

Canine Catch-Neuter-Return (CNR) Good Practice Guides

Good standards of practice in anaesthesia and analgesia - Anaesthetic emergencies - Bradycardia and cardiac arrest

Learning Outcomes:

1. Describe the signs of impending cardiopulmonary arrest in order to prevent progression into cardiopulmonary arrest.
2. Recite the contents required in an emergency crash box
3. Explain how to use **Airway-Breathing-Circulation-Drugs** to perform cardiopulmonary resuscitation on a dog in cardiopulmonary arrest

Anaesthesia causes respiratory and cardiac depression, which may increase the risk of cardiopulmonary arrest. In order to ensure a minimum standard of quality anaesthesia, every veterinarian who administers anaesthesia should be able to perform basic Cardio-Pulmonary Resuscitation (CPR). There must be a CPR protocol in place and a 'crash box' of emergency response drugs easily accessible for every anaesthetic.

Cardiopulmonary Arrest (CPA): can be defined as a sudden cessation of functional ventilation and systemic perfusion. This results in reduced oxygen delivery to tissues, with decreased removal of carbon dioxide and cellular death. Cardiac arrest and respiratory arrest may occur simultaneously but often respiratory arrest occurs first and if not quickly treated, cardiac arrest will soon follow.

Cardiopulmonary Resuscitation (CPR): is an emergency procedure utilised in cardiac and/or respiratory arrest to promote blood flow and improve oxygen delivery to brain, heart, and other vital organs.

Reasons for cardiopulmonary arrest:

- Airway obstruction
- Overdose of anaesthetic agent
- Hypothermia (low body temperature)
- Hypotension (low blood pressure)
- Hypoglycemia (low blood sugar level)
- Severe trauma
- Sepsis
- Hypoxemia (low blood oxygen level)
- Hypercarbia (high blood carbon dioxide level)
- Hypovolemia (low circulating blood volume)
- Vagal stimulation
- Pre-existing cardiac disease

Canine Catch-Neuter-Return (CNR) Good Practice Guides

Having a designated monitoring person recording the dog's physiological parameters every 2-5 minutes during anaesthesia and recording the values on the anaesthetic monitoring sheet should enable the early detection of problems. The early signs of impending cardiopulmonary arrest are listed below. It may be possible to prevent the dog progressing into full cardiopulmonary arrest if these signs are detected and acted upon immediately.

Signs of Impending Cardiopulmonary Arrest (CPA)	Signs of Cardiopulmonary Arrest (CPA)
<ul style="list-style-type: none"> - Weak, irregular pulses, irregular heart sounds, tachycardia - Sudden Bradycardia - Changes in patient's respiratory rate, depth, pattern and effort - Cyanotic, grey or pale mucous membranes - Prolonged capillary refill time - Decreasing end-tidal carbon dioxide - Hypotension - Sudden unexplained increase in anaesthetic depth - Hypothermia despite warming efforts 	<ul style="list-style-type: none"> - No detectable heart sounds on auscultation - No palpable pulses - Fixed, dilated pupils (occurs within 45 seconds of arrest) - Apnea or agonal gasping – may be masked if the patient is being artificially ventilated - Pale, grey, cyanotic mucous membranes. Note: mucous membranes and capillary refill time can remain normal for several minutes after arrest - Absence of bleeding at the surgical site, blood may appear dark if the arrest is due to hypoxemia - Collapse and loss of consciousness of the awake patient - Loss of skeletal muscle tone and cranial nerve reflexes - Note: Equipment such as an electrocardiograph and pulse oximeter may continue to show readings (even normal readings) after the heart has stopped beating.

Emergency/Crash box

There must always be an emergency box readily available that is stocked with essential drugs and equipment for an emergency situation. All members of the surgical team should be familiar with these drugs and equipment and how to use them.

