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RECOVER CPR for veterinary nurses

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ABSTRACT: This article outlines the Reassessment Campaign on Veterinary Resuscitation (RECOVER) initiative. It will review the established evidence-based guidelines for veterinary CPR, which are internationally recognised and endorsed by the American College of Veterinary Emergency and Critical Care (ACVECC) and Veterinary Emergency and Critical Care Society (VECCS). After reading this article, participants should be able to prepare for and recognise cardiopulmonary arrest (CPA), initiate basic life support, provide advanced life support, monitor the CPA patient and provide post-CPA care. Participants will also have access on the different RECOVER certifications available and certification process.

Keywords: Cardiopulmonary arrest (CPA); CPR; RECOVER; BLS; ALS; veterinary nurse

The Reassessment Campaign on Veterinary Resuscitation (RECOVER) was established in 2012 by a group of over 100 veterinary specialists. Their goal was to evaluate evidence-based medicine and form consensus guidelines for CPR in canine and feline patients. The result was refined recommendations that the veterinary community could adopt and follow. The RECOVER guidelines are considered open access (www.veccs.org/recover-cpr) and are available to all veterinary professionals.

RECOVER initiative

The initiative aimed to address five critical aspects surrounding cardiopulmonary arrest (CPA) for the veterinary team: preparedness and prevention, basic life support (BLS), advanced life support (ALS), monitoring, and post-cardiopulmonary arrest care.

Preparedness and prevention

Preparation includes having both the veterinary team and hospital be trained to provide cardiopulmonary resuscitation (CPR) in an organised and efficient manner.

Being prepared first means providing CPR training for all staff members (veterinarians, nurses, assistants and client service representatives). This includes an instructive component as well as hands-on practise. Instructive training involves providing in-house or online education to teach key concepts 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 practising CPR drills with team members to evaluate CPR performance. Regular refresher training for both instructive and hands-on is recommended at least every six months to prevent loss of knowledge and psychomotor skills.

Each hospital should have a designated emergency area with a centrally located, fully stocked crash cart (Figure 1 and Table 1). The crash cart should be organised, routinely audited (ideally daily) to ensure no supplies are missing, and have its location and content standardised (location doesn't change, content organisation doesn't change).

It's beneficial to have a multi-parameter monitor in the vicinity of the crash cart as well as cognitive aids readily accessible (Figure 2). Cognitive aids should have clear visibility and training on the use of them, as they have been shown to improve compliance of RECOVER guidelines. RECOVER created three essential cognitive aids: CPR Algorithm, CPR Emergency Drugs and Doses, and Post-Cardiac Arrest Care Algorithm. These aids are available in the published RECOVER guidelines available on the RECOVER website (www.recoverinitiative.org).

A final consideration in preparedness 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 in providing CPR efforts.

Basic life support

Basic life support (BLS) encompasses recognition of cardiopulmonary arrest (CPA), initiation of chest compressions, establishing an airway, and delivering breaths to provide ventilation.

Prompt recognition and immediate response to CPA are essential to improve outcome and chances of patient survival.

Signs of impending arrest are summarised in Table 2. If CPA is suspected, rapid assessment of the patient (less than 10–15 seconds) should be done to determine if the animal is responsive and if they're breathing. If the answer is no, a call for help should be shouted and BLS should be initiated. It is important to note that evaluation of the patient's circulation status (i.e. heartbeat, pulse) is not performed during this rapid assessment. This is because taking the extra time to auscultate for a heartbeat or palpate a pulse is time taken away from initiating life-saving chest compressions. Additionally, the RECOVER research found that there is considerable inaccuracy in a rescuer's ability to correctly determine if a pulse is present or absent. The research also found that it is more detrimental to delay starting chest compressions on a CPA patient than performing chest compressions in an animal that is not in CPA.

Figure 1. Example of a centralized crash cart in ICU.

Figure 2. Example of a RECOVER cognitive aid located with a centralized crash cart.

