Definition:

Cardiac arrest – sudden cessation of the pumping action of the heart

Signs of cardiac arrest

1. no palpable pulse
2. no heart sounds
3. dilated pupil, no corneal and palpebral reflexes
4. apnea or agonal breathing
5. unconsciousness (if not under anesthesia)
6. electrocardiographic findings:
   A. ventricular asystole (flat liner and rarely, just all P waves)
   B. ventricular fibrillation (wiggly and irregular line; chaotic)
C. pulseless electrical activity
    ECG will appear normal and organized, however no palpable pulse

Management

1. **Basic Life Support (CAB)**

   **Cardiac Massage (external)**

   Begin external massage as soon as cardiac arrest is recognized.

   Compression rate: at least 100 compressions/minute

   Compress the chest adequately and allow elastic recoil.

   Compression should be at least 50% of the compression-relaxation cycle.

   Closed-Chest Compression Techniques
Put your hand across the sternum and squeeze the thoracic wall towards each other (external cardiac compression). An alternative technique is to use the two-hand encircling technique. In this technique, in addition to the external cardiac compression, the other hand is placed across the dorsal aspect of the chest and the thoracic wall is compressed simultaneous with the external cardiac compression.

External cardiac compression in cats is very effective because they are smaller and the chest wall is more compliant. Enough intrathoracic pressure can be produced by the external cardiac compression resulting in blood flow to the brain and heart.

The new Guideline on human CPR emphasizes the importance of performing chest compression first before the airway and breathing. When cardiac arrest is recognized, chest compression should be done immediately while the other members of the team are trying to get the endotracheal tube and then intubating the patient.

**Airway**

Clear airway!
Ensure patent airway.
This requires endotracheal intubation of the cat. If the anesthetized cat is not intubated, make sure that there is no foreign material in laryngeal area by opening the mouth widely and pulling the tongue forward and inspecting the pharynx and the laryngeal area. If the cat is already intubated, inspect the endotracheal tube and look for any kink and foreign material that may be found inside the tube.
Secure the endotracheal tube by tying it with a piece of gauze.

**Breathing**

Administer 100% oxygen.

Initiate positive pressure ventilation. An Ambu bag attached to an oxygen line or a breathing circuit attached to an oxygen source can be used to provide artificial ventilation.

Ventilatory rate
Cat: 10 breaths/minute

The inspiratory phase should be about 1 second and hyperventilation should be avoided. The peak inspiratory pressure during ventilation can be from 10 to 20 cmH₂O.

This basic cardiac life support (basic CPR) continues while the patient is receiving the advanced cardiac life support.

Hook up EKG immediately while performing basic cardiac life support.
2. **Advanced Cardiac Life Support (Drugs and Defibrillation)**

**If the EKG shows asystole or pulseless electrical activity:**

a. Administer epinephrine at 0.01-0.02 mg/kg or vasopressin at 0.8 U/kg IV. This can be administered every 3-5 minutes if the animal is still in ventricular asystole. Follow up the injection of epinephrine with a bolus of saline (3 ml) if the animal is not receiving any fluids. If the fluid is running, use it to distribute the drug to the circulation by increasing its rate of administration. Epinephrine and vasopressin can be given at an alternating fashion every 3-5 minutes.

Central vein is preferred over peripheral vein. In most cases, the peripheral vein will be used. Time may be wasted trying to hit the jugular vein while the cat is in cardiac arrrest. It can be given "intratracheally" using a dose twice or 3X that of the IV dose if there is no venous access.

b. Atropine may be considered in ventricular asystole. If atropine is considered, it is given at 0.04 mg/kg IV. The new CPR Guidelines indicates that atropine should not be used routinely during CPR.

c. Try lowering the head and chest than the rest of the body during resuscitation, if possible.

d. Consider terminating CPR if there is no cardiovascular response to "effective" CPR effort. In the clinic, we usually wait for a minimum of 15 minutes before quitting.

e. Always search for a problem that initiated the arrest and treat it, if possible. Rule out hypovolemia, hypoxemia, acidosis, hyperkalemia, hypokalemia, hypothermia, cardiac tamponade, tension pneumothorax, and pulmonary embolism.

