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Her interest in anaesthesia has led her to further specialise and become an anaesthesia technician for CVS Referrals at Lumbry Park.

Canine hypotension during general anaesthesia

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ABSTRACT: Monitoring anaesthetics is one of the most common tasks undertaken by RVNs and student veterinary nurses. A variety of pieces of monitoring equipment are used to monitor anaesthetics. Many practices own a blood pressure monitor but do not use it to its full potential, particularly as part of routine anaesthetic monitoring. This article will discuss the importance of monitoring blood pressure during an anaesthetic, how important it is to detect hypotension and how to deal with it.

Some definitions

- *Blood pressure (BP)* is defined as the pressure exerted by circulating blood upon the walls of the blood vessels.
- *Systolic arterial pressure (SBP)* is the pressure exerted by the blood as a result of contraction of the left ventricle.
- *Diastolic arterial pressure (DBP)* is the pressure exerted by the blood within the vessel when the ventricle at rest.
- *Mean arterial pressure (MAP)* is the average blood pressure over a single cardiac cycle, and can be calculated: MAP = DAP+1/3(SAP-DAP)

Hypotension is defined as MAP below 60mmHg or a systolic arterial pressure of below 90mmHg. It is one of the most common complications during anaesthesia and is a frequent occurrence even in healthy animals, making blood-pressure monitoring fundamental to good anaesthetic practices. Normal reference values are shown in **Table 1**.

If blood pressure is not being monitored during anaesthesia, hypotension cannot be recognised which means it cannot be corrected. You will *not* be able to tell that a patient is hypotensive by monitoring:

Table 1. Reference ranges for normal blood pressure parameters

Systolic	120–160 mmHg
Diastolic	60–100 mmHg
MAP	At least 60–70 mmHg

- heart rate
- ECG trace
- pulse quality
- pulse oximetry (SPO_2)
- end tidal CO_2 levels

Causes and consequences of hypotension

Intraoperative hypotension results in decreased perfusion to vital organs, ultimately causing tissue damage to the brain, heart and kidneys (**Table 2**). It can be caused by a variety of conditions and drugs (**Boxes 1** and **2**).

Box 1. Pathological causes of hypotension

- Hypovolaemia (dehydration, haemorrhage, GI loss, burns)
- Obstruction (GDV, pregnancy, obesity, positioning during surgery, intestinal endoscopy, dorsal recumbency)
- Raised intrathoracic pressure (IPPV, pneumothorax)
- Heart conditions (arrhythmias, heart failure, etc.)
- Hypothermia
- Brachycephalic breeds
- Sepsis
- Metabolic disease (Addison's, hypothyroidism, etc.)
- Anaphylaxis

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Table 2. Consequences of hypotension

SYSTOLIC PRESSURE	CONSEQUENCES
Less than 80 mmHg	Significant
Less than 60 mmHg	May be associated with poor renal function and oliguria (reduced urine volume)
Less than 50 mmHg	Cerebral circulation is compromised
Less than 30–35 mmHg (for 2 hours or more)	Brain ischaemia occurs

Box 2. Drugs that may cause hypotension

- Beta blockers
- Etomidate
- Inhalant anaesthetics
- Anaesthetic induction agents
- Barbiturates
- Opioids
- Alpha-2-agonists (medetomidine/dexmedetomidine)
- Phenothiazine, e.g. acepromazine (ACP)
- Epidural

Measurement of blood pressure

In the majority of circumstances, blood pressure is measured indirectly. Indirect measurement is a non-invasive measurement of the return of blood flow after temporary occlusion of an artery. The two most common methods of indirect monitoring are Doppler and Oscillometry - both techniques use an inflatable cuff placed around an extremity and both procedures are straightforward and can be easily taught to members of staff.

Doppler reliably measures systolic blood pressure only (**Figures 1a** and **1b**), while oscillometric devices detect oscillations in blood-vessel walls produced by changes in wall diameter during the cardiac cycle and can therefore report systolic, diastolic and MAP. It is unreliable in patients with cardiac arrhythmia because it relies on rhythmic arterial pulsations (**Figure 2**).

Hints and tips

- The cuff bladder that is being used to measure the blood pressure should be 40% of the circumference of the cuff site in dogs. If the cuff bladder is too small the reading will be erroneously high. If the cuff bladder is too large the reading will be too low.
- The mark on the cuff bladder should be aligned over the artery.
- Clip the hair overlying the target artery if using a Doppler probe, the target artery must lie distal to the cuff.
  - antebrachium – clip the palmar aspect of the metacarpus
  - distal pelvic limb – clip the plantar surface of the metatarsus
  - tail base – clip from the tail's ventral midline just distal to the intended cuff site
- The cuff should not be completely occlusive but just tight enough so there is no room to insert a finger between the cuff and the patient's extremity.
- Apply copious amounts of acoustic gel to the clipped site and to the probe.
- Consider using headphones to minimize ambient noise if appropriate.

