The American Heart Association (AHA) published its updated guidelines for cardiopulmonary resuscitation (CPR) in 2010. These guidelines form the basis for many of the CPR recommendations in veterinary medicine. However, there are significant differences between humans and veterinary species. In addition, the Reassessment Campaign on Veterinary Resuscitation (RECOVER) initiative has published guidelines on veterinary CPR.

The first step in CPR is establishing that an arrest has occurred. Initially this is done by pulse palpation, evaluation of respiration, or listening for a heart beat. In the event that one believes that an arrest has occurred, it may be prudent to initiate CPR without 100% confirmation of an arrest. Time is of the essence in these patients.

The 2010 AHA guidelines advocate the initiation of compressions as the first step in CPR. The traditional method of CPR initiation was ABC (airway, breathing, compressions), which has been replaced by CAB (compressions, airway, breathing). Studies have demonstrated that there was no change in outcome for human patients that were treated with compressions-only CPR.

**Compressions** In the initial phases of cardiac arrest, oxygen delivery is dependent on flow of blood. Compressions should be performed at a rate of approximately 80 to 120 bpm in dogs and 160 to 180 bpm in cats. Compress the thorax 30% of the chest wall diameter, and allow for complete recoil of the chest.

Fatigue is an important, and often overlooked aspect of CPR. The person performing chest compressions often will become fatigued, but does not recognize being tired. In the midst of compressions it is common for the person performing compressions to lean on the patient, which results in a lack of complete chest recoil and decreased effectiveness of CPR. Personnel should be changed out every 2 minutes when performing chest compressions to reduce fatigue.

Placement of an ECG during compressions is recommended. It is important not to use alcohol for wetting the ECG leads if there is any chance of defibrillation as this can result in fire. Be sure to continue compressions for 2 minutes before evaluating the ECG rhythm. Keep these evaluations to 10 seconds or less. Resume compressions if necessary.

**Airway** A patient airway should be accomplished as soon as possible after the initiation of chest compressions. Use the largest endotracheal tube that is appropriate for the size of the patients, tie in the tube and inflate the cuff. It is important to remember to continue compressions while attempting to intubate.

**Breathing** Ventilate the patient 8 to 10 bpm. It is important not to over ventilate the patient and to avoid barotrauma by delivering large tidal volumes. Ventilation with 100% oxygen is recommended.

Evaluation of CPR can be accomplished through use of capnography and transcorneal Doppler. Capnography can be utilized to evaluate the adequacy of compressions (EtCO$_2$ >10 mmHg is associated with adequacy of compressions). In addition, an EtCO$_2$ >20 mmHg is a predictor of a return to spontaneous circulation (ROSC). A Doppler probe can be placed on the eye during CPR to evaluate the effectiveness of thoracic compressions, as it is an indicator of carotid artery blood flow. A signal is associated with a pressure greater than 20 mmHg.

**Drugs** Intravenous administration of drugs is the route of choice for emergency drugs. Some emergency drugs are also suitable for intratracheal administration if IV access is not attainable or immediately available. These drugs include naloxone, atropine, vasopressin, lidocaine, and epinephrine. Typically, the dose should be doubled for intratracheal administration.
**Epinephrine** is a mixed adrenergic agonist acting on both alpha and beta receptors. The dose of epinephrine has been controversial. Current recommendations are 0.01 mg/kg of epinephrine IV. This dose may be repeated. Epinephrine administration during the course of CPR should be followed immediately by thoracic compressions. These compressions should continue uninterrupted for 2 minutes following administration before evaluation for ROSC. If ROSC has not occurred, epinephrine can be re-administered or vasopressin can be administered.

**Atropine** is an anticholinergic parasympatholytic that is no longer recommended for routine use in human CPR. However, atropine is still recommended for the treatment of bradycardia. Given that many veterinary patients experience profound bradycardia due to high vagal tone, atropine should still be considered. The typical dose of atropine is 0.04 mg/kg IV in an emergency situation.

**Vasopressin** is a non-adrenergic pressor that causes peripheral, renal, and coronary vasoconstriction. Vasopressin has been investigated and advocated by some researchers. Vasopressin is often alternated with epinephrine in the course of CPR. The dose of vasopressin is 0.2 to 0.8 U/kg IV.

**Lidocaine** is a class Ib antiarrhythmic that is most often used during CPR for the treatment of ventricular arrhythmias. Lidocaine is not recommended for treatment of ventricular fibrillation if defibrillation is an option. The dose of lidocaine in dogs is 2 mg/kg IV and in cats is 0.2 mg/kg IV.

**Fluids**
Intravenous crystalloid fluids may be administered for the treatment of hypovolemia during CPR, if hypovolemia was present prior to the arrest. Large volume of crystalloid fluids (shock doses) should not be administered to patients that were not previously hypovolemic. Crystalloid fluids are often administered during CPR to maintain patency of an intravenous catheter and to facilitate administration of emergency drugs. Suggested fluid rates for balanced electrolyte solutions are 20 ml/kg as a fast bolus for dogs and 10 ml/kg in cats. Use of isotonic saline is also permissible, but may worsen the metabolic acidosis that often accompanies ROSC.

Colloids or hypertonic fluids may be administered for the treatment of hypovolemia. Hetastarch may be administered as a bolus during CPR at a dose of 5 to 10 ml/kg IV in dogs, and 2 to 3 ml/kg IV for cats. Hypertonic saline has been utilized during CPR and may be associated with improved survival from ventricular fibrillation. The recommended dose of 3% hypertonic saline is 4 to 6 ml/kg IV over 5 minutes.

**Open chest CPR**
Internal cardiac massage is indicated when there is penetrating thoracic trauma, when closed-chest CPR and administration of epinephrine has been ineffective, dogs greater than 20kg, and in certain breeds of dogs (barrel-chested breeds). Make a skin incision at the 4th or 5th left intercostal space. The pericardium should be opened at the apex. Compress the heart with the thumb and fingers, concentrating the compressions on the left ventricle. Epinephrine may be administered directly into the heart by injecting into the left ventricular chamber.

**Defibrillation**
Biphasic defibrillators are recommended for defibrillation. The recommended shock energy for biphasic defibrillators depends on the manufacturer. Recommendations for veterinary patients have shock energy starting at 2 to 4 J/kg. Defibrillation should be performed with caution for the patient and staff.

**Continuum of care**
Post-arrest care is an important part of CPR. Many patients that have a ROSC are likely to re-arrest within 12 hours. Current human recommendations include maintaining normotension, glycemic control, evaluation of perfusion and oxygenation, and therapeutic hypothermia. In veterinary patients, these recommendations have not been formally evaluated.

**Statistics regarding CPR**
The survival rates of veterinary patients suffering from cardiopulmonary arrest range from 4% to 9.6%. Many animals respond to CPR, but re-arrest within approximately 12 hours. The survival rates tends to improve for those patients that arrest during anesthesia.
References


