CODE BLUE! CPR FOR VET TECHS

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Overview
The Reassessment Campaign on Veterinary Resuscitation (RECOVER) was established in 2012 by a group of criticalists. Their goal was to evaluate current evidence-based medicine and form a consensus regarding guidelines for veterinary CPR in canine and feline patients. The result was refined recommendations that the veterinary community could adopt and follow.

Hospital and Staff Preparedness
Preparation includes having hospital and staff be prepared and trained to provide CPR in an organized and efficient manner.

Each hospital should have a centrally located and fully stocked crash cart. The crash cart should be stocked with multiple endotracheal (ET) tube sizes, a laryngoscope, ET tube cuff inflators and ties, an AMBU bag, emergency drugs (i.e. epinephrine, atropine, vasopressin), syringes/needles, red rubber catheters, and saline/heparinized flushes. The crash cart should be organized and routinely inventoried to ensure no supplies are missing and no drugs are expired. Ideally, the crash cart should be inspected daily. A piece of tape can be placed across the crash cart with the date and person's initials to verify the crash cart is fully stocked, up to date and ready for use. The crash cart location and content should be standardized, meaning the location doesn't change and the content organization doesn't change (i.e. the ET tubes and laryngoscope are always in the top drawer). It would also be beneficial to have a multi-parameter monitor (with ECG and ETCO2 capability) in the vicinity of the crash cart as well as memory aids readily accessible (i.e. CPR algorithm chart, drug dosage chart). The presence of cognitive aids has been shown to improve compliance of CPR guidelines. Cognitive aids should have clear visibility and training on the use of them improves utilization.

Being prepared also includes CPR training for all staff members (technicians, veterinarians, assistants/kennel staff and receptionists). This includes an instructive component as well as hands-on practice. Instructive training involves providing in-house learning, or access to online or in-person education, to teach all the aspects of CPR. Instructive training improves cognitive skills and teaches staff how CPR is correctly performed. Hands-on training allows for the development of psychomotor skills so that chest compressions and ventilation are provided effectively. Hands-on training can be achieved by performing practice CPR drills with each staffing team. This includes going through the processes of BLS and ALS as well as practicing effective communication between team members during CPR performance. Each staff member should be comfortable performing all roles of CPR (discussed further below). Hands-on training should also provide feedback to each rescuer or rescue team, such as what aspects were done well and what can be improved upon. Regular hands-on training should occur at least every six months to practice, refresh and prevent loss of psychomotor skills.

Another consideration that can be made is having an advanced directive status for each patient in the hospital. Knowing the owner's wishes for their pet ahead of time eliminates confusion and delay regarding providing CPR efforts.

Basic Life Support
Basic life support (BLS) encompasses recognition of cardiopulmonary arrest (CPA), initiation of chest compressions, providing an airway, and delivering ventilation.

Prompt recognition of and immediate response to a CPA event are essential to improve outcome and chances of patient survival. Signs of impending arrest include alterations in respiratory rate/character, uncontrollable ventricular tachycardia, bradycardia, hypotension, weakening pulses, change in mentation (i.e. unresponsiveness) hypothermia, or an acute decline of ETCO2 (during anesthesia).

With the RECOVER initiative, the ABCs (airway, breathing, circulation) of BLS was updated to CAB (circulation, airway, breathing). Their guidelines have been summarized in a CPR algorithm chart, which is a visual aid that can be used by the veterinary team as a step-by-step approach to deliver CPR. The algorithm emphasizes the importance of early BLS intervention.

Chest compressions have two main goals: 1) to restore cardiac and pulmonary tissue circulation, and 2) deliver ventilation to provide oxygenation to tissues to restore organ function. There are two theories behind how chest compressions lead to return of blood flow during CPR, the cardiac pump theory and the thoracic pump theory. The cardiac pump theory states that blood flow is generated from direct compression of the heart through the thoracic wall, which simulates the systolic phase of a normal heartbeat. The thoracic pump theory states that blood flow is generated from increased intrathoracic pressures during compressions, which drives blood through the heart chambers. The cardiac pump theory is ideal for patients weighing less than 7kg while the thoracic pump theory is ideal for patients weighing more than 7kg. According to the RECOVER guidelines, high-quality chest compressions should be delivered at a rate of 100-120 compressions/minute. Compression depth should be delivered by compressing by 1/3-1/2 the width of the patient's chest, allowing for full chest wall recoil between each compression. It was also strongly stressed that chest compression should be delivered with minimal interruptions; ideally, compressions are delivered by rescuers in lateral recumbency in two-minute, uninterrupted cycles. Chest compression technique is also essential, as even high-quality compressions still only produce approximately 25-30% of normal cardiac output. Any delay of initiating chest compressions or prolonged pauses of chest compressions (i.e. stopping to intubate, stopping to place an IV catheter) reduces the likelihood of return of spontaneous circulation (ROSC).

