Evidence-Based CPR: The RECOVER Guidelines

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In June of 2012, the Reassessment Campaign on Veterinary Resuscitation (RECOVER) published the first evidence based guideline for veterinary cardiopulmonary resuscitation (CPR). The initiative was launched after considering the difference in success rates of CPR between human (20%) and veterinary (6-7%) settings, with the human counterpart having established evidence-based guidelines through the American Heart Association. There are definitely physiologic and anatomic differences between human patients and veterinary patients, but one would expect a comprehensive, evidence-based treatment strategy on execution of CPR to improve the outcome through optimization of the CPR protocols. The RECOVER initiative was carried out through the involvement of over 80 experts from the American College of Veterinary Emergency and Critical Care (ACVECC) and American College of Veterinary Anesthesia (AVTA) of multi-national background evaluating published studies available to answer clinical questions organized into 5 different subtopics to arrive at a consensus guideline. This groundbreaking effort not only produced a guideline that is now utilized all over the world to refine CPR practices, but has also injected fuel into the drive towards evidence-based practices in veterinary medicine, and sparked many other movements in the process.

Evidence in CPR

Many clinical questions asked in 5 different “domains” of (1) Preparedness & Prevention, (2) Basic Life Support, (3) Advanced Life Support, (4) Monitoring, and (5) Post-Cardiac Arrest Care were answered to confirm or disprove existing beliefs, provided new knowledge, and also allowed us to identify gaps in the knowledge available to come to definitive answers.

The guideline emphasizes importance in early initiation of CPR as a key factor in successful outcome. Preparation for swift intervention when a patient going into cardiac arrest can be accomplished through thorough training of the staff in both didactic (knowledge) and psychomotor (physical) aspects of CPR. CPR drills simulating the arrest and response allows staff members to better understand the sequence of events and potential turns the event may take. Periodic refresher training sessions at least every 6 months is recommended. Preparation of the facility through setup of a crash cart in a central location, which is regularly checked for stock with a detailed checklist will allow for easy access to supplies and equipment required for CPR. Cognitive aides consisting of the CPR algorithm, drug dosage charts, CPR priority checklist should be readily available in the emergency area, with the staff trained on their usage prior to the event, helping adherence to proper protocol.

Swift intervention is better made when cardiopulmonary arrest (CPA) is recognized quickly, and CPR initiated. Assessment of the patient for CPA should be performed in no more than 10-15 seconds through a standardized approach. If CPA is even suspected, chest compressions should be started right away since any delay can significantly reduce the chance of success, accurate assessment of a lack of a pulse is difficult without taking a long time, and performing compressions on a patient that is not in CPA brings very little harm. In an inpatient situation, clear identification of patients at risk of CPA to the staff should allow for earlier recognition.

Basic Life Support

CPR starts with provision of basic life support (BLS) as the priority, and most important aspect of CPR. The mnemonic CAB is now used to describe the priority order of circulation, airway, and breathing, because breathing is not helpful in oxygen delivery if circulation of blood has ceased. Evidence points towards delay in initiation of compressions leading to lower success rates in CPR. In regards to compressions, there were no differences seen between right and left lateral recumbency. Chest compressions should be performed to 1/3 to 1/2 of chest width (which takes quite a bit of force for large animals, while moderation may be required for smaller patients) at a rate of 100-120 compressions per minute while allowing full chest recoil in between. The compressions should be focused at the highest point of the chest for

dogs with normal conformation, over the heart for keel-chested dogs, and over the sternum in flat-chested dogs (such as some bulldogs). Small dogs and cats should have compressions performed over the heart, and compressions may be performed with a circumferential or two-handed technique. The use of a metronome, songs, or other methods of keeping the rate consistent to recommended rates is useful. Even when compressions are executed properly, it may only produce about 30% of normal cardiac output, which illustrates the need for swift and proper compressions during CPR. Interrupting of compressions significantly reduces the forward flow created through consistent application of compressions, and is best avoided.

Compressions should not be stopped to auscultate the heart, check for pulses, assess the patient, or place an endotracheal tube for a full 2 minutes per cycle of compressions. 10-15 seconds in between 2 minute cycles should be used for assessment of the patient, and compressions resumed promptly if no change in CPA is seen. The compressor should be switched between cycles as well, to prevent physical fatigue as 2 minutes of repetitive compressions is physically demanding.

The airway should be verified to be patent, and any obstructions dislodged. Endotracheal intubation should be performed without interruption of compressions, and ventilations performed approximately at 10mL/kg tidal volume (or 20cmH2O of pressure if no spirometer) at 10 breaths per minute with an inspiratory time of 1 second. Hyperventilation is best avoided to prevent vasoconstriction from low CO2 levels leading to poor cerebral perfusion. Mouth-to-snout ventilation may be used if supplies for endotracheal intubation are not available. In the case of single person CPR, 2 short breaths in between 30 chest compressions is recommended.