Crash box contents:
<ul style="list-style-type: none"> - Adrenaline hydrochloride - Lignocaine hydrochloride - Atropine sulphate - Antagonist drugs such as naloxone or atipamazole tolazoline - Endotracheal tubes various sizes, ties to secure the tube, laryngoscope - IV cannula/catheter or butterfly needles of various sizes - Needles and syringes of various sizes - Ambu bag if available - Emergency drug dose chart

Canine Catch-Neuter-Return (CNR) Good Practice Guides

		Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50
DRUG		DOSE	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml
Arrest	Epi (low dose)(1:1000)	0.01 mg/kg	0.03	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
	Epi (high dose)(1:1000) <i>Use in prolonged CPR</i>	0.1 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Atropine (0.6 mg/ml)	0.05 mg/kg	0.25	0.5	1	1.5	2	2	2.5	3	3.5	4	4
Anti-arrhyth	Amiodarone (50 mg/ml)	5 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Lidocaine (20 mg/ml)	2-8 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Reversal	Naloxone (0.4 mg/ml)	0.04 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Fiumazenil (0.1 mg/ml)	0.01 mg/kg	0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Atipamezole (5 mg/ml)	50 µg/kg	0.03	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
Defib Biphasic	External defib (J)	2-4 J/kg	6	15	30	50	75	75	100	150	150	150	150
	Internal defib (J)	0.2-0.4 J/kg	1	2	3	5	6	8	9	10	15	15	15

HSA ICU Daily Rounds 2020/2015

Emergency drugs can be stored decanted into multi-dose injection vials, labelled with drug name, concentration and expiry date. This allows for quick response when drugs are required for an emergency situation.

Cardiopulmonary Resuscitation (CPR)

When monitoring anaesthesia, we discussed A-B-C-D (airway-breathing-circulation-depth). With CPR we can follow the same principles except using D to refer to drug therapy instead of depth.

A for airway management

Ensure the patient has a patent airway. All anaesthetised dogs should be intubated after induction, but if the endotracheal tube becomes blocked or dislodged for any reason, a patent airway must be established quickly.

B for breathing

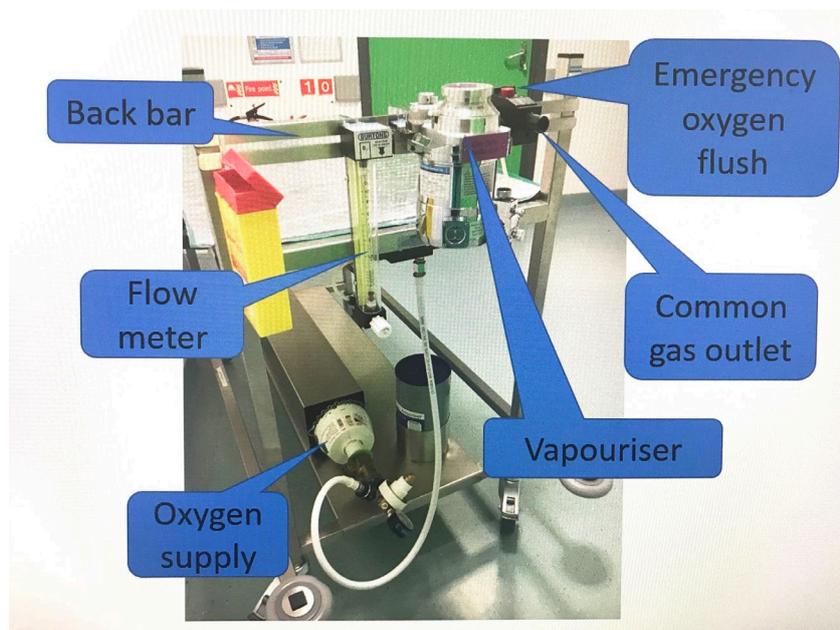
If the dog is not breathing, manual ventilation must be initiated.

This may be administered using an anaesthetic machine delivering 100% O₂ (with the vapouriser turned off) and an anaesthetic circuit with an appropriately sized reservoir bag connected and is called Intermittent positive pressure ventilation (IPPV). Initially patients should be given two breaths with the inspiratory period lasting 1-2 seconds and then assessed for signs of spontaneous ventilation. If spontaneous ventilation does not occur, ventilation at a rate of 10-12 breaths per minute should continue. Remember to close the anaesthetic circuit's APL valve to give a breath and to reopen it immediately to allow the patient to exhale.

