Research Summary & Analysis by
HotDog Veterinary Patient Warming

Reducing the Risk of Pressure Ulcers in Veterinary Procedures

Scott Augustine MD

Purpose

Although the incidence of pressure injuries in veterinary procedures (dental and surgical) is low, the physical consequences for the patient and emotional consequences for the pet owner can be significant. Anything that can help avoid such injuries would be beneficial.

The purposes of this research summary, therefore, are two:

1) to explain the etiology of such injuries (sometimes misidentified as "burns") and recommend ways to avoid them, and
2) to explain the role – both positive and negative—that heat can play.

The paper also explains how the **HotDog Pressure-Reduction Pad** reduces the risk of pressure injuries.

Because the research cited was conducted primarily on canines, this paper refers to patients as dogs. Although variation among animals does exist, the logic applies to all.

Pressure Ulcers

Pressure ulcers, also called decubitus ulcers, are injuries to the skin caused by prolonged external pressure. They can affect superficial tissues, such as the dermis and epidermis, and/or deep tissues, such as the subcutaneous muscles.[1, 2, 3, 4]

Typical illustrations of canine pressure injuries are below.

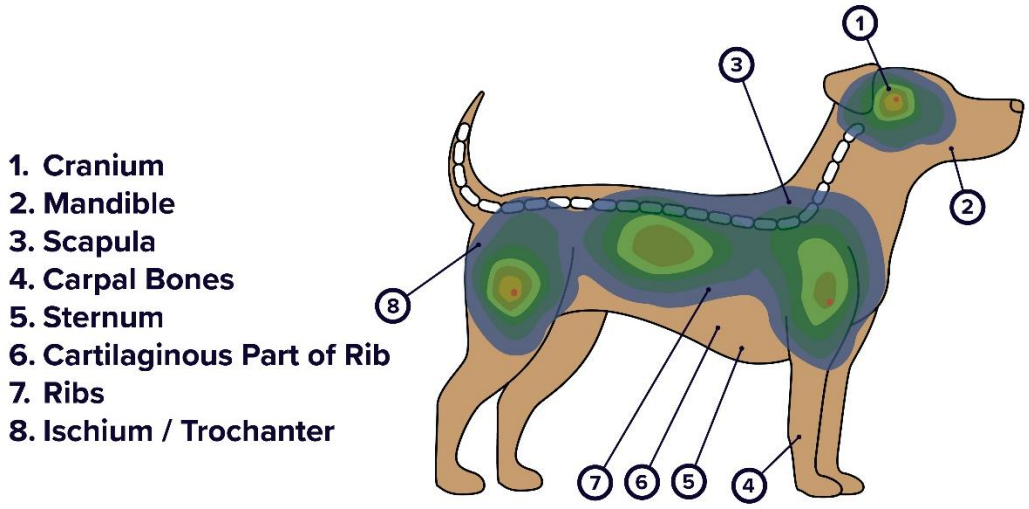


Cause of Pressure Ulcers

Systolic arterial pressure in dogs varies between 90 mmHg and 140mmHg[5]. Researchers have opined that external pressure beginning at 90 mmHg is a moderate risk for pressure injury; pressure between 60 mmHg and 90 mmHg is low risk; pressure below 60 mmHg is considered safe.[6]

Human studies have revealed an inverse relationship between pressure intensiy and duration. That is, tissue damage could be produced by reduced blood flow over an extended period of time or occluded blood flow for shorter periods of time.[1]

Risk zones for pressure injuries are similar in all dogs. The three most important pressure points are the scapula-humeral articulation, the dorsal third of the thirteenth rib and the proximal part of the thigh, centered on the greater trochanter.[6]



These anatomical locations have relatively little soft tissue coverage over boney protrusions. The severity of risk, however, varies widely by type, age, and weight of dog. Greater hypodermal fat in these locations decreases the bony protrusion and increases pressure distribution. Thin dogs, therefore, are at greater risk. In addition, logic dictates that dogs with diminished circulation (caused by age, disease, or dehydration) are also at greater risk.

