RECOVER: Preparedness, Basic and Advanced Life Support. Be Ready to Save Lives!

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Introduction

When a patient suffers from cardiopulmonary arrest (CPA), action must be taken quickly. A well-trained and prepared veterinary care team can mean the difference between life and death. Once cardiopulmonary arrest is confirmed, quality basic life support (BLS), including chest compressions and ventilation, is the most important part of patient resuscitation. Once chest compressions and ventilation (BLS) have been initiated, advanced life support (ALS) can help maximize the chances of recovery. In this presentation, we will first describe the RECOVER guidelines and the BLS algorithm, including the evidence-based approach to providing quality chest compressions and optimal ventilation in dogs and cats. We will also explain key concepts from the RECOVER guidelines in the areas of prevention and preparedness, including best practices for training all members of the veterinary care team to participate in cardiopulmonary resuscitation (CPR) attempts. In the second half of the presentation, we will review the RECOVER guidelines and the ALS algorithm, including recommendations regarding drug therapy with vasopressors, parasympatholytic and antiarrhythmic agents, as well as the electrical defibrillation approach. Additionally, the use and interpretation of the types of monitoring equipment most useful during CPR will be covered, including ECG and capnography.

CPR is a team sport!

Studies in human medicine have shown that for teams to be ready to respond when a crisis arrives, they must receive didactic training AND opportunities (ideally simulated!) to practice skills. Training in cardiopulmonary resuscitation is recommended for ALL veterinary medicine professionals likely to be called upon to intervene during a CPA. In addition to having the declarative, procedural, and conditional knowledge necessary when performing CPR, veterinary teams must also have access to different resources to perform CPR according to RECOVER guidelines. A well-stocked and regularly inspected emergency cart (*crash cart*) is necessary. This cart should contain the equipment necessary for endotracheal intubation (laryngoscope, tubes of various sizes, kling to secure the tube, stylet, etc.), a breathing bag (Ambu -bag), intravenous catheters of various sizes, and the equipment necessary for their placement, syringes, needles, emergency medications (epinephrine, atropine, naloxone, calcium gluconate, atipamezole, flumazenil , etc.), a chart of emergency medication doses according to weight, as well as a cardiopulmonary resuscitation algorithm. An emergency station (crash station) should also be equipped with appropriate monitoring equipment (ECG, capnograph, pulse oximeter, pressure measuring device and accessories, etc.), as well as a source of oxygen. Over time, knowledge deteriorates. It is therefore recommended that a review of concepts relevant to CPR as well as practical exercises be planned during team training. Refresher training and practical exercises at least every 6 months have been shown to improve performance in human medicine.

Recognizing a patient in cardiopulmonary arrest

To give themselves the best chance of resuscitating a patient who has a cardiorespiratory arrest (CPA), veterinary medicine professionals, whether assistants, veterinary technicians, or veterinarians, must be prepared for the rapid recognition of a CPA. A patient in cardiopulmonary arrest is a patient who is unconscious, not breathing, and has no heartbeat. When a patient is unconscious, we must quickly adopt an ABC approach, that is, assess the airway (**A**irways), check if the patient is breathing (**B**reathing), and finally assess if the heart is beating (**C**irculation). Steps A and B are the most important. To perform them, we must open the patient's mouth and see if the airways are clear. Next, we observe the thorax to note the presence or absence of respiratory movements. In the event of unconsciousness and apnea, CPR measures can be initiated immediately. Indeed, it has been shown that in a large percentage of cases, the identification of the presence or absence of a pulse is erroneous (false positive or false negative). As we are at risk of believing that there is a pulse when there is not one, or of believing that there is no pulse when there is one, it is better not to waste too much time assessing pulse. Indeed, the ABC approach should take 10-15 seconds at most. If you choose to assess circulation by palpating the pulse, assessing for the presence of precordial shock, or auscultating the patient, be sure to not exceed 15 seconds for the total duration of your ABC assessment.

Basic Life Support (BLS) – chest compressions

BLS is the most important to put in place during a CPA. Fortunately, BLS does not require too many resources and can be done anytime and anywhere. As soon as a CPA is identified, the veterinary team must quickly apply the two basic intensive care measures, namely chest compressions (cardiac massage) and ventilation.

The initial goals of chest compressions are to provide 1) pulmonary blood flow for oxygen uptake and carbon dioxide removal and 2) tissue perfusion and oxygen delivery to restore cellular metabolism. Experimental evidence suggests that even well-performed external chest compressions produce at best 30% of normal cardiac output, hence the importance of excellent technique. Chest compressions should be started as soon as possible after diagnosis or suspicion of CPA. A delay in the initiation of high-quality chest compressions reduces the likelihood of return of spontaneous circulation (ROSC). Chest compressions should be performed with the patient in lateral decubitus (left or right) to a depth of 1/3 to 1/2 of the width of the chest, at a rate of 100-120 compressions per minute. You should avoid leaning on the chest between compressions. Chest compressions should be performed in uninterrupted cycles of 2 minutes. When the 2-minute cycle is complete, the pulse and ECG should be assessed (see below) and another rescuer should take over for compressions.