Photo = A 'breath' of 100% O₂ being given to a dog via an anaesthetic circuit and reservoir bag.



Canine Catch-Neuter-Return (CNR) Good Practice Guides



The basic anatomy of an anaesthetic machine – note that there is no manometer present

For dogs, peak inspiratory pressure should be kept below a maximum of 20cm H₂O on the manometer if using an anaesthetic machine. Neonates require 12-15 breaths per minute, at a pressure of 10-15cm H₂O. Many anaesthetic machines, however, do not have a manometer so look at the dog's chest when performing IPPV and squeeze the reservoir bag to inflate the lungs so that the chest rises no higher than it would if the dog was breathing naturally.



The manometer (dial and needle) on an anaesthetic machine that has one

Alternatively, an appropriately sized ambu bag can be used connected to the end of the ET tube to deliver room air to the dog if there is no anaesthetic machine available.



Intubated dog with an ambu bag connected to the endotracheal tube to provide breaths

Canine Catch-Neuter-Return (CNR) Good Practice Guides

C for circulation

Check for a heart rate or pulse following intubation and initial commencement of ventilation.

If there is no detectable heartbeat/pulse, circulation is achieved by cardiac compression. Compressions should be started as soon as possible and not interrupted until the return of spontaneous circulation is achieved or a decision is made to stop CPR attempts.

How to perform external cardiac compressions for CPR:

Coordinating breathing/cardiac compressions is determined by the number of people available. One trained person should administer two breaths then fifteen compressions and repeat. Two trained people should ideally administer 10 breaths and 100-120 compressions per minute.

Position the dog in right lateral recumbancy with the back of the dog touching you to enable your body weight to be positioned above the dog's chest. The chest compression rate in dogs and cats should be approximately 100-120 compressions per minute, depending on the size of the patient, with a 1:1 ratio of compression to relaxation. The effectiveness of chest compressions should be monitored by a person holding a finger on the dog's femoral pulse. Effective compressions should produce a palpable pulse.

For larger dogs (>10kg) the heel of one or both hands are positioned over the widest point of the chest and the chest is compressed by approximately 1/3 and excessive pressure should be avoided to prevent intrathoracic trauma. This is called the thoracic pump method.

For smaller dogs (<10kg) the heel of one or both hands are positioned at the fifth intercostal space directly over the dog's heart (usually at the point of the elbow) and the chest compressed by approximately 1/3. Excessive pressure should be avoided to prevent intrathoracic trauma.

Photo = a <10kg dog receiving chest compressions and breaths via an ambu bag.



Alternatively, the heart is compressed using the thumb and forefingers on either side of the chest directly over the heart. This is called the cardiac pump method.

D is for drug therapy

Ensure the dog has venous access via either intravenous cannula or butterfly needle.

Venous access is critical in the successful treatment of cardiac arrest. The anaesthetised dog should already have an intravenous cannula placed. If no cannula is present, one should be placed as soon as possible during resuscitation. Large bore cannulas are most useful during an emergency

Canine Catch-Neuter-Return (CNR) Good Practice Guides

procedure as they provide the least resistance to large amounts of fluids. However large bore cannulas can be difficult to place in the case of severe circulatory collapse so a smaller cannula may need to be used as this may be easier to place. It is therefore recommended to have a range of sizes available in the crash box. Challenges with placing a cannula in an emergency can be avoided by always securing intravenous access in all patients as a routine safety precaution.

Remember to administer anaesthetic and sedative reversal drugs prior to emergency resuscitation.

Drug	Indications
Naloxone	Reversal agent for opioid drugs
Yohimbine	Reversal agent for xylazine
Idazoxan hydrochloride	Reversal agent for xylazine
Atipamazole	Reversal agent for medetomidine
Atropine sulphate	Bradycardia and cardiac arrest
Adrenaline	Cardiac arrest (potent vasoconstrictor)
Lignocaine	Ventricular arrhythmias

Adrenaline, Atropine and Lignocaine should all be in the emergency crash box.

