Heatstroke – providing evidence-based advice to dog owners

Emily J. Hall MA VetMB AFHEA MRSB MRCVS and **Anne Carter** BSc (Hons) MSc PhD FHEA MRSB

School of Animal, Rural and Environmental Science, Nottingham Trent University, Brackenhurst, Southwell, Nottinghamshire NG25 0QF

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.

Emily J. Hall MA VetMB AFHEA MRSB MRCVS

Emily qualified as a veterinary surgeon in 2007, and has worked in small animal first-opinion practice ever since. Emily now teaches veterinary nursing students on the Foundation Degree at Nottingham Trent University, and continues to work in practice at weekends.
Email: emily.hall@ntu.ac.uk

Anne Carter BSc (Hons) MSc PhD FHEA MRSB

Anne has a PhD in canine behaviour and welfare. She continues to research in the field of canine behaviour, welfare and the canine athlete at Nottingham Trent University. Anne course leads the BSc Animal Biology at Nottingham Trent University, in addition to teaching on Anthrozoology and Animal Health & Welfare Masters courses.

Introduction

Heatstroke 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 (Hemmelgarn & Gannon, 2013a; Reniker & Mann, 2002). As the British weather becomes increasingly unseasonable and global temperatures rise, the risk of heatstroke 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). While 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 emphasise 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 evidence-based advice that can be shared with dog owners in veterinary nursing consultations.

What is heatstroke?

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, heatstroke 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 & Knochel, 2002). Hyperthermia in canine patients is defined as a core body temperature above 39.2°C, with brain damage occurring at core temperatures as low as 41°C and all cellular processes and structures being destroyed when core temperature is maintained above 49°C for 5 minutes (Bouchama & Knochel, 2002; Reniker & Mann, 2002). Canine heatstroke is therefore associated with a core body temperature above 40°C, central nervous system dysfunction and varying degrees of organ dysfunction (Bruchim, 2012).

Dogs are particularly at risk of heatstroke due to their physiological cooling mechanisms. Dogs only sweat from their pads, and use panting to dissipate heat through evaporation. When ambient

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

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

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 & 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, & 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 in 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**).

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 & Gannon, 2013a).

Male dogs appear to be at greater risk of developing heatstroke, with retrospective analysis showing males comprise 59–87% of the cases seen with heat illness at referral hospitals (Bruchim et al., 2006; Drobatz & Macintire, 1996; Segev, Aroch, Savoray, Kass, & Bruchim, 2015; Teichmass, Turkovic, & Dorfelt, 2014). 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, & Hazel, 2016). Greyhounds with darker-coloured coats also showed a significantly greater increase in temperature post-race than did dogs with lighter-coloured coats. While 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 heatstroke 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**.

Diagnosing heatstroke

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) (**Figure 4**), 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.

To date, there are published canine heatstroke case series from USA, Germany and Israel, reporting mortality rates of 36–50% (Bruchim et al., 2006; Drobatz & Macintire, 1996; Segev, Daminet, et al., 2015; Teichmass et al., 2014). 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 (Bruchim et al., 2006; Drobatz & Macintire, 1996). Left untreated, symptoms will develop to convulsions, organ failure and eventually death.

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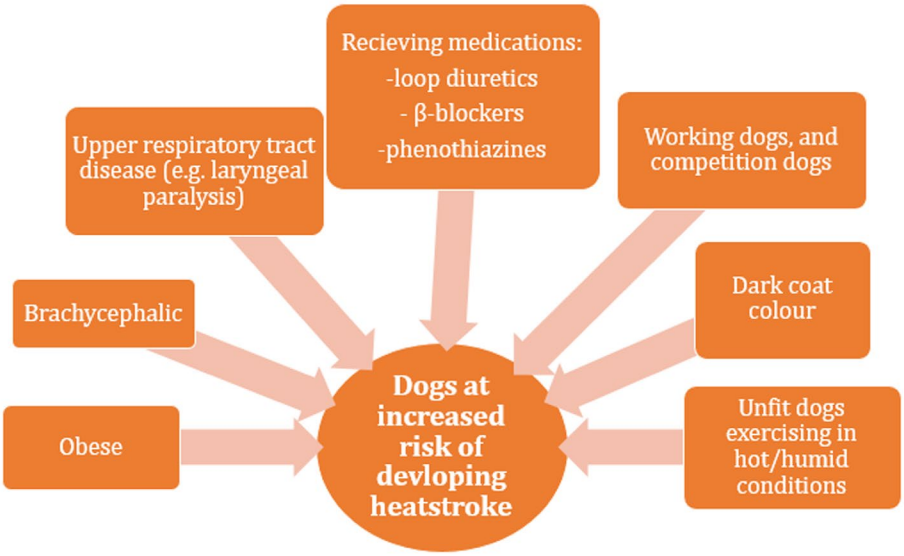

Figure 3. Factors increasing the risk of heatstroke in dogs

Figure 4. A VetTemp® tympanic membrane thermometer

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. While 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 heatstroke 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).