Advanced Life Support

With basic life support provided, the attention of the CPR team should be directed to providing advanced life support, including monitoring, drug therapy, and electrical defibrillation. The two forms of monitoring that prove useful during CPR is the electrocardiogram (ECG) and end-tidal carbon dioxide (ETCO2) monitoring. Pulse oximeters and oscillometric or Doppler blood pressure monitoring is not effective in assessment during CPR due to movement and poor perfusion state. The electrocardiogram is also prone to motion artifacts during compressions, making interpretation difficult. Regardless, specific tracings may be seen during or in between compression cycles, guiding therapy. Asystole, pulseless electrical activity (PEA) and ventricular fibrillation (VF) are notable arrhythmias seen in CPR.

Capnography, or measurement of CO2 in the breaths coming out of the patient is monitored easily in a patient that is endotracheally intubated. ETCO2 measurement is the most reliable form of monitoring for effective compressions since the level of CO2 measured correlates to the level of perfusion the lungs are receiving, given there is no severe pulmonary pathology. ETCO2 levels higher than 10-15mmHg during CPR was observed to give a higher chance of return of spontaneous circulation (ROSC). Upon ROSC, ETCO2 increases significantly as perfusion to the lungs are re-established, and can be used as an indicator of ROSC.

Drugs can be administered intravenously (IV) or intraosseously (IO) during CPR, and access should be established without interruption of compressions. Vasopressors, parasympatholytics, anti-arrhythmics, reversal agents, IV fluids, and alkalinizing agents are used in specific situations during CPR. Vasopressors are indicated for use in CPR regardless of ECG readings to increase systemic vascular resistance and optimizing perfusion through the reduced cardiac output. Epinephrine, an alpha-1, beta-1 and beta-2 adrenergic agonist causes vasoconstriction, and is given at a low does (0.01mg/kg) initially, and at a high dose (0.1mg/kg) with prolonged duration of CPR. Vasopressin is an alternative that may be used in place of epinephrine at 0.8U/kg. Both vasopressors are given every other cycle of compressions due to its half-life.

Atropine has traditionally been given as an anticholinergic and a sympatholytic drug. There is minimal evidence indicating benefits of atropine administration during CPR, though there is also no evidence of harm. Atropine is given at 0.04mg/kg IV or IO at the initiation of

CPR or as soon as IV or IO access is established, with redosing performed every other cycle of compressions. Anti-arrhythmics may be useful in ventricular fibrillation (VF) that does not respond to electrical defibrillation. Amiodarone at 2.5-5mg/kg IV or IO is recommended, with lidocaine at 2mg/kg slow IV or IO being a secondary option. Reversal of any anesthetic or analgesic drugs seems reasonable though no evidence is seen. Opioids can be reversed with naloxone (0.04mg/kg), benzodiazepines with flumazenil (0.01mg/kg), and alpha-2 agonists with atipamezole (0.1mg/kg) or yohimbine (0.1mg/kg), each IV or IO.

Intravenous fluids may be beneficial if the patient is known or is suspected of hypovolemia to help restore intravenous volume and perfusion, but is unlikely to be of any benefit (and may even be detrimental) to those that are euvolemic or hypervolemic. Corticosteroid administration may have been traditionally performed, though evidence suggests more potential harm than benefits, discouraging its use. Sodium bicarbonate administration is considered in patients with prolonged CPA (10-15 minutes) to counter effects of metabolic acidosis which is likely to be present.

Electrical defibrillation is useful in patients with VF and has been associated with a higher rate of ROSC. Electrical defibrillation delivers an electrical shock to the heart “resetting” the myocytes and allowing them to resume a more orderly conduction and contraction pattern. Monophasic and biphasic defibrillators are available on the market. Biphasic models are recommended over monophasic because of the higher success rate and less damage caused by a lower current used. Defibrillation should be performed in between compression cycles to minimize interruptions and allow for recharging of the defibrillator should repeated discharges be necessary.

Post-Resuscitation Care

The survival to discharge rate of a patient that successfully achieves ROSC is quite low, reported to be 16% in one veterinary study. The final outcome has a multitude of factors including underlying disease, the cause of CPA, and damage to tissues sustained during and after CPR. Post-resuscitative care is directed towards respiratory optimization performed through monitoring and providing adequate ventilation and oxygenation, hemodynamic support with IV fluids, vasopressors, and inotropes as indicated, and neuroprotective therapy consisting of seizure control, permissive hypothermia, and intracranial pressure control. Optimization of the respiratory, cardiovascular, and nervous systems allows the best chance for patient life to continue while the underlying disease is treated.

