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Essentials of Anaesthesia

Mini Series

Session One: Anaesthetic Equipment, Drugs and Sedation Update

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Mini online series "Essentials of Anaesthesia"
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Session 1

Anaesthetic equipment, drugs and sedation update

In this first session in this series we will focus on updating on new pieces of anaesthetic equipment that may be useful in practice, looking at practical tips to allow the clinician to make effective use of them. Newly available drugs along with new uses for old drugs will also be discussed. This section will be focused towards incorporating these into current practice protocols to provide the clinician with a wider variety of analgesic and anaesthetic drugs.

Learning objectives

- What new pieces of equipment are available that will aid in improving anaesthetic safety in my practice?
- What drugs that I have used in the past or have on my pharmacy shelf may have new or revived uses?
- What new analgesic and anaesthetic drugs are available that may add to my current clinical practice?

Equipment

1. **Safety checklists**

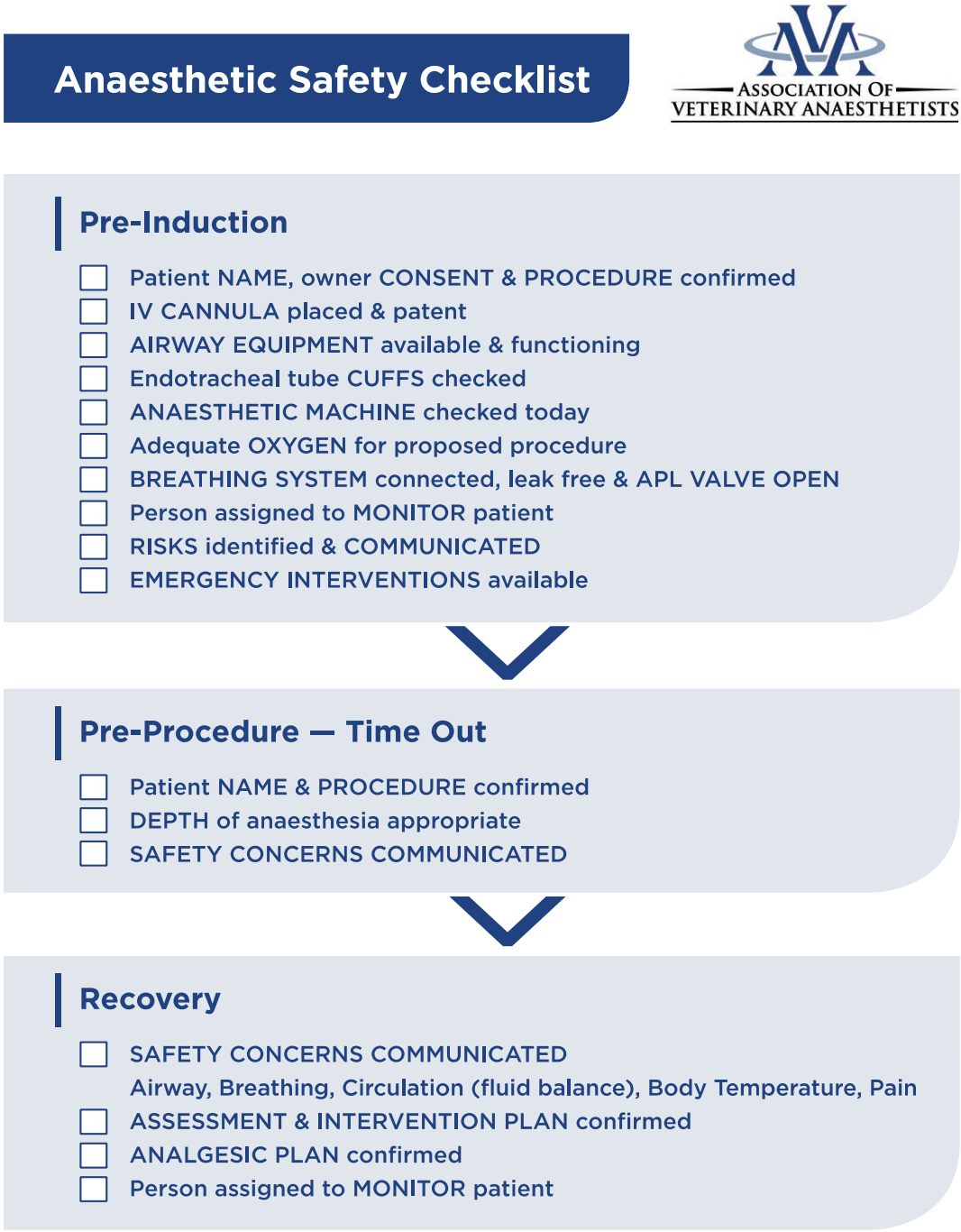
Veterinary development

In the UK and Europe, the Association of Veterinary Anaesthetists (AVA) have developed an anaesthesia checklist and accompanying implementation booklet. The aim of this is increase awareness of and improve safety veterinary anaesthesia. The Royal College of Veterinary Surgeons (RCVS) the UK regulatory body has now included this in their requirements for the Practice Standards Scheme (PSS). The AVA safety checklist is attached but the documents and full guidelines can be downloaded from http://www.ava.eu.com.

Why should we introduce a safety checklist?

Human error is reported to be responsible for over 50% of anaesthetic related death and the likelihood that this is any different in veterinary medicine is slim. It is often a very small component that is missed that leads to a chain of events, with the end-point being either serious harm or death. Checklists are designed to eliminate the need to memorise every single step of a protocol and therefore self-limit any errors that may eventually lead to a fatal outcome.

The introduction of a safety checklist is likely to come up against criticism and often fear of change from members of staff who feel it is unnecessary, but this is usually a short lived occurrence and eventually most will come to embrace its use. Ensuring that preparation is good and specific patient factors are taken into consideration can be the difference between successfully dealing with an emergency situation and death



Example safety checklist

2. Airway devices