Reducing the likelihood of hypotension particularly in at-risk patients

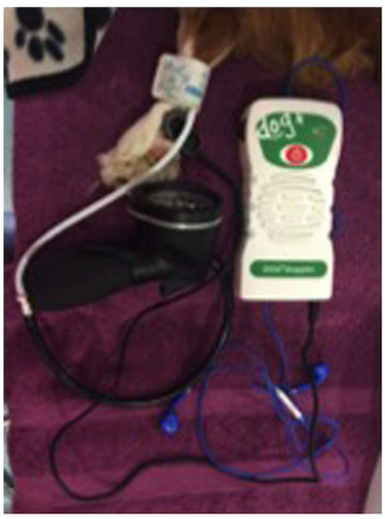
- Ensure adequate hydration pre-, peri- and post-anaesthesia. Even when not using pre-operative fluids it is important to be confident that a patent IV line is available before induction.
- Optimise management of underlying conditions such as cardiovascular disease or sepsis as early as possible prior to anaesthesia.
- Use potentially hypotensive drugs with care.
- Keep the patient warm – consider using an insulated jacket at the time of sedation.
- Carefully consider whether pre-operative NSAIDs are appropriate.

Management of Hypotension

- Inform the surgeon and discuss the possible causes.
- Check the patient's temperature; if it is low warm the patient as mentioned above.
- Consider options for repositioning the patient.
- Reduce the level of volatile agent (minimise depth of anaesthesia) – a common cause of hypotension.
- Improve cardiac output using intravenous crystalloid fluid therapy during anaesthesia – the goal of aggressive fluid therapy is to increase cardiac output and circulating volume. It also helps restore tissue perfusion and can help manage electrolyte and acid-base disturbances.
  - crystalloids – 10ml/kg over 10 minutes (multiply rate by 4–6 if already giving 5ml/kg/hr)

(a)

(b)



Figures 1a and 1b. (a) A Doppler blood pressure measuring device; (b) a Doppler device in use

Figure 2. An oscillometric device for measuring blood pressure

- colloids – can be considered but there is no evidence of benefit over crystalloids
- blood transfusion – depending on packed cell volume (PCV)

- Use sympathomimetic drugs – most commonly used is dobutamine (**Box 3**); primarily a β1agonist, it helps increase cardiac output by increasing cardiac contractility. Side effects include arrhythmias, tachycardia and vasodilation.
- Atropine – if the heart rate is low and blood pressure is low, atropine can help increase heart contractility, which will help improve blood pressure.(NB: Atropine given intravenously can cause a short-term drop in heart rate; it is poorly effective in patients that are hypothermic.)

Box 3. Protocol when administering dobutamine

- The patient should be maintained on normal surgical fluids (Hartmanns or saline at 10ml/kg/hr).
- Inject a vial (250 mg) of dobutamine into a 500 ml bag of saline.
- Flush through the giving set and attach to the patient via a Y connector.
- Where very low volumes are required for small dogs, draw some of the made-up solution into a 20 or 50 ml syringe and use a syringe driver, as this gives greater accuracy.
- When blood pressure has returned to within normal limits, reduce the rate of dobutamine infusion slowly.
- Dose for Dogs – 0.6–1.2 ml/kg of the 0.5 mg/ml solution per hour (this is equivalent to 5–10 µg/kg/minute). For example:

  10 kg dog at 0.6 ml/kg/hr = infusion pump to be set at 6 ml/hr
- Start at a low dose, and increase if there is no improvement.

Hypotension and the use of NSAIDs

Associated nephrotoxicity is much more likely to occur in dogs that are dehydrated, hypotensive or hypovolaemic. Adequate IV fluid therapy should be provided before NSAIDs are administered in these cases (pre-operative blood-pressure monitoring may be essential).

Hypotension can frequently occur under anaesthesia but early recognition and aggressive management to restore blood pressure to within an acceptable range minimises the risks of kidney damage, making the use of NSAIDS safe peri- and post-operatively.

Conclusion

Monitoring an anaesthetic is an essential tool to enhance safety. Monitoring blood pressure will help prevent or treat significant hypotension which, if prolonged and uncorrected, will cause reduced tissue perfusion with the potential for end-organ damage.

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