FOUR LEG NEWS

It's getting hot in here! (Somewhere)

Welcome to the HEAT WAVE EDITION of FourLeg News. This may seem like an odd topic for this time of year (for those of us in the Northern Hemisphere), so I could take this opportunity to dedicate this issue to our Southern Hemisphere friends. In reality, it started from looking up cold weather articles… but there were so many 'hot articles', that it just made sense to put them together and put it out there! You will find the articles pretty much stand alone… as there isn't really a 'Rehab-Correlation' to be made with many of the articles. But that doesn't mean you shouldn't know about this topic and these articles. So, for the betterment of your knowledge, here are the Hot Temperature Articles that I thought you might like!

Cheers! Laurie

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Monitoring body temperature: Methods, devices, and reliability

Ganio, M.S., Brown, C.M., Casa, D. J., et al, *Validity and reliability of devices that assess body temperature during indoor exercise in the heat* Journal of Athletic Training, 44(2), pp. 124-135, 2009.

In order to determine if there are relevant changes to a dog's core temperature during exercise we first need to know if the tools used to measure body temperature can provide reliable and accurate information. This human study compared several body temperature measurement devices.

The devices were tested in a controlled laboratory environment with a hot ambient temperature of approximately 36.4°C and a cool ambient temperature of approximately 23.3°C. Fifteen men and ten women were participant in this study. The devices were tested against rectal body temperature measurement, considered the accurate control.

The devices tested were an adhesive forehead strip thermometer, a temporal artery scanner, digital oral thermometer (two types), a tympanic ear thermometer, two different axillary temperature devices on the arm, and an ingested intestinal thermistor.

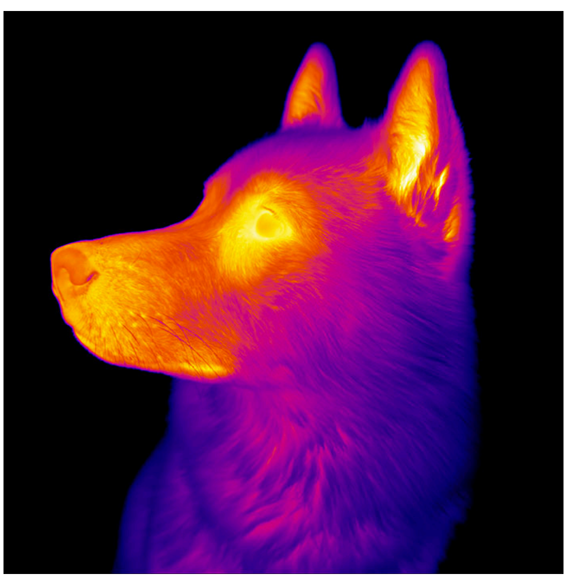
Volunteer temperatures were evaluated after 20 minutes of standing in active in a cool temperature, again after 20 minutes of standing inactive in a warm temperature, and after walking on a treadmill in a warm temperature every 30 minutes for a 90 minute period of exercise. After exercise volunteers were moved back to the cool room and were monitored every 20 minutes for a 60 minute period.

The conclusion of this study was that the readings of all but one of the tested devices deviated too much from the rectal temperature control to be considered accurate for scientific or safety applications. The only device that fell into the acceptable range was the intestinal thermistor. The good news is that rectal temperature is the most common way to measure core body temperature in dogs. However, while assessing other research, that may use other devices to measure the core temperature of canine athletes we need to be aware of the questionable accuracy of some temperature taking devices.

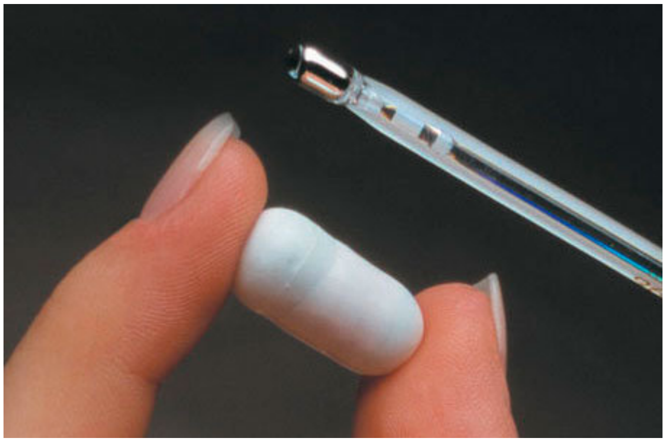
Rizzo, M., Arfuso, F., Alberghina, D., Giudice, E., Gianesella, M., Piccione, G., *Monitoring changes in body surface temperature associated with treadmill exercise in dogs by use of infrared methodology* Journal of Thermal Biology, 69, pp. 64-68, 2017.

If it is important to monitor dogs for hyperthermia during exercise the accuracy of that measurement is important. Rectal temperature measurements are considered the most accurate, but are difficult to obtain without interrupting the dog's activity.

This study looked at the possibility of using surface temperature, measured non-invasively with infrared technology, as an accurate tool to determine the temperature changes in dogs while exercising. 10 Jack Russell x Miniature Pinscher were recruited to walk, trot, and run on a treadmill while having the surface temperature (usually approximately 5°C lower than the dog's core temperature) of various specified body regions measured by an infrared camera and an infrared thermometer device. These measurements were then compared to the rectal temperature of the dogs.