Table 1. Summary of essential supplies needed in a crash cart.

Crash cart essentials	
Airway • Endotracheal (ET) tubes • Laryngoscope • ET tube ties • ET tube cuff inflator syringe	Venous access • IV catheters • T-ports • 1-ml syringes • 3-ml syringes • Multiple needle sizes • Multiple saline/heparinised flushes
Breathing • Red rubber catheters • Suction equipment/supplies • Manual resuscitator (i.e. AMBU bag, anaesthetic reservoir bag)	Drug administration • Epinephrine • Atropine • Vaspopressin • Norepinephrine • Anti-arrhythmics (lidocaine, amiodarone) • Reversal agents (naloxone, flumazenil, antipamezole)
Equipment • Defibrillator • ECG monitor • Capnograph	

With the RECOVER initiative, the ABCs (airway, breathing, circulation) was updated to CAB (circulation, airway, breathing), due to an updated statement in 2010 from the American Heart Association (AHA). While there are no studies in human or veterinary medicine that directly look at whether chest compressions or intubation/ventilation should be initiated first, what is certain is that chest compressions are necessary for blood flow and to improve the chances of return of spontaneous circulation (ROSC). It is also known that the process of intubating and providing breaths is longer, when providing chest compressions can start immediately. By focusing on compressions first, there is less delay in starting CPR efforts.

Chest compressions have two main goals, to restore cardiac/pulmonary tissue circulation and deliver ventilation to oxygenate tissues and restore organ function. There are two theories on how chest compressions return blood flow during CPR and where the compression point should be. 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. This compression point is directly over the heart and is ideal for narrow- or keel-chested dogs, small dogs, cats and paediatric dogs and cats. Using your thumb over the compression point is an alternative to using a hand-over-hand technique when following the cardiac pump theory (Figure 3). The thoracic pump theory states that blood flow is generated from increased intrathoracic pressures during compressions, which drive blood through the heart chambers (Figure 4). This compression point is over the widest aspect of the chest and is ideal for flat-chested dogs. Round-chested dogs are unique in that the compression point is directly over their sternum when in dorsal recumbency. High-quality chest compressions should be delivered in lateral recumbency at a rate

Table 2. Summary of clinical signs of impending cardiopulmonary arrest.

Signs of impending CPA
• Changes in mentation • Alterations in respiratory rate/pattern • Uncontrollable ventricular tachycardia (V-tach) • Bradycardia • Collapse • Weakening pulse quality • Prolonged hypotension • Prolonged hypothermia • Acute decline of $ETCO_2$ (under anaesthesia)

Figure 3. The author demonstrating cardiac pump theory chest compressions on a feline CPR mannequin.

of 100–120 compressions/minute (cpm). Compression depth should be delivered by compressing one-third to one-half of the width of the patient's chest. When compressing, the rescuer needs to allow for full chest wall recoil between compression depths in order to optimise cardiac output. Rescuers should perform compressions by standing behind the patient and should be above the level of the patient, which means it's sometimes necessary to use a step stool. The rescuer should place one hand over the other, with the heel of their hand over the appropriate compression point (directly over the heart or over the widest part of the chest). They should also have their elbows locked and bend at the waist in order to draw compression power and force from their core rather than their arms (Figure 5). Following this chest compression technique is essential, as even high-quality compressions only produce approximately 25–30% of normal cardiac output. It's strongly stressed that any delay of initiation or prolonged pauses of chest compressions reduces the likelihood of ROSC.

Intubation should occur as soon as possible once chest compressions start, with ventilation being delivered simultaneously. Ideally, intubation should be done in lateral recumbency so chest compressions aren't interrupted. Using a laryngoscope ensures endotracheal versus oesophageal intubation. Once intubated, inflate the cuff and securely tie the endotracheal tube to prevent dislodgement. The breath delivery rate in dogs and cats should be 10 breaths per minute (bpm). Manual ventilation can be provided with either an AMBU bag connected to an oxygen source or a rebreathing bag connected to an anaesthetic circuit.