Intubation should occur as soon as possible after chest compressions are started, with ventilation being delivered simultaneously to chest compressions. Ideally, intubation should be done in lateral recumbency, so as to not disrupt chest compressions. Use of a laryngoscope ensures endotracheal versus esophageal intubation. Once in the trachea, the cuff needs to be inflated and the ET tube securely tied (to prevent dislodgement) so ventilation can begin. According to the RECOVER guidelines, the breath rate in dogs and cats should be 10 bpm. There have been studies in human medicine showing that higher respiratory rates (which were previously recommended) can lead to impaired venous return to the heart from increases in intrathoracic pressure. Manual ventilation can be provided with either an AMBU bag connected to an oxygen source or a rebreathing bag connected to an anesthetic circuit (with only oxygen running through). In the event intubation is not available, the rescuer can perform mouth-to-snout ventilation as an alternative. To deliver mouth-to-snout breaths, the patient's mouth is held tightly closed, the rescuers mouth is placed over the nares (creating a seal over the snout), then blows into the nares. Mouth-to-snout ventilation should be delivered in cycles of 30 chest compressions followed by two breaths. The mouth-to-snout process can also be advised over the phone to a pet owner as a means of providing ventilation while en route to the hospital.

Advanced Life Support

Advanced life support (ALS) encompasses aspects of CPR performed after initiation of BLS and until ROSC or cessation of CPR efforts occurs. This includes IV or intraosseous (IO) access, emergency drug administration, monitoring equipment, and defibrillation if warranted.

IV access is the preferred route for administered emergency drugs; however, alternative routes include IO or intra-tracheal (IT). Similar to intubation, obtaining IV/IO access should not impede BLS procedures. IO access is ideal for neonates as their bone cartilage isn't fully formed. IO catheters are most commonly placed using a hypodermic needle, size 22g or bigger, in the femoral or humeral heads. Anything that can be given IV can be given IO. In the event IV or IO access isn't obtainable, you can administer drugs IT. The proper protocol for IT administration involves placing a red rubber catheter down the ET tube, administering the drug (doses usually at 10x the IV/IO dose), then flushing the red rubber catheter with 5-10mls sterile saline to ensure the drug reaches the pulmonary tissues. The drugs that are safe to give via the IT route are norepinephrine, atropine, vasopressin, lidocaine, and epinephrine; this can be remembered with the mnemonic NAVLE.

The primary drug therapies used in CPR includes vasopressors (epinephrine, vasopressin), parasympatholytics (atropine) and antiarrythmics (lidocaine). Additional drug therapy includes reversal agents, IV fluids, and alkalinizing therapy.

Vasopressors are powerful drugs that increase peripheral vascular resistance (cause vasoconstriction), which redirects blood flow from peripheral circulation to central circulation. Use of vasopressors are essential as they improve cerebral and coronary perfusion. Epinephrine is a catecholamine that improves arterial blood flow, cardiac contractility and heart rate by stimulating alpha- and beta-adrenergic activity. Vasopressin affects vascular smooth muscle through V1 receptors, causing vasoconstriction. Vasopressin improves myocardial and cerebral oxygenation and maintains effectiveness despite hypoxemia and acidotic states.

Parasympatholytics reduce the activity of the parasympathetic nervous system. Atropine decreases vagal tone by increasing sinoatrial automaticity and atrioventricular conduction. Atropine can prevent an unstable bradycardia from progressing to asystole.

Antiarrythmics are used to treat abnormal heart rhythms resulting from irregular electrical activity of the heart. Lidocaine or amiodarone should be used to treat ventricular fibrillation or pulseless ventricular tachycardia in the event defibrillation is not available or in if the arrhythmia is refractory to defibrillation.

