# AAS Guide to Hypothermia and Patient Warming©

*Hypothermia occurs in up to 85% of anesthetised small animal patients, with body temperatures commonly below 33°C! This causes prolonged and poor quality recoveries and may contribute to mortality. Warming animals in recovery is slow, consumes nursing time and can result in thermal injuries. Hypothermia during anaesthesia is preventable. At Darvall, We Warm Animals.*

## Body Mass : Surface Area, Thermoregulation & Anesthesia

**The large body surface area relative to body mass of small animals results in greater heat loss** which occurs in an exponential manner (Body Weight)$^{0.75}$. Anaesthetized cats positioned on heating pads develop hypothermia unless the surrounding air is also warmed. Clipping hair from surgery sites, flattening the hair coat, using cold or evaporative skin prep solutions, wetting hair or opening body cavities exacerbates heat loss.

**Anaesthesia depresses CNS thermoregulation and prevents usual methods of conserving heat** such as seeking a warm environment, body positioning, hair coat erection, peripheral vasoconstriction or generating heat by shivering. Hypothermia in anesthesia:

- reduces the requirement for Anesthetic drugs so patients appear "deeper"
- prolongs recovery by altering drug distribution, metabolism and excretion,
- decreases surface heating efficiency because of peripheral vasoconstriction

**Traditional hypothermia prevention** during anesthesia includes using heat sources such as hot water bottles, circulating warm water blankets and electric heating pads or heating under surgery table tops. IV fluid lines are commonly placed in dishes of warm water.

Burn from hot water bottle during anesthesia

**Calories and warming IV fluids**
A calorie (cal) is the amount of heat required to raise 1 ml (or 1 gm) of $H_2O$ 1°C. The specific heat of animal tissue is 0.83 cal/gm. Therefore a 10 kg dog requires 8,300 cal (8.3 kcal) to raise its temperature 1° C.

**Warming IV fluid** administered during surgery: a 10 kg dog administered **10 ml/kg/hr** = 100 ml/hr. If the fluid is warmed to 44°C and the dog is 34°C, then we can deliver:

(44-34°C) = 10°C x 100 ml/hr = 1000 cal/hr

**Warming the dog to 37°C would take:**

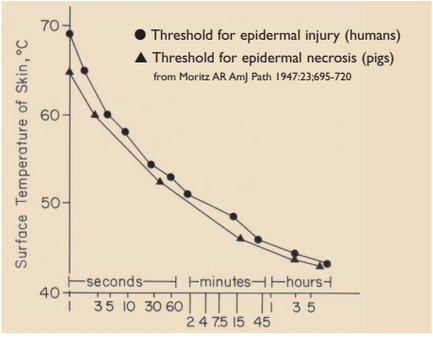
(37-34) = 3°C x 8,300 cal = 25,000 cal
25,000 cal / 1000 cal/hr = **25 hours!**

**Respiratory heat loss**
Most respiratory heat loss is caused by humidification. The nose and pharyngeal mucosa transfer heat and moisture to the air during inspiration, but recover it during expiration which conserves heat. Intubation inhibits this heat/moisture conservation. Saturated air holds 44 mg $H_2O$/L at 37°C which requires 24 calories. A 10 kg dog taking 20 x 100ml breaths/min ventilates 120 L/hr so could loose (24 cal/L x 120 L/hr) = 2880cal/hr (equivalent to 1/3°C/hr of body temp.).

**Thermal Burns**
Thermal injury to skin is an exponential relationship between source temperature and contact time (see graph below). Burns occur at temperatures below 50°C; hot tap water may reach 60°C which causes epidermal necrosis after 10 seconds of skin contact. In 2008 the UK Veterinary Defence Society reported a high incidence of burns caused by use of warmed wheat bags.

**Electric heating pads** have a low thermal mass so cycle on and off continuously. Simple controllers can be variable in performance or may fail, causing higher temperature delivery and potentially burns. These devices should always be insulated from the skin surface.

**Time-Temperature relationship for thermal injury to skin**




## Prevention is Better than Cure - New Techniques for Patient Warming

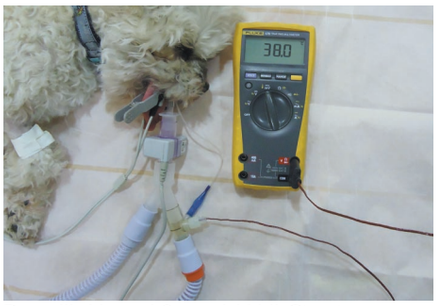
*Devices that deliver heat "mass" at constant, physiologically safe & controlled temperatures.*

**IV fluid line heaters**
Provide constant, controlled heating of IV fluids external to the IV line, which fits into a thermal track and is a held it in place by a hinged "door". Warm IV fluids prevent heat loss rather than "warm" hypothermic animals.

**Forced Warm Air Heating**

A constant flow of warm air at controlled, physiologic temperatures is delivered to a blanket which distributes the heat to the animal. Blankets designed for people generally lie over the patient. Animals have a hair-coat which differs from people so heating is more effective if applied from underneath, allowing warm air to rise into the hair coat where it is trapped forming a heat layer. **AAS Darvall Veterinary Warm Air Blankets** are designed to be placed underneath small animals in surgery. These blankets effectively warm patients during anesthesia, surgery, recovery & critical care.

**Inspired air warming & humidification**
Artificial noses connected to the ET tube adapter humidify inspired air but increase dead space in very small animals.
**Warming Inspired Air using Darvall Heated Smooth Wall Tubing**: a heating element imbedded into the ribbing of the tubing wall warms inspired gas to around 39°C. A sensor imbedded at the Y piece monitors gas temperature to control heating. Recent research shows that in animals as small as 3kg, warming inspired air was as effective as Darvall Forced Warm Air heating at preventing heat loss during anesthesia.




Darvall's Heated Smooth Wall Circuits Revolutionary