Cardiopulmonary Resuscitation (CPR) Proceedings

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Objectives:

1) To describe the RECOVER CPR algorithm for in hospital arrests
2) To recognize when an arrest has occurred
3) To demonstrate proper compression and ventilation technique
4) To identify the proper monitoring equipment and summarize the information that it can provide
5) To recognize the 4 arrest rhythms and tell if they are shockable or non-shockable
6) To explain when and what medications should be given

In 2012, the Reassessment Campaign on Veterinary Resuscitation (RECOVER) initiative published the first evidence-based guidelines for veterinary CPR. It was a large literature review which covered the topics of preparedness and prevention, basic life support, advanced life support, monitoring and post cardiac arrest care. Through this, a CPR algorithm was created (see end of document).

Please visit https://recoverinitiative.org/ if you are interested in an online course reviewing basic life support and advanced life support.

Basic life support

AB +/- C Assessment

The early delivery of high-quality chest compressions with minimal interruptions is vital for improving return of spontaneous circulation (ROSC) in a patient that has undergone cardiopulmonary arrest (CPA). A patient should have CPR initiated if they are unresponsive and apneic. Be sure during the assessment for breathing, that you also check the patient's airway to ensure that there is not an airway obstruction. You do not need to feel for a pulse as it has been shown that it can be difficult to determine if there is a pulse or not in these patients and often the wrong call is made or it delays the start to basic life support. Taking the time to determine if there is a pulse can delay the start of basic life support. The airway and breathing +/- circulation assessment should occur in less than 15 seconds.

Compressions

Compressions should begin IMMEDIATELY upon recognition of CPA. Most patients should be placed in lateral recumbency with the patient's spine against the compressor. Some patients who are boxed shape with a flat back (e. g. Bull dogs and French bull dogs) should be placed on their back (if you put them on their back and they stay on their back without tipping over, they should probably be on their back). The ideal compression rate is 100-120 compressions per minute and a compression depth of 1/3-1/2 of the width of the thorax while ensuring complete recoil (ensure that you are not leaning on the chest). Compressions should be performed for a full 2 minutes before the compressors are rotated.

The posture for performing chest compressions is very important for achieving good quality chest compressions. Your hands should be placed over each other with your fingers interlocked or interlaced and the heel of you hand should be where most of the pressure is concentrated. Your elbows should be locked and your shoulders should be directly over your hands, using your core muscles to generate the force of the compressions. This means that most people will either need to stand on a stool

or to get on the table with the patient or that the compressions should be performed on the floor so that the proper technique can be performed.

The compression point will be determined by the shape of the animal's chest. For round chested dogs who have a roughly equal width and depth (often dome shaped chests if you look from above or run your hand over their chests) should be compressed over the widest aspect of their chest implementing the thoracic pump theory. Keel chested dogs who have a greater depth than width (chest shaped more like a ski slope) and dogs and cats < 10 kg should have compressions performed directly over their heart implementing the cardiac pump theory. For small dogs and cats, you could consider using a one-handed technique over the heart ensuring that your hand stays in a "V" shape and that your fingers don't start to round becoming more like a "C". If your end tidal CO_2 is low after you have started compressions, first ensure that you are optimizing the rate and depth, as well as allowing full recoil and then consider moving your hands to the other compression point.

Ventilation

Dogs and cats should be intubated as early as possible during CPR. The compressions SHOULD NOT stop while the patient is being intubated and they should remain in lateral or dorsal recumbency. Sometimes gauze or suction may be required to clear the oropharynx. Ensure that you are using a cuffed endotracheal tube otherwise the breath that you are giving will take the path of least resistance and come out around the tube instead of going down to the lungs during compressions. Also ensure that you secure the tube in place otherwise it is very likely that the tube will be dislodged. You should ventilate the patient at a rate of 10 breaths per minute (or 1 breath every 6 seconds) with a 1 second inspiratory time and delivering approximately 10 ml/kg.

Advanced life support

Monitoring

The first step of advanced life support is initiating monitoring if it is not already on the patient. This includes an ECG and $ETCO_2$. This is the first step because we must know the rhythm to determine how we are going to treat it. We want to ensure that an ECG is on the patient at the 2-minute switch so that a rhythm diagnosis can be made. Please note that the ECG will not be helpful during compressions as there will be too much interference; this should only be evaluated during compressor changes.