In one study, dogs placed on a hard surface—lacking any pressure reduction—experienced pressure as high as 170 mmHg[6]. Because this is higher than the 90 mmHg to 140mmHg arterial pressure, this external pressure causes ischemia--a constriction, or even complete collapse and occlusion, of blood vessels, especially capillaries.

Insufficient blood flow prevents oxygen-carrying red blood cells from reaching the tissue, leading inevitably to tissue hypoxia (oxygen saturation <90%) or anoxia (absence of oxygen). The consequence of anoxia is cellular death. Cells oxidize carbohydrates to produce energy and combine oxygen with nitrogen and hydrogen to produce proteins that build new cells. Without carbohydrate energy and the ability to build replacement cells, tissue becomes necrotic.

Consequences of Heat

Depending on the circumstances, actively heating a veterinary dental or surgical patient can either be extremely beneficial or—in the case of anoxia—can exacerbate a bad situation.

Normothermia

Anesthetic-induced hypothermia is a well-recognized phenomenon that occurs in both human and animal patients. Normal core temperature for dogs is 99.5°F to 102.5°F[7]; therefore, hypothermia can be defined as body temperature below 99.5°F. The benefits of surgical normothermia—and the deleterious effects of surgical hypothermia—are legion. Maintaining surgical normothermia reduces wound infections, reduces blood loss, and reduces morbid cardiac events.[8] For humans, active surgical warming is the standard of care.

Hypoxia

With moderate pressure—that is, pressure sufficient to cause hypoxia, but not anoxia--heat actually increases blood flow…thereby reducing the risk of pressure injury.

In a non-human mammal study, heating tissue to 36°C caused increases of approximately 25% in perfusion and 50% in red blood cell concentration.[9] The authors concluded that these benefits were due to a combination of factors:

1) increased perfusion in opened vessels and/or opening of previously closed vessels;

2) the presence of temperature-sensitive precapillary sphincters with the capability to alter resistance to flow based on the ambient temperature;

3) increased capillary pressure which in turn led to increased perfusion;

4) increased production of endothelial relaxation factor (a vasodilator), which led to increased perfusion; and

5) decreased blood viscosity and decreased resistance in red blood cell membranes.

Anoxia

The addition of heat to anoxic tissue—tissue with no access to oxygen-carrying red blood cells—accelerates the creation of pressure ulcers. A temperature increase of 1°C (1.8°F) can raise metabolic activity (and oxygen consumption) by up to 10%[9]. thereby shortening the time in which the tissue will become starved for oxygen…and hastening tissue death. When heating is present, injuries actually caused by pressure-induced anoxia are often misidentified as burns.

Desiring the benefits of warming (and to avoid the negative consequences of hypothermia) described above, veterinary clinics routinely use active-warming devices—like HotDog warming—to help patients remain normothermic. HotDog warming transfers heat conductively, safely heating the patient's perfused skin.[10] The heat is carried from the body's surface tissue to the core by blood flow. If the tissue is anoxic, however, this transfer does not occur. Metabolic activity in the heated, non-perfused tissue increases…and tissue death may follow.

HotDog Pressure-Reduction Pad

The polyfoam in the HotDog Pad reduces the downward force created by the weight of the patient by spreading it over a larger area. The same force, spread over a larger area, results in lower pressure. As noted above, the goal is 60 mmHg or less.

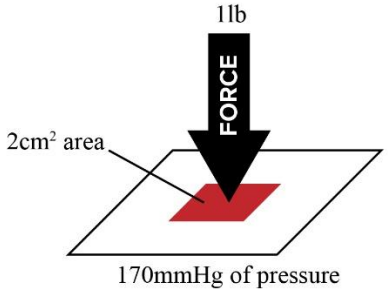
The HotDog Pad's reactive support surface operates on the principle of immersion. That is, it allows the patient's body to sink in. As the body sinks in, more of the body surface comes into contact with the support surface, redistributing the patient's weight over a larger surface area and reducing pressure. High density foams have been recommended by the Pressure Ulcer Prevention Consensus Report to reduce the incidence of pressure ulcers[11]. Five human studies established that people who lay on high density foam pads were 60% less likely to develop pressure ulcers compared to people who lay on regular foam mattresses.