Securing the airway is an important part of the anaesthetic process. While the gold standard remains endotracheal intubation with a cuffed tube there are no a variety of devices available providing an alternative method for suitable cases. There also remains a difference in opinion as to whether cuffed endotracheal tubes should be used in the cat. The use of supraglottic airway devices (SGADs) have gained popularity in medical anaesthesia for a variety of procedures and avoid the necessary to paralyze the patient prior to securing the airway.

The recent development of the v-gel airway (docsinnovent.com) has further refined the LMA and i-gel airway for specific veterinary use. The v-gel is now available for use in the cat, rabbit and dog. The original feline model had an inflatable cushion situated on the dorsal aspect of the device, which has now been removed in version two, whereas the rabbit model has no inflation device. The newly released canine version has a channel to allow for management of reflux. Both are anatomically designed to be species specific, sealing the laryngeal and peri-laryngeal tissues without passing through the glottis. They are available in 6 sizes for cats, 6 sizes for rabbits and 4 sizes for dogs.

Following careful lubrication, the v-gel is inserted gently with the device held horizontal with the opening ventrally, keeping it in the midline until it sits into the peri-laryngeal area. Direct visualization of the larynx is not required.To confirm correct positioning normal patient ventilation should be observed and bag movement in the breathing system should be visible at all times. Ideally capnography should be available to ensure correct positioning and also to warn the user if the v-gel moves during use. Extra care should be taken when moving or re-positioning the patient to ensure the device does not move.

Potential problems

- Device movement
- Airway obstruction
- Inappropriate lubrication
- Gastro oesophageal regurgitation (the channel with the canine version accounts for this)
- Incorrect size

3. Veterinary specific laryngoscopes

Traditionally used laryngoscopes are designed for use by the right handed medical anaesthetist for intubation, positioned above the human patient's head. The light source on the blade is located on the right hand side. When used to intubate the veterinary patient, the light source often impedes visualization of the larynx. A range of veterinary specific laryngoscope blades are now available. The fibre optic light source on these models is located on the left-hand side of the blade, allowing for improved visualization and illumination of the larynx. They are available in a number of lengths and have a straight blade improving visualization over a curved human blade.

