medications after initiation of CPR and defibrillation attempt; medications should be administered during CPR as soon as possible following a rhythm check.
- Epinephrine: 1 mg IV q3–5min (4)[B] or vasopressin 40 U IV single dose (4)[B] (can be used once in lieu of the 1st or 2nd dose of epinephrine in VT or VF, but not in PEA):
  - Vasopressin is not recommended in children.
  - Pediatric dose of epinephrine: 0.01 mg/kg
- Magnesium sulfate: 1–2 g diluted in 10 mL D_5W IV push in suspected torsades de pointes (4)[B]:
  - Magnesium is relatively contraindicated in renal failure, but given the consequences of not correcting this rhythm, contraindication is only relative in this setting.
- Antiarrhythmics:
  - Consider if VT/VF is unresponsive to 2–3 shocks and the 1st dose of vasopressor.
  - Amiodarone is the drug preferred by the AHA. Dosing: 300 mg IV push followed by 2nd dose of 150 mg IV (4)[B]

- Amiodarone for perfusing tachyarrhythmias: 150 mg over 10 minutes; repeat as needed followed by a maintenance infusion of 1 mg/min for the first 6 hours.
- Lidocaine: Initial dose, 1–1.5 mg/kg IV; a repeat loading dose of 1–1.5 mg/kg can be given at 5–10-minute intervals if VT/VF persist to maximum dose of 3 mg/kg (4)[C], then followed by drip if perfusing rhythm is recovered.

- Endotracheal medications (NAVEL): Narcan, atropine, vasopressin (and Valium), epinephrine, or lidocaine. Each may be placed in 5–10 mL of normal saline or sterile water and given by ET followed by bagging. Dosage should be 2–2.5× recommended IV dose. IV or IO is preferred.

Second Line

- Dopamine: 2–10 mcg/kg/min IV for bradycardia
- Procainamide: 30 mg/min IV in refractory VF/VT (maximum dose: 17 mg/kg) is permissible. However, because the time to a useful level by infusion is so long, it is unlikely to be of benefit in cardiac arrest, but may be useful in perfusing tachycardias (4)[C].
- Calcium: May be useful in hyperkalemia, ionized hypokalemia secondary multiple transfusions, and Ca^+ channel blocker toxicity; otherwise, no clear benefit is shown.
- High-dose epinephrine: No survival benefit is seen with a high dose (0.1 mg/kg), but it should be considered in exceptional situations, such as β-blocker or calcium channel blocker overdoses.
- Bicarbonate: 1 mEq/kg IV only in known preexisting bicarbonate-responsive acidosis, hyperkalemia, or to correct widened QRS complex in known responsive overdoses (i.e., tricyclics). Also may be considered in patients with prolonged or unknown downtime (4)[C].

ISSUES FOR REFERRAL

- Consider communication with the medical examiner's office.
- Consider communication with an organ/tissue bank.

ADDITIONAL THERAPIES

Therapeutic hypothermia after resuscitation (to 32–34°C within 6 hours of collapse for 12–24 hours) should be performed if possible. The greatest benefit is seen in VF as initial rhythm and short downtime (<25

minutes), but it should be considered with any patient who has ROSC and coma state (5).

IN-PATIENT CONSIDERATIONS

Admission Criteria/Initial Stabilization

- Decreasing the EMS response interval increases survival (4)[A].
- The home use of automatic external defibrillators does not improve survival (6).

ONGOING CARE

FOLLOW-UP RECOMMENDATIONS

Patient Monitoring

- Admit to ICU or CCU on continuous monitoring.
- Consider EEG to assess for nonconvulsive status epilepticus.

PROGNOSIS

- The outcome is related to underlying disease, age, duration of arrest, and other factors.
- The outcome is poor with the following indicators:
  - >4 minutes to CPR or >8 minutes to ACLS
  - Arrest occurs out of hospital
  - Resuscitation effort >30 minutes
- ~17% survive in-hospital arrest.
- ~1–10% survive to leave the hospital in out-of-hospital arrest, varying by geographic region.
- ~10–15% of those with VF survive.
- If the arrest is out of hospital without a return of vital signs from ALS prehospital care, the patient is unlikely to respond to ED resuscitation efforts.
- If the patient has an ROSC with coma, strongly consider induced hypothermia to improve the neurologic outcome (number needed to treat in VF = 6).

COMPLICATIONS

- Significant neurologic, hepatic, renal, or cardiac ischemic injury or multiorgan systems failure
- Rib fractures, hemopneumothorax, abdominal organ injury from CPR

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ADDITIONAL READING

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SEE ALSO

Algorithm: Coronary Syndrome, Acute

CODES

- I46.2 Cardiac arrest due to underlying cardiac condition
- I46.8 Cardiac arrest due to other underlying condition
- I46.9 Cardiac arrest, cause unspecified

CLINICAL PEARLS

- C-A-B replaces ABCs for the priority of approach to a patient with a suspected cardiac arrest.
- Prompt initiation of CPR, particularly chest compressions (push hard, push fast, and don't interrupt!), and immediate defibrillation (in witnessed VF and pulseless VT but not in PEA) are 1st priority.
- For an unwitnessed arrest, complete 2 minutes of CPR before attempting defibrillation.
  - Epinephrine is the 1st drug to give in any case requiring CPR: Intraosseous and endotracheal routes are preferred if peripheral access is not attainable. Central line may be considered if unable to achieve access and if performed femoral approach is preferred.
- Therapeutic hypothermia has significantly improved neurologic outcomes in cardiac arrest and should be initiated as soon as possible in any patient with ROSC and coma state.