**If the EKG shows ventricular fibrillation after performing basic life support:**

a. Defibrillate or give one shock immediately. Perform precordial thump, if there is no electrical defibrillator. Precordial thump involves delivering a blow with the fleshy part of the palm onto the patient’s chest.

   **Dose for Electrical External Defibrillation**

   4-6 joules/kg

b. Perform 2 minutes of basic life support and determine if the rhythm is shockable.

c. If shockable, continue basic life support while charging the defibrillator. Give 1 shock and then
resume basic life support immediately for 2 minutes.

d. Give vasopressor during basic life support. Epinephrine or vasopressin is given IV.

e. After 2 minutes of basic life support, check the rhythm again. If shockable, continue basic life support while charging the defibrillator. Give 1 shock and resume basic life support immediately.

f. Consider giving an antiarrhythmic. The choices are amiodarone, lidocaine, and magnesium. Amiodarone is the best drug for this purpose. However, it is not readily available in veterinary practice because of the cost. Lidocaine can be tried; however its efficacy has not been proven from clinical trials. Magnesium is indicated if the patient is hypomagnesemic and the rhythm is torsade de pointes.

g. After 2 minutes of basic life support, check the rhythm again. If shockable, continue basic life support while charging and give 1 shock and then resume basic life support immediately. GO BACK TO step d and follow the sequence of steps again if the animal continues to have shockable rhythm. The decision to quit CPR can be made if the ECG shows ventricular asystole and after 12-15 of unsuccessful resuscitation.

**DRUGS USED IN CPR**

**Epinephrine**

- endogenous catecholamine
- has both alpha- and beta-adrenergic activity
- inotrope of choice in CPR
- causes peripheral vasoconstriction
- improves coronary and cerebral perfusion pressure
- Dose: 0.01mg/kg IV

**Vasopressin**

- stimulates V1a receptors causing vasoconstriction
- may replace the first or second dose of epinephrine
- shown to exert a greater vasoconstrictive effect under conditions of hypoxia and acidosis than does epinephrine
- Dose: 0.8 u/kg

**Atropine**

- parasympatholytic
- direct vagolytic action
- enhances sinus node automaticity and atrioventricular conduction
- main indications
  * symptomatic bradycardia
  * may initiate electrical activity during asystolic cardiac arrest initiated by strong vagal reflex
- routine use is not recommended anymore
- Dose: 0.04 mg/kg IV

**Intravenous Fluids**

- if the animal is euvoletic, administration of fluids (crystalloids) is not indicated during CPR. However, determining euvoleticemia especially in unwitnessed cardiac arrest and anesthetized cats is tricky and difficult. The author recommends administering fluids at 5.0 ml/kg/hour if volume status cannot be determined immediately.

- if the patient is in shock and hypovolemic, fluids should be given at a faster rate to replace one blood volume in one hour (cat: 40-50 ml/kg).

- use balanced electrolyte solution (e.g., Lactated ringer’s solution, Plasmalyte, and Normosol) without dextrose

- during anesthesia, balanced electrolyte solution is usually given at the rate of 5-10 ml/kg/hour IV. Therefore, the ability to fluid resuscitate the patient will be easier. It may simply mean increasing the rate of infusion without the need for inserting an IV catheter.

**Lidocaine**

- suppresses ventricular arrhythmias and raises ventricular fibrillation threshold
- may be given in ventricular fibrillation; efficacy has not been proven
- dose: 0.25 mg/kg IV (cats)

**Sodium bicarbonate**

- no proven efficacy
- used only after basic cardiac life support and administration of other drugs
- given if preexisting metabolic acidosis is documented
- given if resuscitation is prolonged
- rationale for its use: treat metabolic acidosis caused by hypoxia-induced anaerobic metabolism during arrest
- if blood gas analysis is not available, administer at 1.0 mEq/kg slow IV during the later part of resuscitation
Calcium chloride

- no beneficial effect
- may induce reperfusion injury
- lowers survival rate
- may adversely affect the neurologic outcome
- given only if the cause of cardiac arrest is:
  - hypocalcemia
  - hyperkalemia or
  - overdose of calcium channel blocker