Heatstroke - providing evidence based advice to dog owners.

This is an Accepted Manuscript of an article published by Taylor & Francis in the Veterinary Nursing Journal on 17.11.2016 available online:
http://doi.org/10.1080/17415349.2016.1245119

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Neither author has any conflicts of interest, or financial interest in this work.

Abstract

With increasing summer temperatures and milder winters, the risk of heatstroke in dogs is growing. Veterinary nurses have a vital role in identifying high risk patients and advising owners of the risks of heatstroke. Nurses are able to recommend preventative measures and first aid necessary to minimise the risk of heatstroke; in addition to increasing the chances of survival where heatstroke does occur. This article will provide an overview of the evidence that can be presented to owners during nursing consultations, and the prognosis of patients presenting with heatstroke.

Keywords
Heatstroke, hyperthermia, canine, cooling.

Introduction

Heat stroke is a potentially fatal condition that can be classified into classical heatstroke, caused by exposure to high temperatures and humidity, or exertional heatstroke caused by strenuous physical exercise (Reniker and Mann, 2002; Hemmelgarn and Gannon, 2013a). As the British weather becomes increasingly unseasonable, and global temperatures rise the risk of heat stroke increases. Traditionally colder seasons are warming, and sudden periods of intense summer heat increasing allowing little time for athletes to acclimatise to warmer temperatures (World Meteorological Organization, 2016). Whilst some sports, such as sled dog racing and canicross (see figure 1) are traditionally associated with a winter racing seasons, other canine sports such as canine agility continue through the summer months, increasing the risk of canine athletes suffering from heat related illness. As the popularity of exercising and competing with pet dogs increases, it is essential that veterinary professionals emphasize the importance of being heatstroke aware, and educate clients of the risks, symptoms and first aid treatments for heatstroke.

This article will examine the current veterinary literature, in order to provide evidenced based advice that can be shared with dog owners in veterinary nursing consultations.

Figure 1. Canicross is an increasingly popular sport, with owners and dogs competing in harness off road over various distances.

What is heat stroke?

Heatstroke occurs when heat generated by metabolism, exercise and environmental conditions overwhelms the body's cooling mechanisms, meaning it can no longer dissipate heat. In human medicine, heat stroke is defined as 'a form of hyperthermia associated with a systemic inflammatory response, leading to a syndrome of multi-organ dysfunction in which encephalopathy predominates' (Bouchama and Knochel, 2002). Hyperthermia in canine patients is defined as a core body temperature above 39.2^{o}C, with brain damage occurring at core temperatures as low as 41^{o}C, and all cellular processes and structures being destroyed when core temperature is maintained above 49^{o}C for 5 minutes (Bouchama and Knochel, 2002; Reniker & Mann, 2002). Canine heat stroke is therefore associated with a core body temperature above 40^{o}C, central nervous system dysfunction and varying degrees of organ dysfunction (Bruchim, 2012).

Dogs are particularly at risk of heat stroke due to their physiological cooling mechanisms. Dogs only sweat from their pads, and use panting to dissipate heat through evaporation. When ambient temperature is less than body temperature, 70% of canine body heat is lost from radiation and convection. As environmental temperature increases beyond body temperature, dogs must rely on panting alone to maintain normothermia, and this becomes ineffective in high humidity (Hemmelgarn and Gannon, 2013a).

The environmental conditions within a car on a hot day will rapidly prevent any effective heat loss by a dog's normal cooling mechanisms. A dark coloured car, parked in full sun on a day with an ambient temperature of 22°C, can reach an internal temperature exceeding 47°C within an hour (McLaren, Null and Quinn, 2005). The same car's internal temperature reached 40°C after 10 minutes and approached 60°C when parked in full sun at 31°C for an hour. Opening the windows slightly was shown to have very little effect on the rate of temperature increase, and no effect on the overall total temperature increase (McLaren et al., 2005). This highlights the importance of continuing to educate clients about the risk to dogs left it hot cars, in particular the message that "not long, is too long" (PDSA, 2016).