The heart pump theory is based on the concept that the left and right ventricles are directly compressed, while the chest pump theory is based on the concept that external chest compressions increase overall intrathoracic pressure. Blood flow generated by the thoracic pump mechanism probably predominates in large dogs with round chests (Labrador, Bernese Mountain dog). It is therefore recommended to compress the thorax at the highest point of the chest wall.

In dogs with a deep chest whose thorax is shaped like a keel (Greyhound, Standard Poodle), it is recommended to perform compressions directly over the heart. In this case, the heart pump theory applies. In dogs with a flat chest (English bulldog), compressions on the sternum, directly over the heat, with the patient in dorsal recumbency may be more effective.

Finally, chest compressions should be performed in cats and small dogs (< 7 kg) directly at the level of the heart. A one-handed technique is generally employed.

To perform effective chest compressions, keep your elbows locked, press your hands together and interlace your fingers, and align your shoulders, elbows, and hands. This allows compressions to be performed using the core muscles rather than the biceps and triceps which will tire quickly.

Summary :

- 100-120 compressions per minute.
- Superimposed hands and interlaced fingers.
- Shoulders, elbows and hands aligned.
- Force adjusted to compress the thorax from 1/3 to 1/2 of its thickness.
- Compression points (highest point of the thorax or at heart level) depending on the patient.
- 2-minute cycle, then pulse check, ECG reading and change of rescuer for compressions.

Basic Life Support (BLS) – ventilation

The patient should be intubated as soon as possible. Dogs and cats can (and should!) be intubated in lateral recumbency. It is important not to stop chest compressions to proceed with intubation. The veterinary team must therefore look for opportunities to practice intubating patients in lateral recumbency so as not to be caught off guard during a crisis! If an endotracheal tube is not immediately available or if it is a single rescuer CPR, mouth-to-snout ventilation should be performed. To do this, the patient's mouth should be held firmly closed with one hand, the neck is stretched to align the muzzle with the spine to open the airways, and the mouth covers the patient's nostrils to obtain a good seal. Then, the person blows firmly into the nostrils twice (maximum 5 seconds total) to inflate the lungs. If the patient is not intubated, it is not possible to perform chest compressions and ventilations simultaneously. Thus, it will be necessary to apply 30 chest compressions, stop the compressions, give 2 breaths, then resume the compressions respecting the 30:2 ratio. Alternating compressions and ventilations should be continued for 2-minute cycles and another rescuer should take over compressions (if available).

If the patient can be intubated (equipment available and at least 2 rescuers present), chest compressions and ventilations must be performed simultaneously. In intubated patients, ventilations are applied at a rate of 10 breaths per minute, or every 6 seconds. Each breath should last approximately 1 second. It is very important to inflate the cuff and secure the endotracheal tube once the patient is intubated. This will allow compressions and ventilations to be performed simultaneously.

Summary:

- Intubated ventilation: 10 breaths per minute (1 per 6 seconds); 1 second per breath.
- The endotracheal tube cuff MUST be inflated.
- The endotreal tube MUST be secured.
- Non-intubated ventilation: 30 compressions followed by 2 inspirations (30:2).

Advanced Life Support (ALS) – monitoring

There are only two monitoring devices that are useful during cardiopulmonary resuscitation: the electrocardiogram (ECG) and the capnograph ($ETCO_2$). Pulse oximeter and blood pressure monitors (whether Doppler or oscillometric devices) are not useful during CPR and are even sources of distraction.

The ECG is useful because it allows a diagnosis of the rhythm, which is essential to guide further CPR treatments. Indeed, depending on the rhythm, drug treatment or electrical defibrillation will be indicated. The goal of ECG monitoring during CPR is to diagnose which of the four most common rhythms is present: (1) asystole, 2) pulseless electrical activity (PEA), 3) ventricular fibrillation (VF), or 4) pulseless ventricular tachycardia (VT).

Asystole and PEA are “non-shockable” rhythms. VF and pulseless VT are “shockable” rhythms. ECG clips must be quickly installed (without alcohol) as soon as BLS (compressions and ventilation) is started. It is not possible to evaluate the ECG during cardiac compressions due to motion artifacts. The ECG should therefore be rapidly assessed while the rescuers are rotating between 2-minute CPR cycles. Do not forget to palpate to evaluate the presence of a pulse during the brief pauses between 2 cycles and to ensure that the ECG clips are in place before stopping the compressions.