The practice of performing compressions at 100–120 cpm and delivering breaths at 10 bpm should be done in uninterrupted 2-minute BLS cycles. It is known that it takes approximately 60 seconds of continuous chest compressions to build up cerebral perfusion pressure (CPP). There are human studies that have shown an increased survival when doing uninterrupted chest compressions compared to more frequent pauses in CPR. Human studies have also shown rescuer fatigue when doing compressions for 1–3 minutes, which results in poorer quality. At the end of each 2-minute BLS cycle, rescuers should rotate out to prevent fatigue and the patient should be rapidly assessed for ROSC before starting the next 2-minute cycle.

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 venous access, emergency drug administration, monitoring equipment and defibrillation if warranted.

Venous access is the preferred route to administer emergency drugs. Obtaining venous access should not impede BLS procedures. In the event venous access cannot be achieved, alternative routes of drug administration include intraosseous (IO) or intratracheal (IT). Common sites for IO catheterisation include the femoral head or humerol head. Anything that can be given IV can be given IO at the same dosage. The protocol for IT administration involves placing a red rubber catheter down the ET tube, administering the drug (doses usually at 2.5–10 times the IV dose), then flushing the red rubber catheter with 5–10 ml sterile saline to ensure the drug reaches the pulmonary tissues and does not remain within the ET tube. The drugs that are safe to give via the IT route are noradrenaline, atropine, vasopressin, lidocaine and adrenaline.

The primary drug therapies used in CPR include vasopressors, parasympatholytics and anti-arrythmics. Additional drug therapies include reversal agents, alkalinising therapy and IV fluids.

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. Adrenaline is a catecholamine that improves arterial blood flow, cardiac contractility and heart rate by alpha and beta adrenergic activity. 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 and can also prevent an unstable bradycardia from progressing to asystole. Anti-arrythmics are used to treat abnormal heart rhythms resulting from irregular electrical activity of the heart.

Anti-arrhythmic agents such as lidocaine and 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.

Figure 4. The author demonstrating thoracic pump theory chest compressions on a large breed canine CPR mannequin.

Reversal agents (naloxone, flumazenil, atipamezole) should be administered if there has been recent administration of a reversible drug.

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), as there are conflicting studies on whether there is improved or detrimental outcomes with the use of alkalinising therapy.

The use of IV fluids was also investigated and it was found that 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.

Monitoring

The mainstay of monitoring equipment during CPR is electrocardiogram (ECG) and capnography ($ETCO_2$). Having an ECG is essential to evaluating the heart rhythm and should be quickly interpreted between each 2-minute cycle of BLS so as not to interrupt chest compressions. The three most common arrest rhythms in dogs and cats are asystole, pulseless electrical activity (PEA) and ventricular fibrillation (V-fib). Asystole indicates complete cessation of electrical and mechanical heart activity (Figure 6). PEA indicates cessation of mechanical heart activity (lack of pulses) but continuation of electrical heart activity (Figure 7). During PEA, the electrical activity in the heart is sufficient to generate electrical potentials that can be picked up by ECG. However, there's absent or very weak mechanical activity, meaning the heart fails to generate sufficient blood flow to produce palpable pulses. V-fib indicates uncoordinated mechanical heart activity (Figure 8). During V-fib, the muscle cells in the ventricles have a "quivering" mechanical activity, resulting in ineffective contractions and insufficient cardiac output. If uncorrected, V-fib can progress to pulseless ventricular tachycardia (PVT), which occurs when the quivering mechanical activity of the ventricles becomes very rapid (HR > 200bpm) and complexes repeat. When V-fib progresses to PVT, there's insufficient ventricular filling and therefore no cardiac output. Capnography is the best indicator of chest compression efficacy and earliest indicator of ROSC. Effective chest compressions result in increased pulmonary blood flow, which in turn improves alveolar gas exchange. $ETCO_2$ values greater than 15 mmHg 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 until ROSC has been achieved.