This advice also applies to owners leaving dogs in vans, caravans, conservatories and mobile kennels. In situations where this cannot be avoided such as summer dogs shows, competitions and holidays, appropriate action should be taken to prevent the dog's environment becoming unsuitably hot. Positioning the vehicle in complete shade, avoiding dark coloured vehicles, using reflective sun shades, fully opening windows or where possible doors to ensure air movement, providing free access to water and above all constantly monitoring the dog's conditions can reduce the risk of overheating (see examples in figure 2).

Figure 2. Dogs housed in cars with examples of appropriate modifications to prevent overheating: light coloured cars, parked in full shade, reflective sun shade and tinted windows, open windows, boots left open, free access to water, and subject to regular checks by the owner.

Certain breeds of dog are more at risk of developing heatstroke. Brachycephalic breeds including the Pug and Boxer have been shown to overheat faster than non-brachycephalic breeds in environments warmer than room temperature, as their narrowed respiratory tract increases the muscular effort and energy required to effectively ventilate. This has two effects, body temperature further increases due to muscle work, and evaporation is limited by the reduced respiratory capacity (Canine Health Foundation, 2012). Dogs with other respiratory disorders, in particular laryngeal paralysis are also at greater risk of heatstroke (Hemmelgarn and Gannon, 2013a).

Male dogs appear to be at greater risk of developing heat stroke, with retrospective analysis showing males comprise 59-87% of the cases seen with heat illness at referral hospitals (Drobatz and Macintire, 1996; Bruchim, et al.,2006; Teichmass, Turkovic and Dorfket, 2014;

Segev, Aroch, Savoray, Kass and Bruchim, 2015). Male racing greyhounds have also demonstrated significantly greater post-race rectal temperatures than female dogs, despite pre-race temperatures being the same in both genders (McNicholl, Howarth and Hazel, 2016). Greyhounds with darker coloured coats, also showed a significantly greater increased in temperature post-race, than dogs with lighter coloured coats. Whilst this may be common sense, it is important to remind owners of darker coloured dogs that they may overheat faster when exercising.

Dogs exercising in warmer conditions have developed heat stroke in as little as 6 minutes, highlighting the potential risk of even walking a dog to the veterinary practice in hot weather (Bruchim et al., 2006). Dogs at increased risk of developing heatstroke are shown in figure 3.