The capnograph has several uses. First, the presence of CO_2 measurable by $ETCO_2$ suggests the correct positioning of the endotracheal tube in the trachea. However, it is suggested to confirm the placement of the endotracheal tube by direct visualization of the tube passing into the larynx and not to rely solely on $ETCO_2$. Furthermore, because $ETCO_2$ is proportional to pulmonary blood flow, it can also be used as a measure of the effectiveness of chest compressions in conditions where pulmonary blood flow is low (i.e. during CPR!) The capnograph is therefore a tool to inform us about the quality of our chest compressions under constant ventilation conditions (10 breaths per minute, 1 second per inspiration). A return of spontaneous circulation (ROSC) is more likely if the $ETCO_2$ during CPR is greater than 18mmHg. If the $ETCO_2$ is less than 18 mmHg , adjustments to the chest compression technique must be implemented (see above). During ROSC, $ETCO_2$ increases dramatically due to the rapid increase in circulation, and is therefore an indicator of ROSC. If during CPR, the $ETCO_2$ suddenly increases by more than 15 mmHg or becomes greater than 35 mmHg, the pulse must be evaluated (DO NOT STOP THE COMPRESSIONS THOUGH!) If a pulse is detected, chest compressions are stopped. If there is doubt about the presence of a pulse, chest compressions are continued until the end of the 2-minute cycle.

Venous access

During CPR, it is common to have to administer antagonists and/or emergency medications, and sometimes intravenous fluids depending on the situation. Venous access is therefore necessary. Quickly, an intravenous catheter must be placed, ideally as close as possible to the heart (jugular vein, otherwise cephalic, otherwise saphenous vein). The most important thing is to have venous access! A cut -down can be performed if it is difficult/impossible to place the catheter. Other possible routes of administration are the intraosseous route and the intratracheal route. The intratracheal route can be used for epinephrine and atropine. However, the doses to be used are not known. It is suggested to double the usual doses. The drug administered intratracheally via an orange catheter (red rubber tube) should be diluted in sterile saline. Once the medication has been injected, a little air must be pushed in and ventilations resumed. When medications are

administered intravenously, it is important to follow the administration of the medication with a flush of non-heparinized saline (between 5-15 ml depending on the size of the patient).

The antagonists

When performing CPR, it is important to know whether the animal has received medications. Indeed, certain medications can be antagonized. However, it is important, during CPR, to prioritize the BLS, then the installation of monitoring equipment BEFORE the administration of the antagonists. If the animal has received an opioid (hydromorphone, methadone, remifentanil, etc.), naloxone must be administered. If he received dexmedetomidine, atipamezole should be administered. Finally, if he received a benzodiazepine (midazolam, diazepam), flumazenil will be administered. It is important to cease administration of any sedative/analgesic/anesthetic infusions that the animal may be receiving, and, if under general anesthesia, to discontinue administration of isoflurane or other volatile anesthetic agent.

Emergency medications

When a “non-shockable” rhythm such as asystole or PEA is diagnosed, it is recommended to administer a vasopressor, such as epinephrine, to increase peripheral vasoconstriction, via its action on α1 adrenergic receptors. Epinephrine also has an action on β1 and β2 receptors. Previous recommendations suggested starting with a low dose of epinephrine (0.01 mg/kg IV/IO every other cycle) and using a high dose (0.1 mg/kg) during prolonged CPR. However, the new RECOVER recommendations no longer suggest using the high dose regardless of the duration of CPR. Another vasopressor agent is vasopressin. It acts on peripheral V1 receptors. However, this medication is generally less available in veterinary clinics (and more expensive!) Atropine is a parasympatholytic drug that has shown some benefit in only a few studies. Atropine at a dose of 0.04 mg/kg IV/IO may be considered during CPR in dogs and cats, especially if there is evidence or suspicion of increased vagal tone before the CPA. An increase in vagal tone is possible during abdominal pain/condition, respiratory disease, ocular surgery/pain, opioid administration and in brachycephalic breeds. As mentioned above, antagonist administration is recommended in animals that have received opioids, dexmedetomidine and /or a benzodiazepine. However, the administration of antagonists should not delay the initiation of basic intensive care (compressions and ventilation), nor the administration of epinephrine if a “non-shockable” rhythm has been identified on the ECG.

Electrical defibrillation

The goal of defibrillation is to depolarize as many myocardial cells as possible to drive them into a refractory period, allowing the sinoatrial node to take over. Defibrillation should be done as soon as a shockable rhythm is diagnosed. The use of biphasic defibrillators is recommended over monophasic defibrillators because lower energy is required. For monophasic defibrillators, an initial dose of 4-6 J/kg should be used, while biphasic defibrillation should start at 2-4 J/kg. The second dose can be increased by 50%. After defibrillation, chest compressions should be resumed immediately, and a 2-minute cycle of CPR completed before reassessing the ECG and determining if the patient still has a “shockable” rhythm. If necessary, he will have to be shocked again. Safety measures must be taken to avoid injury to yourself, a team member or the patient.

References available upon request.