The four arrest rhythms seen are asystole, pulseless electrical activity, ventricular fibrillation and pulseless ventricular tachycardia. These can be divided into non-shockable and shockable rhythms. Non-shockable rhythms include asystole and pulseless electrical activity. Shockable rhythms include ventricular fibrillation and pulseless ventricular tachycardia. The ECG algorithm (at end of document) can help you determine the proper steps.

End tidal CO_2 ($ETCO_2$) should be used as soon as the patient is intubated. $ETCO_2$ is a useful indicator of cardiac output during CPR. However, for it to be a useful indicator of cardiac output, the breaths must be delivered consistently at a rate of approximately 10 breaths per minute and a consistent depth. Research has shown that an $ETCO_2$ > 15 mmHg is associated with better outcomes in dogs with CPA. If the $ETCO_2$ is <15 mmHg, be sure you re-evaluate your chest compressions and optimize them as mentioned above (increase depth to ½ width of chest, ensure rate is between 100-120 bpm, ensure correct location based on patients conformation, do not lean on chest and allow full recoil). If the

$ETCO_2$ increases drastically during CPR, you should feel for a pulse to confirm there is ROSC while compressions are still occurring. Compressions should then be stopped, and you should ensure that you can still palpate a pulse.

Drugs for non-shockable rhythms

Common drugs administered during CPR include vasopressors, parasympatholytic and reversals. The use of vasopressors and parasympatholytics should be initiated after you have a rhythm diagnosis so you can determine the cause of the arrest and will be more beneficial during CPR than the reversal agent. If during the first 2 minutes of compressions, you do not have a rhythm diagnosis yet (i.e. the ECG wasn't on the patient when it arrested) it is reasonable to give the reversal as the first agent.

Vasopressors

The most common vasopressor given during CPR is epinephrine. Vasopressors work by causing peripheral vasoconstriction and shunting blood to the important areas of the body like the heart and brain. This improves the coronary perfusion pressure and the cerebral perfusion pressure. Low dose epinephrine should be used (0.01 mg/kg or o.01 ml/kg) during CPR every 3-5 minutes (every other cycle of BLS). High dose epinephrine (0.1 mg/kg or 0.1ml/kg) could be considered if the CPR is prolonged (>10 minutes) or as a last attempt. High dose epinephrine is associated with higher rates of return of spontaneous circulation (ROSC) however it is also associated with worse neurological function in survivors and reduced hospital discharge rates.

Parasympatholytics

The most common parasympatholytic used during CPR is atropine. High vagal tone can be caused by gastrointestinal disturbances, respiratory disease, brain disease or ophthalmologic surgery. This can lead to severe bradycardia, decreased blood pressure and perfusion and ultimately cardiac arrest. The dose of atropine is 0.04 mg/kg (~0.1 ml/kg) and it can be repeated every 3-5 minutes. Because of the longer half-life, it should only be repeated once during a CPR attempt. It has been shown that atropine is unlikely to cause harm to a patient during CPR however there is less evidence supporting an overall benefit.

Treatment of shockable rhythms

As mentioned above, shockable rhythms in CPA are ventricular fibrillation and pulseless ventricular tachycardia. The goal of defibrillation is to stop the uncoordinated or rapid ventricular activity using electrical (defibrillation) or mechanical (precordial thump) maneuvers. Defibrillation leads to depolarizing as many cardiac cells as possible, leading them to their refractory period and stopping their ineffective activity. When successful, the natural pacemakers of the heart should take over which may allow for the return of a perfusing rhythm. If the patient has an ECG on when CPA occurs and you see the patient develop a shockable rhythm, BLS should be initiated as the defibrillator is being charged. Defibrillation should then occur, and you should go back to a 2 minute cycle of CPR without ECG assessment until the 2 minutes is complete. If CPA occurs without an ECG on, the patient should have 2 minutes of BLS and then if a shockable rhythm is identified, BLS should continue again only until the defibrillator is charged. Once defibrillated, the patient should immediately have 2 minutes of BLS. If there is prolonged shockable rhythm (>10 minutes) you can consider increasing the dose by 50% or using an antiarrhythmic (amiodarone or lidocaine).

References

Fletcher DJ, Boller M, Brainard BM, *et al*. RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 7: clinical guidelines. J Vet Emerg Crit Care 2012;**22**:S102–31

Fletcher DJ, et al. RECOVER BLS and ALS online modules through RECOVER initiative. http://www.recoveinitiative.org/