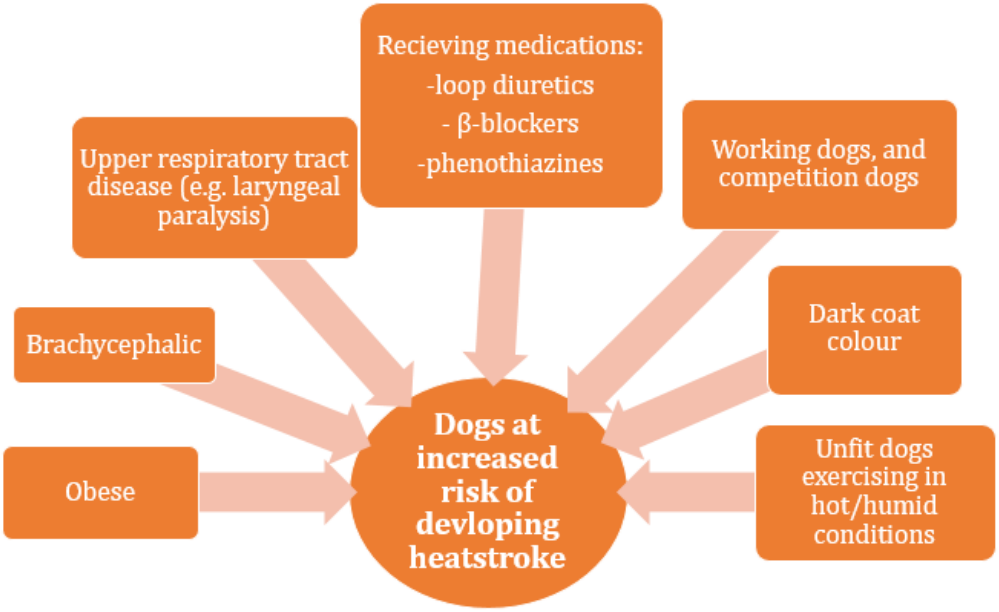

Figure 3. Factors increasing the risk of heatstroke in dogs

Diagnosing heat stroke

Heatstroke diagnosis relies on accurate clinical history, including exposure to high temperature, or recent exercise, and careful clinical examination. Crucially, by the time the patient presents at the veterinary practice, their core body temperature may have dropped to normal or subnormal. Pet owners now have access to thermometry devices such as the PetTemp® and VetTemp® (Advanced Monitors Corporation, California, USA) (Figure42), and Thermofocus Animal® (Tecnimed, Varese, Italy) (Figure 5) , as well as physiological tracking devices such as the PetPace™ collar (PetPace LLC, Massachusetts, USA. This information can be helpful in reaching a diagnosis, and can be used to suggest appropriate action before commencing a journey to the veterinary clinic.

Figure 4. A VetTemp® tympanic membrane thermometer

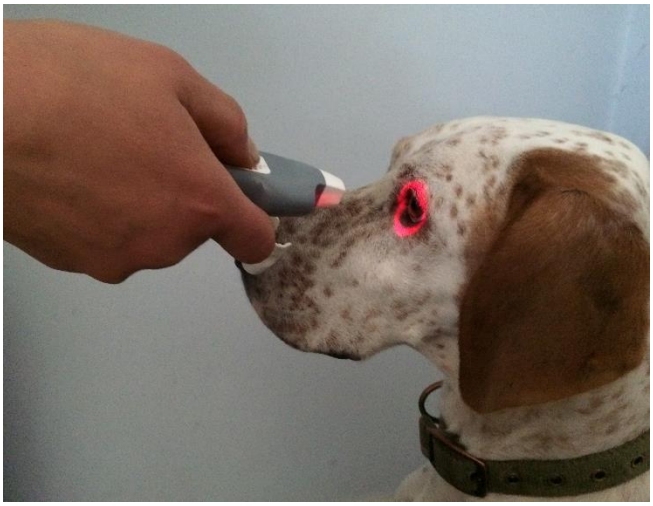

Figure 5. A Thermofocus Animal® non-contact infrared thermometer

To date there are published canine heatstroke case series from USA, Germany and Israel, reporting mortality rates of 36-50% (Drobatz and Macintire, 1996; Bruchim et al,. 2006; Teichmass et al., 2014; Segev et al., 2015). Typical presenting clinical signs are presented in Figure 6, and include excessive panting with exaggerated tongue protrusion, tachycardia, collapse, haemorrhagic vomiting and diarrhoea, shock and bleeding disorders (Drobatz and Macintire, 1996; Bruchim et al., 2006). Left untreated, symptoms will develop to convulsions, organ failure and eventually death.