4. Heat and moisture exchangers

Loss of body heat during anaesthesia by the respiratory tract is a component of intra-operative hypothermia in the small animal patient. Heat and moisture exchangers (HMEs) consist of a hygroscopic material that allows for retention of exhaled heat and water vapor. On the next inhalation the incoming cold and dry gas is warmed and humidified when passing through the material. A bacterial and viral filter may also be incorporated and aid in reducing contamination of the breathing system. They are available in a number of sizes, selected on the basis of patient size. Consideration should be made for both the diameter of filter and volume contained within. The diameter is important when considering resistance to airflow through the device and the volume with respect to equipment dead space.

5. Warming devices

Patient hypothermia is one of the most common complications encountered during small animal anaesthesia. It is a potential cause of peri-anaesthesia morbidity and a likely overlooked component of a prolonged recovery from anaesthesia. Heat loss occurs by several mechanisms, including convection and radiation and effective patient warming is essential during anaesthesia. Peripheral vasodilation, often due to various drugs used in the process of anaesthesia encourage redistribution of heat from the central to peripheral compartments. Ensuring a warm environment surrounding the patient aids to minimize radiation of patient heat. In addition to effective patient warming, continuous or regular monitoring and recording of body temperature should be utilized to optimize intervention.

Methods available to achieve active patient warming include

- Forced warm air devices e.g. Bair Hugger, Cocoon
- Heated blankets e.g. Hot dog

Care should be taken with any heated blanket device to ensure that different heat zones are not present which may lead to overheating in specific areas.

6. Endotracheal tubes and cuffs

Endotracheal tubes (ETT) are available in a number of different materials, each with a cuff possessing different properties. Silicone and PVC ETTs have several advantages over red/orange rubber tubes, including; they are see-through, they mold to the shape of the trachea when warmed at body temperature, they do not crack, most have a Murphy eye,
ETT materials and cuff types.

- PVC
    - Precurved
    - Low pressure- high volume cuff
- Silicone
    - Straight but flexible
    - High pressure- low volume cuff

Silicone ETTs may require use of a stylet to facilitate correct placement due to their flexible material.

7. Monitoring equipment

"There are no safe anaesthetic drugs, only safe anaesthetists".

Safe anaesthesia is a multi-factorial process involving patient assessment, careful use of appropriate anaesthetic drugs and patient monitoring. Continuous monitoring is essential to detect any changes that may impact on patient safety and to ensure any alteration in status is treated in the most appropriate manner. Patient monitoring consists of a combination of manual patient assessment by the anaesthetist and use of electronic monitoring equipment. The use of electronic equipment should not be used as an absolute substitute to manual assessment, but rather in addition. Multiple electronic monitoring methods are also more useful than single pieces of equipment to allow more thorough assessment of patient status.

Multi parameter monitors are continuing to become cheaper to purchase, easier to use and more compact. They allow the anaesthetist to monitor patient status, assessing multiple body systems simultaneously. Advantages of having all information displayed on a single screen include making it easier to visualize patient information and the ability to cross reference data.

New technology has resulted in the further development of pulse oximetry. Pulse oximeters with signal extraction technology (SET), such as those manufactured by Masimo SET® can separate the signal produced from arterial blood from other artefacts such as those produced by pulsatile venous blood. This allows more accurate calculation of SpO_2 even during tissue motion and less false alarms and inaccurate readings. Rainbow technology also allows the calculation of dyshaemoglobinaemias and total haemoglobin concentration in humans with its algorithms. The addition of Pi (Perfusion index) and PVi (Pleth variability index) technology to pulse oximetry devices allows the non-invasive assessment of volume status. This technology allows the user to employ goal directed fluid therapy protocols. Current algorithms are based on human data, but advances are likely to allow further extrapolation for our veterinary species.