Reversal agents should be administered if there has been recent administration of a reversible drug.

The use of IV fluids was also investigated as part of the RECOVER initiative. Routine use of fluids in euvolemic patients is not recommended; it has been associated with decreased coronary perfusion from increased central venous pressure, which causes opposing blood flow to heart and brain circulation. Conversely, in hypovolemic patients, use of IV fluids may be beneficial in increasing circulating volume during CPR.

Sodium bicarbonate should only be considered after CPR efforts have lasted greater than 10 minutes, or in severe cases of metabolic acidosis ($pH < 7.2$). There are conflicting studies on whether there is improved or detrimental outcomes with the use of alkalinizing therapy.

The mainstay of monitoring equipment during CPR is the electrocardiogram (ECG) and capnograph (ETCO2). Having an ECG is essential to evaluating the heart rhythm and should be interpreted between each two-minute cycle of BLS. The three most common arrest rhythms in dogs and cats are asystole, pulseless electrical activity (PEA) and ventricular fibrillation (VF). ETCO2 is the best indicator of chest compression efficacy and earliest indicator of return of spontaneous circulation (ROSC). Effective chest compressions result in increased pulmonary blood flow, which in turn improves alveolar gas exchange. ETCO2 values greater than 15-20mmHg have been associated with an increased rate of ROSC.

Due to the lack of a pulse and adequate pulse quality during CPA, monitoring tools such as pulse oximetry and indirect blood pressure devices are ineffective and useless.

Electrical defibrillation is the process in which the entire heart is depolarized and “reset.” Defibrillation is warranted if VF or PEA is noted on the ECG. The defibrillation dose as recommended is 2-4J/kg. If external defibrillation is not available, another therapy that can be tried (although there has been minimal documented efficacy) is the precordial thump. The precordial thump is a method of manual defibrillation in which you strike the patient with the heel of your hand directly over the heart.

Open-chest CPR is known to be more effective than closed-chest CPR at restoring ROSC. Indications for open-chest CPR include: abdominal/thoracic surgery, chest wall trauma, penetrating chest wounds, tension pneumothorax, pericardial effusion, or a lack of ROSC from prolonged (greater than 10 minutes) CPR efforts. Performing open-chest CPR requires substantial resources, a skilled veterinary team, and advanced post-resuscitative care, and therefore isn’t commonly seen in clinical practice.

CPR Positions & the Technician’s Role

The positions technicians take part in during CPR are: 1) chest compressor, 2) airway manager, and 3) ALS rescuer. There should also be a designated team leader, who can also rotate through the positions.

BLS should be performed in two-minute cycles, at which time the compressor should rotate to prevent fatigue and administering less efficacious chest compressions. As mentioned previously, intubation, ventilation and ALS tasks should not postpone or interfere with BLS efforts.

The team leader is responsible for delegating tasks to each member of the rescue team. They also should have a post-code summary discussion with the team to foster collaboration and a unified mentality on how the code went. It’s important to note that the team leader doesn’t necessarily need to be the veterinarian; there have been studies in the human field that showed there was no difference in CPR outcome whether or not the team leader was a clinician.

Team dynamics play an important role in improving the effectiveness of a CPR attempt and outcome. There has been evidence in human literature that CPR performance is improved with the use of closed loop communication. Closed loop communication is when a clear, directed order is given to a team member (by name) by the team leader. The given order is then repeated back to verify the order was heard correctly and delivered.

All aspects of CPR also need to be recorded and documented as part of the medical record. Things like compression start time, size of ET tube, ventilation start time, and drug dose, route and administration time should be noted. Currently, there is a subcommittee within RECOVER that is working on creating a standardized CPR form.

Post-CPA Care and Prognosis

Following CPR and ROSC, patients may suffer from multiorgan failure, cardiogenic shock, hypoxic/anoxic brain injury, and whatever preexisting condition(s) contributed to the impending CPA event. Therefore, post-CPA care required dedicated one-on-one nursing care that focuses on respiratory optimization, hemodynamic optimization, and neuroprotection.

Many animals will ultimately die despite CPR efforts. Statistics range from 35-58% of ROSC and only 2-10% survival to discharge.

References

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