Non-medical Aspects

Even when patients at risk of CPA are identified ahead of time and the team is prepared with the appropriate facilities to perform CPR, administration of CPR can be quite chaotic. The aim is to bring as much organization and order to the chaos as humanly possible. One of the biggest factors to keeping the order is the organization of a team. There are several roles to be established ahead of time in training for any one person to be comfortably able to fill all roles necessary. The roles needed are: CPR leader, compressor, ventilator, record keeper, drug handler, and the veterinarian. The CPR leader should be identified at the beginning of CPR, so assigning of subsequent tasks can begin immediately. Staffing permitting, the CPR lead should be freed from tasks aside from assigning and keeping the team organized. Compressor and ventilators provide the compression and ventilation, and may make sense to alternate with each other between compression cycles if staffing is limited. The record keeper should keep a detailed medical record during CPR, and this task is facilitated with a CPR record form. The drug handler will prepare and administer drugs in most cases. The veterinarian ideally is not fulfilling any of these roles, being able to focus on the patient and making judgments on whether CPR efforts should continue, decisions on drug administration, communication with the owners, and any medical interventions that are necessary for the patient.

Communication during CPR is also vital to inn organizing the effort and preventing mistakes. Closed-loop communication, performed through the person making a request addressing an individual clearly by name, the addressed individual repeating back their

understanding of the request, the request being fulfilled being announced, and the requestor acknowledging the completion.

Keeping the communication loops closed each time may feel awkward if it is not used on a regular basis, but contributes to very organized communication allowing everyone on the scene to stay on the same page on the status of the CPR. Double checking each other on tasks being performed is also possible, preventing the preventable mistakes.

Debriefing is another form of communication that is hugely beneficial for the team, regardless of the outcome. After the conclusion of CPR, every member should participate in a 5-15 minute debriefing session discussing the CPR. The discussion will be lead by the CPR lead, discussing the following points:

1. What went well with this CPR session?
2. What could we have done differently?
3. Are there any goals we can set for ourselves for future CPR sessions?
4. Are there any serious concerns you would like to bring up?

Debriefing sessions will bring your team even closer together as a functional unit. This also provides opportunities for staff members to express any stress they may have faced in a productive and constructive manner, and a chance for better understanding of the event that passed. Debriefing is intended for us to be able to think towards bettering our effectiveness in CPR, providing each individual patient the best possible chance of recovery and positive outcome. Bring your open mind, active listening, and participation to each of these debriefings. Commend each other on what was done well, regardless of the outcome. Discuss what could be done differently to perform CPR better. Every opinion is important, and should be discussed in a professional manner. Being open in communication requires trust and willingness to give and take feedback without bias and being personally affected.

Has RECOVER Made a Difference?

In the first year since the implementation of the RECOVER guideline into our CPR training protocol, a total of 54 CPR efforts (35 dogs,18 cats, 1 chinchilla) have been made at the author's practice (data collection for the second year is ongoing). The average age was 9 years old, with variable reasons. The average duration of CPR was 11 minutes, with the shortest effort lasting 1 minute and the longest 32 consecutive minutes (one effort lasted 47 minutes total, with intermittent ROSC). The ROSC rate was 24.1% (13 of 54), with a survival-to-discharge rate of 3.7% (2 of 54). The average duration of CPR effort achieving ROSC was 9.5 minutes (high: 27, low 1). One of the patients who were eventually discharged was suspected to have experienced hyperkalemia related cardiac arrest from urinary obstruction, while the other was suspected to have suffered from severe metabolic acidosis and potential over-supplementation of potassium as insulin doses were reduced without a change in KCl content of IV fluids (diabetic ketoacidosis patient). Comparison with previously published statistics unfortunately does not yield a significant difference at our practice. The staff, however, feels better prepared for the ultimate emergency, and feels confident the best chances are provided for each of our patients.

Other Effects of RECOVER

RECOVER has brought on some indirect changes to the veterinary field in addition to providing standardization of CPR protocols. The Academy of Veterinary Emergency and Critical Care Technicians (AVECCT) is in the process of using similar evidence grading methods used by the RECOVER initiative in creating evidence-based nursing guidelines, inspired by the initiative. Evidence-based veterinary medicine (EVBM) has gained significant momentum since RECOVER guidelines were published, and while this could be temporally a coincidence, there is no denying the initiative adds significant weight to the importance of EVBM. ACVECC is now offering a college sanctioned veterinary CPR BLS training program through Veritas, offering certification for both didactic and psychomotor training. The training program, in the long term is anticipated to reach the public. As the immediate next steps, an advance life support course is

being designed, and a trainer certification program is also in the works. Advancement in the field of veterinary emergency and critical care has been accelerated due to the RECOVER initiative.