Anaesthetic agents

Inhalational anaesthesia remains the mainstay of maintenance of general anaesthesia. Both isoflurane and sevoflurane are suitable for this purpose, when administered to individual patient requirements. The increase in literature around the use of intravenous maintenance protocols may provide an alternative to inhalational anaesthesia in certain cases. Both propofol and alfaxalone have been reported for use for total intravenous anaesthesia (TIVA). The increase in awareness of environmental sustainability, alongside the importance of anaesthesia within this is likely to lead decision making on the impact of the agents selected and the best protocols in the future.

- Propofol 0.1-0.4mg/kg/min (It is not advisable to use the propofol preparation with preservative for infusions)
- Alfaxalone 0.7-1.0mg/kg/min

Partial intravenous anaesthesia (PIVA) involves the maintenance of anaesthesia using inhalational agents such as isoflurane or sevoflurane, supplemented with intravenous analgesics. Suitable intravenous agents for this technique include fentanyl, ketamine and lidocaine (dogs only). The use of a combination such as MLK (morphine or methadone, lidocaine and ketamine) is a popular and alternative intravenous infusion.

- Fentanyl 5-15mcg/kg/hr
- Ketamine 5-20mcg/kg/min
- Lidocaine 25-50mcg/kg/min

Analgesics
Prescribing of analgesia has increased considerably over recent years, most likely due to a combination of better understanding of pain and analgesic requirements and owner education. Administration of analgesia in the cat still lags behind the dog, possibly due to concerns regarding feline renal function, difficulty in pain assessment, side effects and suitable analgesic choices.

Improvement and refinement of pain assessment tools, particularly in the cat has increased the practitioners' ability to address feline analgesia provision.

Pain assessment
When considering whether an animal is in pain there is a multitude of information to take into account when deciding the best management strategy for that patient. Unless you look for something, you will never find it, so a simple starting point is that all patients should be evaluated for signs of pain after surgery at appropriate intervals.
There are several pain scales to assess pain in dogs, but often your overall impression and clinical experience tells you the most. If you consider an animal to be in pain, then that animal should receive analgesia. The patient can then be reassessed at a time frame appropriate to the drug used. It is always best to provide analgesia than leave a patient in pain. If the patient improves following analgesia, then the pain hypothesis holds up. On the converse side, if animals are repeatedly medicated with drugs without being in pain, then they may suffer detrimental effects from the drugs.
A **visual analogue scale** is a measure used widely in humans. The patient is asked to put a mark on the line where they consider their pain to be. The line is a scale from 0-100. Zero indicates no pain at all and 100 represents the worst pain imaginable. The distance from the no pain end to the patient mark is their pain score. This has been validated in cats for intervention and the authors suggest analgesia should be administered at a pain scale of 30/100.
Similar to this is a **numerical rating scale** which is numbered from 0-10 and the patient marks the number which correlates to their level of pain.
Both scales are very easy to use and can be applied to everyday practice with little extra work. Ideally the same person should score the pain each time to give the best representation of how the patient changes over time. Validation of this scale suggests we administer analgesia at 4/10.
A **simple descriptive scale** will have several expressions used to describe pain and the patient has to select the description best fitting their pain. These scales have been used in veterinary studies evaluating analgesia.

There are several pain scales designed for dogs, which are **composite descriptive scales**. They have several categories, each with a list of descriptors which are designed to assess the behavioural response to pain. For example, first you look at the dog from outside the kennel and assess its behaviour. You would then put on a lead, if appropriate, and lead the dog from the kennel. Next you apply pressure around the wound to assess the dog's reaction. Finally, you make an overall assessment of your impression of the dog's pain levels. Each descriptor is assigned a score, so the total of all descriptors is the dog's pain score. The most widely used in the Short Form of the Glasgow Composite Pain Scale (search to download).
For cats there are also several options. The Colorado State Pain Scale is another pain scale (search to download this) which has undergone validation as well as the Botacatu pain scale (Brondani et al. 2011). The Glasgow feline acute pain scale for cats (Calvo et al 2014) has been refined to include feline pain faces developed from photo and video capture of both painful and non-painful cats. More recently the feline grimace scale has been developed and is now available as an App based system to allow patient side assessment and recording.