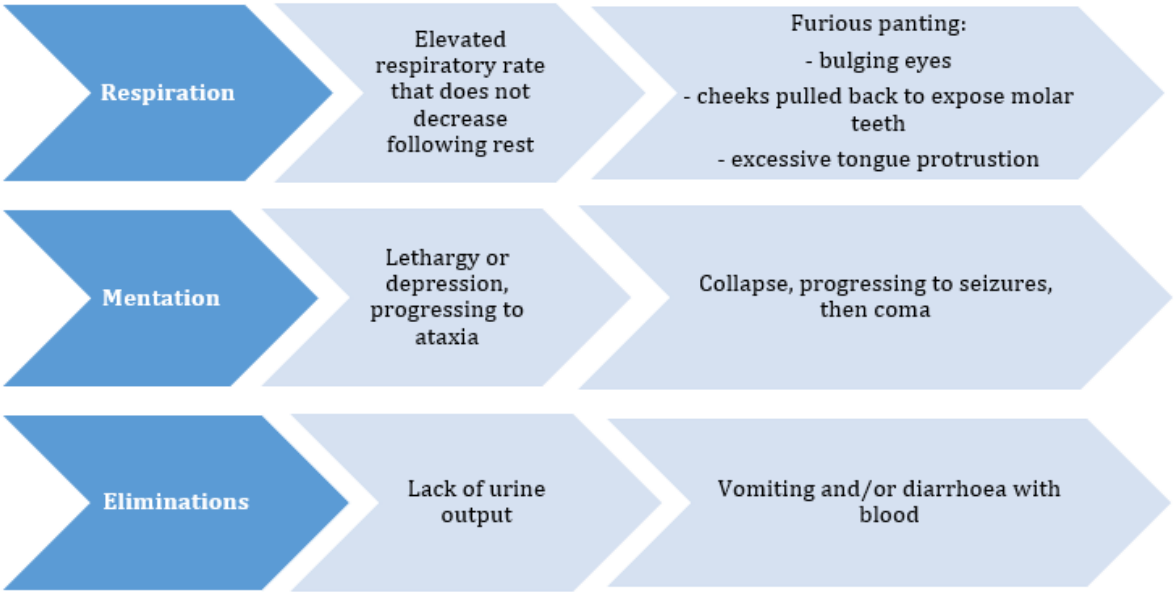

Figure 6. Progression of clinical signs associated with heat stress in dogs

Triage and active cooling – what is the evidence?

Bruchim et al. (2006) showed that whole body cooling prior to arrival at the veterinary hospital, was associated with an increased survival rate. Whilst the finding was not statistically significant, they suggested vastly different cooling methods as a potential reason for limiting the efficacy of this treatment. They also found that dogs presented to the hospital more than 90 minutes after their collapse, were more likely to develop disseminated intravascular coagulopathy (DIC), associated with a greater mortality rate.
This highlights the importance of educating clients about the risks and first aid treatment for heatstroke, and shows the importance of ensuring front-line reception staff are well equipped to advise owners on managing potential heat stroke cases, including advising early presentation to the practice. Owners should be instructed to begin actively cooling their dog, before or during their journey to the veterinary practice (Bruchim et al., 2006; Mann, 2012).

Owners should also be advised on appropriate methods of cooling their animal (Figure 7). Using iced water, ice baths or ice coats should be avoided. Very cold water or materials contacting the skin induces peripheral vasoconstriction limiting heat loss. Extreme cold will also induce shivering, which will further increase body temperature through muscle activity (Hemmelgarn and Gannon, 2013b). Immersing dogs into water baths should also be avoided, as there is a risk of drowning in patients with reduced mentation. Water can be hosed or sponged over the dog, focusing on the large bleed vessels in the neck, ventral abdomen and inner thigh, if cooling a thick coated dog, water soaked towels may be more appropriate, as thick coats can trap water against the skin, acting as insulation (Hemmelgarn and Gannon, 2013b).