Electrical defibrillation is the process in which the entire heart is depolarised and "reset". Defibrillation is warranted if V-fib or PVT is noted on ECG. The dosing depends on the type of defibrillator; monophasic dosing is 4–6 J/kg, biphasic dosing is 2–4 J/kg. Chest compressions should continue up until and immediately following defibrillation. After defibrillation, the 2-minute BLS cycle restarts and ECG should not be evaluated until the end of the cycle.

Post-cardiopulmonary arrest care

ROSC is the resumption of a heartbeat, palpable pulse, or spontaneous breathing. Following CPR efforts and ROSC, patients suffer from the post-cardiac arrest (PCA) syndrome, which involves multi-organ failure, cardiogenic shock, hypoxic/anoxic brain injury, and whatever pre-existing condition(s) contributed to the inciting CPA event. PCA care requires dedicated one-on-one nursing to minimise the likelihood of CPA reoccurring and to maximise the likelihood of the patient recovering and going home. PCA care focuses on cardiovascular, respiratory and neurological support. Cardiovascular support includes haemodynamic support with IV fluids, vasopressor agents and positive inotrope agents. It also includes continued ECG monitoring and the initiation of blood pressure monitoring. Respiratory support includes oxygen support, evaluation of pulse oximetry, continued $ETCO_2$ (if still intubated), and evaluation of blood gases. Neurologic support includes oxygen support, neuroprotection using osmotic agents (i.e. mannitol, hypertonic saline), 30–45 degree elevation, and permissive hypothermia (allows a lower than normal temperature in order to decrease the metabolic demands of the brain).

Unfortunately, many animals still perish despite CPR efforts. Statistics range from 35% to 44% of ROSC with only 6% survival to discharge.

Figure 5. The author demonstrating correct chest compression technique on a large breed canine CPR mannequin. This includes standing behind the patient, bending at the waist, keeping elbows locked, having hand-over-hand, and using the correct compression point.

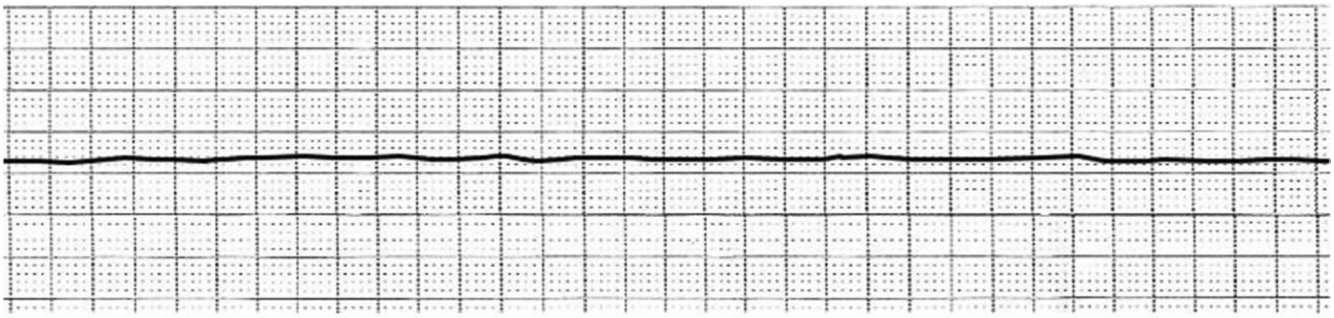

Figure 6. An ECG tracing showing the common arrest rhythm asystole.