Foams with a high density will generally feel firmer and can withstand more pressure. Conversely, low-density foams will feel softer, but cannot withstand pressure or weight. Density is a measurement of weight per unit of volume, measured in pounds per cubic foot (PCF). In other words, the density of foam is expressed by measuring the weight of one cubic foot of the material. Foams with a density measurement of 1.7 PCF or higher are considered to be high density.

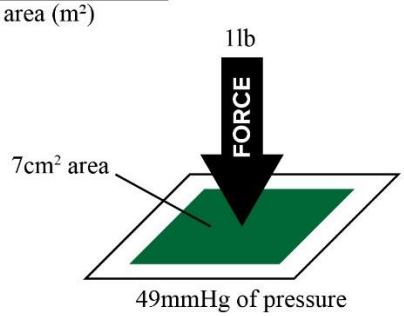
The density of the foam in the HotDog Pressure-Reduction Pad **is 4.0 +/- 10% PCF**

The following demonstrates the benefit of adequate pressure reduction.

$$\text{Pressure}(N/m^2) = \frac{\text{perpendicular force (N)}}{\text{area } (m^2)}$$



Same force, smaller area = higher pressure



Same force, larger area = lower pressure

Units of Pressure

1N/m² = 0.0075mmHg
1000N/m² = 7.5mmHg
N/m² = newtons per square meter
mmHg = millimeters of mercury

Conclusions

- **Adequate pressure reduction is crucial during veterinary surgical and dental procedures.**
- **The HotDog Pressure-Reduction Pad can help reduce the risk of pressure injuries caused by anoxia.**
- **Patients heated with HotDog warming may experience increased blood flow and red blood cell concentration, even with partially occluded capillaries (hypoxia).**
- **Patient injuries routinely identified as "burns" are actually pressure injuries.**

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[1]Agrawal K, Chauhan N. Pressure ulcers : Back to the basics. Indian J Plast Surg. 2012; 45(2):244–254. doi: 10.4103/0970-0358.101287

[2] Bhattacharya S, Mishra RK. Pressure ulcers: Current understanding and newer modalities of treatment. Indian J Plast Surg. 2015;48(1):4-16. doi: 10.4103/0970-0358.155260

[3] Bluestein D, Javaheri A. Am Fam Physician. 2008;78(10):1186-94

[4] Wake WT. *Perm J.* 2010;14(2):56–60. doi: 10.7812/tpp/09-117

[5] Williamson JA, Leone S. Noninvasive arterial blood pressure monitoring. In Burkitt Creedon JM, Davis H (eds): Advanced Monitoring and Procedures for Small Animal Emergency and Critical Care, Ames, IA: Wiley-Blackwell, 2012, pp 134-144.

[6] Caraty J. Comparison of different supports used in veterinary medicine for pressure sore prevention. *J Small Anim Pract* 2019;60(10):623-630. doi: 10.1111/jsap.13061. Epub 2019 Jul 31.

[7] Weir M, Taking Your Pet's Temperature. https://vcahospitals.com/know-your-pet/taking-your-pets-temperature

[8] Harper CM, McNicholas T, Gowrie-Mohan, S. A simple, safe, and effective way of reducing complications of surgery. British Medical Journal 2003; 326:721. doi: 10.1136/bmj.326.7392.721

[9] Patel S, Knapp CF, Donofrio JC, Salcido R. Temperature effects on surface pressure-induced changes in rat skin perfusion: Implications in pressure ulcer development. Journal of Rehabilitation Research and Development. Vol 36 No. 3 July 1999. https://www.rehab.research.va.gov/jour/99/36/3/patel.pdf

[10] https://vetwarming.com

[11] McInnes E, Jammali-Blasi A, Bell-Syer SEM. Higher density foam mattresses and sheepskins reduce risk of pressure ulcers. Cochrane Database Syst Rev 2015;9:CD001735. doi: 10.1002/14651858.CD001735.pub5.