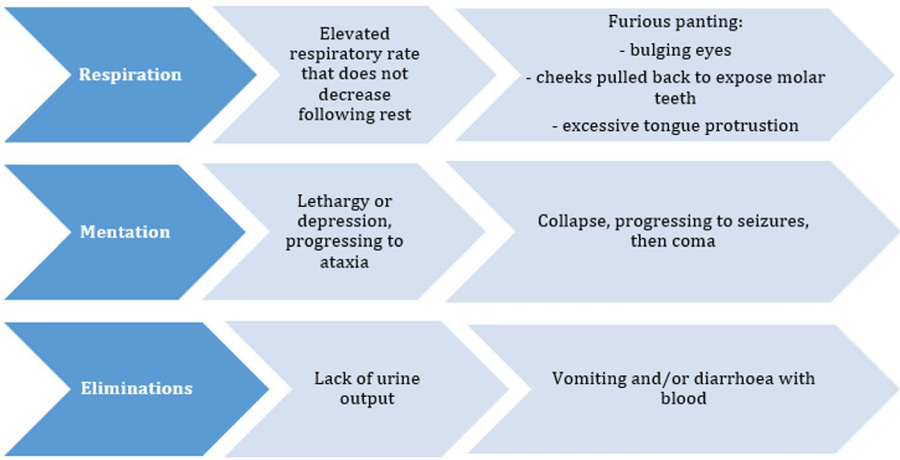

Figure 6. Progression of clinical signs associated with heat stress in dogs

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

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 induce peripheral vasoconstriction, limiting heat loss. Extreme cold will also induce shivering, which will further increase body temperature through muscle activity (Hemmelgarn & 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 & Gannon, 2013b).

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, Kamath, Nucci, Johnson, & Shepherd, 1993).

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Options for cooling dogs in the field:

- Offering the dog a small amount of lukewarm water to drink
- Moving the dog into shade
- Laying the dog on a cold surface
- Placing the dog in an air conditioned car
- Spraying/sponging the dog's neck, ventral abdomen and inner thighs with lukewarm water and using fans to circulate the air

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

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.

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 semi-coma/coma status	• Drobatz and Macintire (1996) • Bruchim et al. (2006) • Segev, Aroch et al. (2015)

It is essential that continuous temperature monitoring is performed, and active cooling should be stopped once a rectal temperature of 39.5°C is reached, to prevent the patient developing hypothermia (Drobatz, 2009; Hemmelgarn & Gannon, 2013b). Rectal temperature is thought to lag behind true blood temperature during periods of heating and cooling, so once a rectal temperature of 39.5°C is recorded, true blood temperature could be below 39°C (Greenes & Fleisher, 2004). Owners using tympanic membrane or non-contact infrared thermometers should also be warned of the potential limitations of these devices. Tympanic membrane thermometers have been shown to read consistently below rectal temperature in dogs, by approximately 0.6°C, highlighting a need for normal canine tympanic membrane temperature ranges (Gomart, Allerton, & 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 & Macintire, 1996; Teichmass et al., 2014).

Conclusion

With reported mortality rates between 39% and 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

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Multiple Choice Questions

1. Hyperthermia is defined as a temperature above which point in degrees celcius?

(a) 39.2

(b) 41.0

(c) 49.0

(d) 37.5

2. Which breed of dog is likely to be more susceptible to heatstroke?

(a) Labrador

(b) Golden Retriever

(c) Pug

(d) West Highland White Terrier

3. Which of the following clinical signs is not associated with heatstroke?

(a) Disseminated intravascular coagulopathy

(b) Hypothermia

(c) Tachycardia

(d) Collapse

4. Male dogs are reportedly at higher risk of developing heatstroke than female dogs?

(a) True

(b) False

5. A dark coloured car parked in full sun when the ambient outside temperature is 22 degrees Celsius can reach what temperature within an hour?

(a) 60°C

(b) 70°C

(c) 47°C

(d) 37°C

6. Opening the windows slightly on a car is shown to have little effect on the rate of temperature increase.

(a) True

(b) False

7. What are the reported mortality rates for heatstroke?

(a) <10%

(b) 39-50%

(c) 25-38%

(d) 15-24%

8. Exertional heat stroke may be caused by which of the following?

(a) Confinement in a hot care

(b) Exposure to high temperatures and humidity

(c) Strenuous physical exercise

(d) Being kept in a conservatory in the summer

9. The temperature (when maintained for five minutes) at which all cellular processes and structures are destroyed is:

(a) 39.2°C

(b) 41°C

(c) 49°C

(d) 37.5°C

10. Radiation and convection are used to dissipate excess body heat when environmental temperatures rise above body temperature?

(a) True

(b) False

For the answers to the MCQs, please go to: http://www.bvna.org.uk/publications/veterinary-nursing-journal

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