Perioperative hypothermia – prevention is better than cure

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THE aims of this article are to:

- **define normothermia, hypothermia and to present the risks of perioperative hypothermia in the anaesthetised patient;**
- **describe the physiological effects of hypothermia on the patient;**
- **describe methods by which perioperative hypothermia can be reduced/prevented; and**
- **discuss methods of temperature monitoring.**

Every patient undergoing anaesthesia is at risk of developing perioperative hypothermia. Animals undergoing routine surgery in most small animal practices are probably not at a great risk, although it is a very common and treatable complication of general anaesthesia, and the longer the procedure the greater the risk.

Normothermia is the condition of a normal core body temperature. Hypothermia is classified as a core temperature of less than 36°C.

Normal thermoregulation

Thermoregulation is regulated by the hypothalamus, which detects changes in core temperature and instigates mechanisms to produce or retain heat.

Anaesthetic agents cause CNS depression, which decreases the sensitivity of the hypothalamus and, therefore, anaesthetised animals cannot regulate their body temperature.

Heat production occurs secondary to metabolism and enzymatic activity, such as occurs in the liver, produces heat as a result of chemical reactions. Digestion and skeletal muscle activity also play a part in the production of body heat.

Methods of heat loss

- evaporation – via respiratory tract, skin and sweat glands
- radiation – from warm body to cooler surrounding air

- convection – warm air around body rises and is replaced by cool air
- conduction – heat loss to a cold surface in direct contact with a patient, such as a theatre or x-ray table

Research shows that core body temperature drops rapidly following induction of general anaesthesia, increasing the risk of unintentional hypothermia occurring in the patient. Contributing factors vary, and may increase the risk of hypothermia in the surgical patient.

Contributing factors

Factors that may promote hypothermia include:

- anaesthetic drugs and techniques – for example ACP disrupts the control of thermoregulation. High doses of opioids can depress metabolic heat production
- inability to move
- reduced gut activity
- ambient temperature – for example air conditioned theatres
- patient size – a smaller patient will cool down more quickly due to its large body surface area: volume ratio
- an increase in respiratory heat loss – for example via non re-breathing circuits and increased dead space
- contact with cold surfaces
- evaporation of heat from the surgical site
- administration of cold fluids – for example IV or into body cavities
- clipping of fur
- wetting of skin – for example surgical aseptic preparation, urination on coat
- type of surgery – for example surgery involving a major body cavity (abdomen), will involve more evaporative losses than musculoskeletal procedures (Figure 1)

Physiological effects

Hypothermia has a general depressive effect, which can be harmful. The effects on the cardiovascular system can include reduction in heart rate and cardiac output, leading to a drop in arterial blood pressure. The heart rate drops due to a depression of the heart's conductivity. Hypothermic animals are also at greater risk of cardiac arrhythmias. There is also an increase in the clotting time of blood due to decreased activity of clotting factors. Blood viscosity may also increase during severe hypothermia, increasing the risk of clotting.

The reduction in hepatic metabolism prolongs the actions of drugs used, including anaesthetics and analgesics. It will decrease requirements for anaesthesia so the patient may become too deep, and will often lead to a prolonged recovery time.

Shivering in recovery massively increases the animal's oxygen requirements, decreases effective ventilation and increases pain levels.

Reducing heat loss

- Insulation – the use of bubble wrap, blankets, table coverings
- Reducing evaporation losses – re-breathing circuits, HME devices
- Warmed fluids – IV and lavage fluids
- Warming devices – warm air systems, heat pads, hot hands
- Passive surface rewarming – prevent further heat loss. Place blankets over the patient to decrease convection and under the patient to decrease conduction. Blankets can reduce heat loss by approximately 30%
- Active surface rewarming – increase air temperature around the patient. Warm water bottles, hot hands, circulating warm water heating pads and forced air warming blankets
- Active core rewarming – heat centrally to rapidly warm the body core. Warm IV fluids, warm peritoneal/pleural lavage, warm water enemas, warm saline into the bladder and heated, humidified inhaled air
- Assessment of each stage of anaesthesia can pinpoint areas where we, as nurses, can implement protocols to prevent/ reduce the incidence of perioperative hypothermia

Preoperative patient

- Once the patient has been premedicated, keep it in a warm, draft-free kennel while awaiting induction.
- Allow it the opportunity to urinate, thus avoiding any accidents while under anaesthetic.
- If it is on preoperative fluids, make sure they are warmed prior to administration. In-line fluid warmers pass the fluid through a coil of warm water and are designed to keep the fluid at a constant temperature (Figure 2). Passing the giving set through a bowl of warm water is also effective, but less practical as the water needs changing frequently as it cools.
- For normothermic patients, take measures to prevent heat loss.
- For hypothermic patients, active warming is necessary with the use of warming devices.
- If you have access to an incubator, place smaller patients in this while awaiting surgery.
- Consider the procedure the patient is being prepared for; if an animal is at higher risk of hypothermia (eg a young, small terrier with a portosystemic shunt), try clipping it before it is anaesthetised.

Induction

Induction of general anaesthesia typically results in a 1ºC fall in core temperature within the first 30 minutes. Surgical preparation increases heat loss because of evaporation of alcohol and water.

The following measure can help prevent hypothermia during induction:

- Uuse a heat pad and blankets on your prep table.
- Cover the patient immediately to provide insulation and prevent heat loss. The use of blankets, bubble wrap or foil can be used to create layers of insulation.
- Clip as little fur as is necessary for the procedure.
- Use warm water in your scrub solution and try to limit the amount of alcohol used, especially in small exotic patients.
- In high-risk patients the use of bubble wrap and bandages on the extremities is very effective at preventing heat loss (Figure 3).
- Be quick when getting an animal into surgery. Think ahead what you might need, be organised and systematic and, if possible, have an extra nurse on hand if the patient is critical.