Opioid analgesia
Which opioid do you select for analgesia for surgical procedures?

Methadone is a pure mu opioid agonist and also possesses NMDA receptor antagonist properties. It has been documented to provide superior analgesia to buprenorphine in the dog and may be a more suitable choice for pre-operative analgesia. It is easier to "top up" during anaesthesia when required, has a quick onset time and a duration of action of up to 4 hours.

Opioid	Bradycardia	Analgesia	Respiratory	Use
Methadone	**++ expect HR 60-80**	**+++ μ agonist & NMDA antagonist**	**+**	**Excellent analgesia 0.1-0.3mg/kg q4-6hrs CRI 0.1mg/kg/hr**
Morphine	**+ low doses may be sympathomimetic**	**+++ μ agonist**	**+**	**Excellent analgesia 0.1-0.3mg/kg q4-6hrs CRI 0.1mg/kg/hr Emesis**
Buprenorphine	**+/-**	**++ partial μ agonist**	**+/-**	**Good analgesia 0.02mg/kg q6-8hrs Oral transmucosal use in cats**
Butorphanol	**+/-**	**+ Kappa agonist μ antagonist**	**+/-**	**Excellent sedation w ACP or alpha 2's**
Fentanyl	**+++**	**+++ μ agonist**	**+++ (dose dependent)**	**Excellent analgesia Intra-op CRI 5-20μg/kg/hr Post-op CRI 2-5μg/kg/hr Transdermal patch 2-5μg/kg/hr Interventional analgesia 1-2μg/kg IV**
Pethidine	**Low doses vagolytic**	**+**	**-**	**For mild sedation**

Paracetamol
Paracetamol is **only** to be used in dogs and may be a suitable alternative when a patient becomes intolerant to NSAIDs or a NSAID cannot be administered for various reasons. It has no anti-inflammatory effects and no renal or gastric injury has been reported at clinically used doses. Its site of action is most likely as a COX enzyme inhibitor, but due to its clinical effects this is likely to be specific to within the CNS. Its analgesia and anti-pyretic effects are both thought to be centrally mediated.

It may also have some serotonergic effects acting at 5-HT receptors, amongst other reported sites of action. It is dosed at 15mg/kg IV or 20mg/kg PO every 8 hours (based on more recent published data) and may be administered in conjunction with corticosteroids or NSAIDs if necessary.
The licensed veterinary product also contains codeine and is licensed for sole use only in dogs for 5 days only.

Sedation
While alpha-2 agonists remain the main sedative agents for use in the healthy patient, there are occasions where their use may be contraindicated. In these situations, an alternative should be selected where possible or the lowest effective dose used. Alfaxalone has also been reported for use as a suitable agent for intramuscular and subcutaneous administration for sedation. Its use is reported in the cat in combination with butorphanol and the addition of midazolam may also be useful. It may prove useful for sedation in the sick or geriatric cat for the purposes of imaging and non-surgical procedures. The onset time is around 15 minutes and the duration of action is expected to be around 30 to 40 minutes.

Doses
Alfaxalone 2-3mg/kg
Butorphanol 0.2-0.3mg/kg
Midazolam 0.2mg/kg

The combination may be mixed in the same syringe and administered either IM or SC. The volume may prove too large for a single IM injection and therefore either multiple injections may be required or SC should be used as an alternative. Its effect may be variable and additional sedation may be required e.g. low dose alpha-2 agonist or ketamine and therefore IV access should be established as soon as safely possible.

A new alpha-2 agonist product, Zenalpha® is a combination of medetomidine and vatinoxan (a peripheral alpha-2 antagonist) licensed for IM administration in dogs for sedation for non-invasive/non-painful procedures. It has recently been launched in Europe, having been available in North America since 2022. It is licensed for sole administration and has been reported in combination with opioids such as butorphanol. The addition of vatinoxan is reported to reduce the peripheral vasoconstriction seen with the alpha-2 agonists and offer advantages over sole alpha-2 use.