In cardiopulmonary arrest:

- Draw up Adrenaline (0.01mg/kg) and administer the drug intravenously followed by sterile saline to flush the drug through the cannula and into the dog.
- If no response to Adrenaline after 2 minutes, draw up Atropine (0.02mg/kg) and administer intravenously followed by sterile saline.
- Alternate Adrenaline and Atropine intravenously every 2 minutes until femoral pulse is present or CPR is stopped.

Adrenaline, Atropine and Lignocaine may all be administered either intravenously or through the endotracheal tube to be absorbed via the mucous membranes and pulmonary tissue. Administration via the endotracheal tube route requires twice the IV dose and must be followed by ventilation to ensure the drug is absorbed. Note that in small patients the emergency drugs may need to be flushed down the endotracheal tube but ideally an intravenous route is preferred.

Fluid Therapy:

If cardiopulmonary arrest is due to hypovolemia, aggressive fluid therapy may be required during CPR. Fluid resuscitation should be approached cautiously in patients whose volume status was normal prior to arrest. Cardiac arrest is a rapidly vasodilating process, therefore it is recommended that fluids be administered rapidly as calculated boluses so that overhydration, which may predispose the patient to pulmonary and cerebral oedema, is avoided.

Following the administration of any emergency drugs, a fluid bolus should be given to create adequate circulation of those drugs throughout the body. For dogs boluses of 40ml/kg are recommended. Be sure not to exceed shock rates of: 60ml/kg/hr - 90ml/kg/hr.

Canine Catch-Neuter-Return (CNR) Good Practice Guides

1. Assessing the effectiveness of CPR: Every 2 minutes pause to assess patient
2. Evaluate apex beat and peripheral pulses
3. Use stethoscope to listen for bilateral lung sounds
4. Check pupils
5. Check for response to stimuli
6. MM colour and CRT
7. If available; run Electrocardiogram (ECG)

The minimum number of people to run a resuscitation team is two – one to compress the chest and another to ventilate the patient. A third person to interchange during compressions or to draw up drugs is helpful. CPR is usually performed by the manual administration of artificial respiration and cardiac compressions so that adequate oxygenation of the heart and brain can be maintained. Start CPR as soon as arrest is recognised. CPR should be continued until cardiac function/respiration returns or when the veterinary surgeon makes the decision that all efforts have been attempted and there is no return of spontaneous circulation and CPR efforts should cease.

A low percentage of dog's recover from cardiac arrest even if all measures described above are performed. However, if the dog does recover, careful monitoring of the dog is essential as it is common for the patient to arrest again. The dog should be monitored closely for several hours, including; temperature, lung sounds, respiration rate and pattern, pulse quality, heart rate and rhythm, mucous membrane colour and capillary refill time and urine output.

Dog is exhibiting impending CPA or is in CPA - Performing CPR checklist:

1. Inform other staff members to get help = 3 people minimum for efficient CPR
2. Stop anaesthetic drug administration and reverse anaesthetic drugs if possible
3. Airway - establish patent airway = Intubate with endotracheal tube
4. Administer 2 big breaths, check for spontaneous breathing and femoral pulse
5. Breathing - if not breathing = Ventilate via anaesthetic circuit/ambu bag at 10 breaths per minute
6. Check for femoral pulse or heart sounds
7. Circulation - if no pulse/heart sounds = External cardiac compressions at 100-120 compressions per minute, continue for 2 minutes then swap with another staff member and continue until femoral pulse is present or CPR is stopped
8. Check for femoral pulse, if present stop compressions and check for heart sounds with stethoscope
9. Drugs - ensure intravenous access for emergency drug therapy = Alternate administration of Adrenaline (0.01mg/kg) and Atropine (0.02mg/kg) every 2 minutes with intravenous fluid boluses

References:

University of Edinburgh and Animals Asia (2011). Desexing of the dog and cat for Chinese Veterinary Practitioners.

Fletcher, D. J., et al. (2012). "RECOVER evidence and knowledge gap analysis on veterinary CPR. Part 7: Clinical guidelines." *Journal of Veterinary Emergency and Critical Care* 22(s1): S102-S131.