Radiography

This can be a time when animals will lose body heat very quickly, through laying on a lead lined x-ray table. Think ahead when you have an animal in x-ray, whether pre or post-surgery, to not accelerate heat loss through carelessness:

- Lay the patient on a blanket and heat pad.
- Cover it with a blanket between exposures.
- Use an x-ray mattress on top of the table. Radiolucent x-ray mattresses are available, providing insulation and comfort to the patient.

Surgery

The following measures will help to reduce heat loss during surgery:

- Make sure the ambient temperature in theatre is 22-24°C (if your surgeon prefers a cooler theatre wait until the patient is covered before reducing the temperature).
- Use a heated operating table.
- For standard metal theatre tables use a rubber mat and surgical mattress.
- Surgical heat pads are available. Care must be taken to choose heat pads that are specifically designed for use with an anaesthetised patient. Some brands produce inconsistent heat and should only be used in the conscious patient, so it is able to move off it.
- Vacuum supports are excellent for small and exotic patients. These are filled with polystyrene balls, which are great for retaining heat. Place a heat pad under it, a blanket on it, and position the patient. Then use the pump provided to evacuate excess air to conform it to the shape of the patient, which acts like an insulated trough. These are fairly inexpensive and available in a variety of sizes.

- Forced warm air systems, such as the Bair Hugger, are very effective at providing a constant ambient temperature around the patient. Note that the filters in the unit need to be changed annually and a new blanket used for each patient.
- Use waterproof drapes, especially if the procedure is to involve lavage – for example for peritonitis.
- Warm irrigation and IV fluids. Fluids cool very quickly, so warm them as required. Fluid warming cabinets are great for the busy practice as multiple bags of fluid can be stored at a constant temperature. Immersion in warm water is efficient but slow. Heated corn bags, hot hands or a hot water bottle can be wrapped around the drip line. IV fluid heaters are also commercially available. Note that care should be taken not to overheat fluids when using a microwave. Proteins in gelatine-containing fluids, for example Gelofusine, may be denatured by excessive heat.
- Humidify and warm inhalation gases. Heat-moisture exchangers, such as the Portex Thermovent, are devices that sit between the circuit and the ET tube. They heat and moisten the inhaled gases and help prevent evaporation losses from the respiratory tract. They also trap bacteria and viruses so should only be used once, and the correct size selected for the patient. Note that the use of an HME will increase mechanical dead space and resistance to breathing; care should be taken when using in patients with respiratory deficits. In smaller patients, a widebore needle can be inserted directly into the HME device and attached to the capnograph Luer connector to decrease dead space further.
- A re-breathing circuit like a circle or to-and-fro system will also help retain heat. A mini-Lack should be considered instead of a T-piece as it requires lower flow rates.
- Exposed viscera should be covered with warm, damp swabs to reduce drying and cooling.

Recovery

The following measures will help to reduce heat loss when a patient is in recovery:

- As soon as possible remove all the drapes and equipment, dry the patient if necessary, and get it covered with a warm blanket/warm air blanket (Figure 4).
- Increase the ambient temperature when possible.
- Continue to monitor the temperature every 30 minutes until the patient is normothermic.
- Prepare the recovery kennel in advance with a heat pad and blanket and ensure the area is draft free.
- Once the patient is conscious and lifting its head, offer it some food, unless contraindicated. This will kick-start its metabolism and will rapidly increase recovery time.

The direct heat source should be removed or switched off when the patient is about 1ºC below normothermic, as it will continue to warm up and may even become hyperthermic if left unattended for even a short period of time.

Monitoring equipment

It is best practice to take a patient's TPR twice daily and prior to induction, as it will alert you to any dramatic changes in the animal's parameters. This data should be noted on the monitoring record.

Digital thermometers are cheap and quick these days. These are good for pre and postoperative monitoring, but the best way to monitor core body temperature is with an oesophageal probe.

The measurement of the rectal temperature during anaesthesia has a number of disadvantages. It may be difficult to gain access under the drapes, or surgery may be in that area. It may compromise theatre sterility and the presence of feaces or air in the rectum may give an artificially low temperature reading.

Once the animal is intubated the oesophageal temperature probe can be placed. It can be loosely taped to the oesophageal stethoscope with non-toxic tape, and the animal's saliva or some water-based lubricant used to aid its passage.

Patient monitors are available in all shapes and sizes, from a basic TPR monitor to a vital-signs monitor that includes capnography, ECG monitoring, pulse oximetry, non-invasive blood pressure and invasive blood pressure measurements (Figure 5).

Conclusions

- Unintended hypothermia resulting from anaesthesia is a very common and treatable complication.
- A drop in body temperature is inevitable in all patients undergoing anaesthesia but, by taking small steps, we can all make efforts to reduce the degree of heat loss.
- We do not necessarily need costly specialist equipment to make a difference to the safety of a patient's anaesthetic and recovery.
- Be organised and prepare for every eventuality.
- Treat every patient as an individual and do not get complacent. Although we place animals under anaesthesia every day, we should not forget the implications or ever forget how important all patient monitoring is.
- Measuring temperature is really under-appreciated in general practice and should be done much more often.
- If you have monitoring equipment in your practice make it routine to use it for all procedures. If your staff are not trained in how to use the equipment your practice has invested in, why not teach them?

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Further reading

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