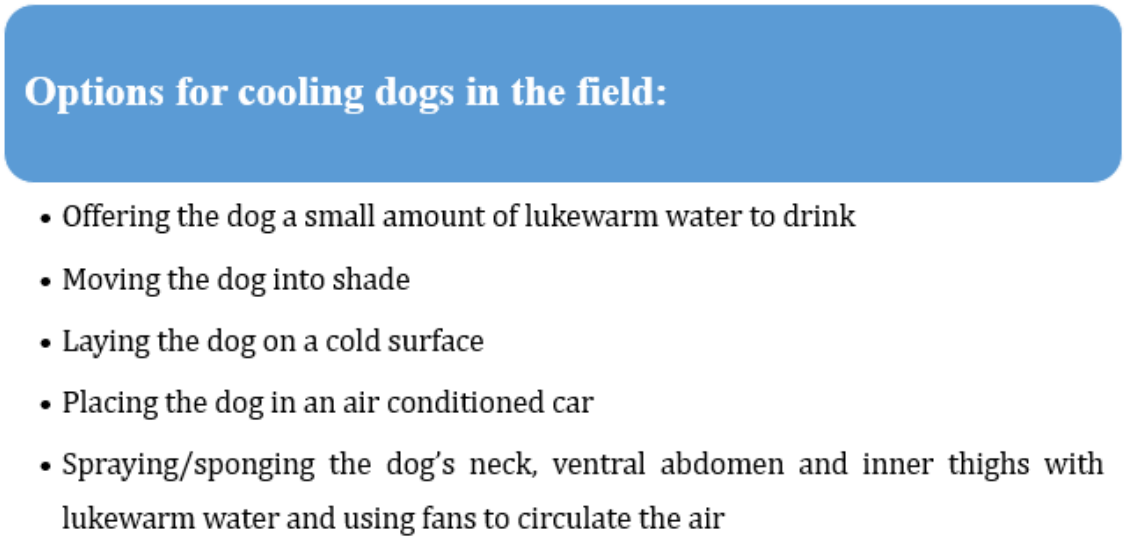

Figure 7. Cooling mechanisms that can be used in the field

The use of "cooling jackets" as a method of cooling dogs with heat illness cannot currently be recommended, as the only published data evaluating their use demonstrated a higher post-race rectal temperature in racing Greyhounds wearing cooling jackets immediately post-race, compared to those not using the jackets (McNicholl et al., 2016).

Once in the practice, these cooling methods can be continued. More invasive methods such as iced peritoneal lavage, can be associated with higher risks of complications such as peritonitis, and have been shown to be no more effective than using "evaporative techniques", a garden hose spraying water over the patient, coupled with a fan blowing room temperature air over the patient (White et al., 1993).

It is essential that continuous temperature monitoring is performed, and active cooling should be stopped once a rectal temperature of 39.5ºC is reached, to prevent the patient developing hypothermia (Drobatz, 2009, Hemmelgarn and Gannon, 2013b). Rectal temperature is thought to lag behind true blood temperature during periods of heating and cooling, so once a rectal temperature of 39.5ºC is recorded, true blood temperature could be below 39ºC (Greenes and Fleisher, 2004). Owners using tympanic membrane, or non-contact infrared thermometers should also warned of the potential limitations of these devices. Tympanic membrane thermometers have been shown to read consistently below rectal temperature in both dogs, by approximately 0.6 ºC, highlighting a need for normal canine tympanic membrane temperature ranges (Gomart, Allertone and Gommeren, 2014).

Prognostic indicators – what is the evidence?

With such a high mortality rate, and the intensive nursing required to treat these patients, it is essential that owners are informed of the likely outcome and costs associated with this condition. Euthanasia should be discussed with owners if prognostic indicators are poor, or financial constraints limit treatment options. Failure to provide adequate care, or communication of the options available to owners of heatstroke patients has led to disciplinary action (RCVS, 2015).

In order to provide owners with a realistic prognosis, patients should therefore be thoroughly examined, with particular emphasis on core temperature, neurological assessment, body condition scoring, blood glucose levels and clotting profiles (as listed in Table 1). Most dogs with fatal heatstroke, die or are euthanased within 24 hours of presentation. Dogs surviving beyond 48 hours from admission, have an excellent chance of recovering (Drobatz and Macintire, 1996, Teichmass et al., 2014).

Table 1. Clinical findings that predict poor outcome for heatstroke patients.

Factors known to predict poor outcome for heatstroke patients:	**Evidence sources:**
Hypothermia on admission to the veterinary clinic	- Drobatz and Macintire, 1996 - Teichmass et al., 2014 - Segev, Aroch et al., 2015
Hypoglycaemia that fails to respond to intravenous glucose	- Drobatz and Macintire, 1996 - Segev, Aroch et al., 2015
Increased prothrombin time on admission	- Bruchim et al., 2006 - Segev, Aroch et al., 2015
Obesity	- Bruchim et al., 2006 - Segev, Aroch et al., 2015
Presenting in a semicoma/coma status	- Drobatz and Macintire, 1996 - Bruchim et al., 2006 - Segev, Aroch et al., 2015

Conclusion

With reported mortality rates between 39-50%, heatstroke is a serious condition that all dog owners should be aware of. Understanding of the most at-risk patients, will allow veterinary staff to identify owners who would benefit from additional guidance and information regarding the risks of heatstroke, identifying heat stress, and the first aid action that should be taken in the event of heatstroke being suspected. Early and appropriate action and veterinary intervention improves the prognosis for the dog, but most importantly, heatstroke is a totally preventable condition. As climate change brings more unpredictable weather, it is even more important that owners are armed with the knowledge required to protect their pets from heat related illnesses.

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