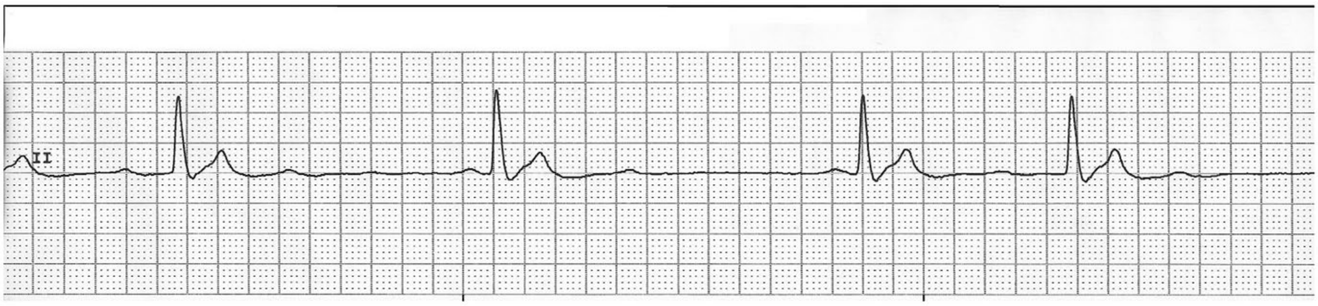

Figure 7. An ECG tracing showing the common arrest rhythm pulseless electrical activity (PEA).

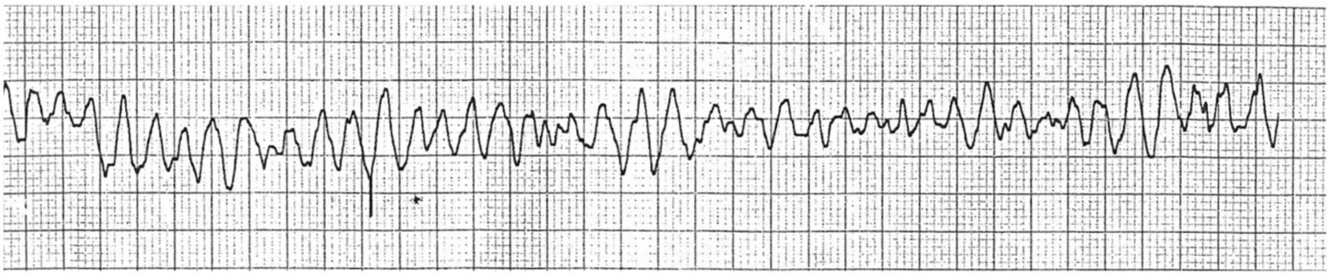

Figure 8. An ECG tracing showing the common arrest rhythm ventricular fibrillation (V-fib).

CPR positions and the nurse's role

The positions nurses take part in during CPR are BLS rescuers (1 – chest compressor, 2 – airway manager/breather), ALS rescuer, and team leader.

The team leader is responsible for delegating tasks to each member of the rescue team. The leader organises CPR efforts, assigns team positions, ensures proper technique of each rescuer, facilitates communication, and directs the flow of the team. It's important to note that the team leader doesn't need to be a veterinarian; there have been studies in the human field showing there was no difference in CPR outcome whether the team leader was a clinician or nurse. The BLS rescuers are primarily responsible for providing compressions and delivering breaths, and they usually rotate amongst themselves after each 2-minute cycle. The ALS rescuer is responsible for obtaining venous access, delivering drugs and connecting the ECG and $ETCO_2$ monitoring equipment.

During a CPR event, using closed-loop communication is preferred. This consists of the leader giving a clear, directed order to a team member by name and then that order is repeated back to the leader to verify it was heard correctly. Closed-loop communication reduces the chance of medical errors from misunderstanding verbal orders.

All aspects of CPR need to be documented as part of the medical record. Using a standard CPR flowsheet serves as a checklist of tasks and ensures the details of CPR are recorded. RECOVER subcommittees developed a standard CPR reporting form that is available at www.recoverinitiative.org/cpr-guidelines/current-recover-guideline. The person responsible for recording the CPR rescue attempt is delegated by the team leader, and is often either the team leader themselves, the ALS rescuer, or an additional staff member if available.

Following any CPR event, it's recommended for the rescue team to have a debriefing session. Debriefing allows the team to talk and review their performance and team dynamics. Questions such as "what was done well?", "what can be improved upon?" and "how does everyone feel?" allow for an open discussion in a safe environment that can be used as a therapeutic learning experience.

RECOVER certification

As the veterinary field advances, so do expectations pet owners place on veterinary professionals. Similar to our human counterparts, RECOVER has established certifications for veterinary CPR, which include becoming certified as a RECOVER BLS Rescuer, RECOVER ALS Rescuer, or both.

Certification is a two-part process that involves both an online didactic course and an in-person hands-on course. There is also an option of certifying as a RECOVER BLS and ALS Instructor once you've completed the rescuer certifications. Detailed information about the certification process can be found at www.recoverinitiative.org/veterinary-professionals/how-certification-works-2. As RECOVER is the internationally recognised authority for veterinary CPR, certification is available to all practising veterinarians and veterinary technicians/nurses who complete the online course and hands-on training. The hands-on training is currently being offered at conferences such as International Veterinary Emergency and Critical Society (IVECCS) and European Veterinary Emergency and Critical Care Society (EVECCS). Detailed information about hands-on BLS and ALS Rescuer Certification courses can be found at https://recoverinitiative.org/recover-rescuer-certification-courses-2/.

Conclusion

The RECOVER initiative was founded to provide a standard set of guidelines for veterinary CPR. Veterinary nurses play a critical role in the recognition, initiation, monitoring and care of patients who experience CPA. Following these guidelines ensures we are providing the best CPR to have the best possible patient outcomes.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Multiple Choice Questions

1. **How often should a crash cart be audited?**
   (a) Bi-weekly and after every code
   (b) Weekly and after every code
   (c) Daily and after every code
   (d) Every other day and after every code

2. **When assessing the unresponsive patient to determine if they are in cardiopulmonary arrest, how long should your assessment be?**
   (a) 10–15 seconds
   (b) 15–20 seconds
   (c) 20–30 seconds
   (d) 30–45 seconds

3. **What is the new algorithm for providing basic life support?**
   (a) ABC
   (b) CAB
   (c) BCA
   (d) CCB

4. **What is the RECOVER-recommended compression rate for dogs and cats?**
   (a) 120–140
   (b) 100–120
   (c) 80–100
   (d) 60–80

5. **What is the RECOVER-recommended breath rate for dogs and cats?**
   (a) 40
   (b) 30
   (c) 20
   (d) 10

6. **Basic life support should be performed in _____ minute cycles**
   (a) 1
   (b) 2
   (c) 3
   (d) 4

7. **What class of drug is adrenaline?**
   (a) Anticholinergic
   (b) Anti-arrhythmic
   (c) Catecholamine
   (d) Vagolytic

8. **What two pieces of monitoring equipment are the MOST important during CPR?**
   (a) ECG and stethoscope
   (b) ECG and Doppler
   (c) ECG and pulse oximeter
   (d) ECG and capnography

9. **Which of the following is not a common arrest rhythm?**
   (a) Ventricular tachycardia
   (b) Ventricular fibrillation
   (c) Asystole
   (d) Pulseless electrical activity

10. **An ETCO2 reading of greater than _____ is associated with ROSC**
    (a) 5 mmHg
    (b) 10 mmHg
    (c) 15 mmHg
    (d) 20 mmHg

11. **Based on current evidence-based medicine, what is the likelihood for ROSC?**
    (a) 45–50%%
    (b) 35–45%
    (c) 25–30%
    (d) 15–20%

12. **Based on current evidence-based medicine, what is the survival to discharge?**
    (a) 6%
    (b) 10%
    (c) 12%
    (d) 15%

For the answers to the MCQs, please go to: **http://www.bvna.org.uk/publications/veterinary-nursing-journal**