While exercising there was a significant increase in surface temperature of all specified body regions. Regions where there are more active locomotor muscles had higher surface temperatures (ribs, flank, back, and internal thigh), as metabolic heat from working muscles is transferred to the surface to be dissipated, but the only surface temperature that was significantly comparable to the rectal temperature was the eye (measured near the caruncula lacrimalis). The researchers caution that this measurement is not interchangeable with rectal temperature measurements, but it may be feasible to use this region, where results are not as heavily influenced by coat thickness and colour, to monitor a dog for hyperthermia during exercise using surface temperature readings.



Angle, T.C., Gillette, R.L., *Telemetric measurement of body core temperature in exercising unconditioned Labrador retrievers* The Canadian Journal of Veterinary Research, 75, pp/ 157-159, 2011.

The use of an ingestible telemetric monitoring device is another possible alternative to rectal temperature that allows continuous and accurate monitoring of core temperature during exercise.

25 dogs were used to test the reliability of the ingestible CorTemp Disposable Temperature Sensor, a single use battery operated sensor in a silicon capsule, which was swallowed 15 minutes prior to exercise.

Using these devices, which collected temperatures continuously with no missing data points from all 25 dogs, it was possible to monitor the core temperature changes in real time response to exercise and the environment. The data indicated that the unconditioned dogs, exercised by running alongside a golf cart for 20 minutes experienced a progressive increase in core temperature from pre-exercise to post-exercise periods, followed by a progressive decrease in core temperature during the 10 minute post-exercise cool down period. The data also showed that the dogs did not reach a stabilized core temperature during the 20 minute period. The ingestible telemetric capsule allowed for data to be collected that would not be possible with the use of a rectal device requiring the interruption of exercise, especially considering how rapidly a drop in temperature occurred just 5 minutes into the cool down period following exercise.

Risk factors for heat stroke death

Bruchim, Y., Klement, E., Saragusty, J., Finkeilstein, R., Kass, P., Aroch, I., *Heat stroke in dogs: A retrospective study of 54 cases (1999-2004) and analysis of risk factors for death* Journal of Veterinary Internal Medicine, vol. 20, pp. 38-46, 2006.

Normal body temperature for a dog is 38°C or 101°F. A dog is considered to have severe heat stroke if their core body temperature rises to 41°C or 105.8°F. This increase in core temperature and the associated central nervous system dysfunction can occur as a result of exposure to heat and humidity in the environment when heat dissipation is impaired by environmental temperature increases (environmental heat stroke) or physical exercise when heat dissipation cannot keep pace with heat production (exertional heat stroke).

Dogs regulate their body temperature by dissipating heat via radiation and convection from body surfaces, which accounts for 70% of the total body heat lost. Panting is an evaporative cooling mechanism via pulling air across moist mucus membranes. These mechanisms become less efficient as ambient temperature and humidity increase.

This retrospective study looked at 54 cases of canine heat stroke admitted to veterinary hospital (in Israel) over a five year period. All dogs were presented for treatment between the months of March and October with the majority (78%) of them during the summer months of June, July, and August. 63% of the cases were exertional heat stroke (with a mean duration of exertion of 58 minutes). Clinical signs of presented dogs included collapse, tachypnea, tachycardia, coma/semicoma, disorientation, seizures, thrombocytopenia, increased coagulation time, and renal failure.

There was a 50% mortality rate in the cases with no significant difference in mortality rate between dogs suffering from exertional heat stroke vs those with environmental heat stroke. Meteorological data for the dates the dogs were presented was recorded so that environmental risk factors could be analysed. In addition, factors such as time lag between initial collapse and treatment, as well as whether or not owners took action to cool their dogs prior to seeking treatment were also evaluated.

Survival rates were significantly higher in the dogs that were brought in for treatment with a lag time of less than 90 minutes from collapse. There was no significant increase in survival rate for dogs cooled by owners prior to seeking veterinary treatment, except in the case of dogs that were cooled at home and sought veterinary treatment with a lag time of less than 90 minutes (these individuals had a 100% survival rate). The fatality rate in obese dogs was 82%, a significant increase.

Since the majority of the cases were exertional heat stroke, and the fatality rate of dogs considered obese was significantly higher, owners should be cautioned against strenuous exercise on hot humid days (when exertional factors and environmental factors could combine at unsafe levels) and owners of obese dogs need to be aware that their pets are at an increased risk of death from heat stroke.

Environmental influence on body temperature & stamina

McNicholl, J., Howarth, G.S., Hazel, S., *Influence of the environment on body temperature of racing greyhounds* Frontiers in Veterinary Science, vol. 3, article 53, 2016.

If exertional heat strain is a significant risk among dogs, are athletes such as racing greyhounds, particularly those in warmer climates, at an increased risk of suffering heat strain? This study evaluates the occurrence and associated risk factors of heat strain for racing greyhounds based on both environmental factors (temperature and humidity) and dog-related factors (physical attributes of the dog). Previous estimates of thermoneutral zones have been made using a variety of methods and comparing several types of dog. For example, the suggested greyhound thermoneutral zone is 16 - 24°C whereas the estimated thermoneutral zone for Innuit dogs is -25 - 10°C.

A sample of 229 greyhounds from 46 races in South Australia, Australia were included in this study. Core temperatures was measured using a rectal thermometer both before and after racing. Urine samples were collected and analyzed for myoglobiuria. Ambient temperatures during the races were recorded and were measured at a range of 11°C - 40.8°C with a relative humidity ranging from 17% to 92%. Other factors such as shade, dog weight, sex, and coat colour were also recorded.

There are a couple of factors to consider when considering the risk of heat strain on racing greyhounds. First, heat is generated as a byproduct of ATP produced during muscle activity. The large locomotor muscles of the greyhound may cause increased heat generation resulting in exertional hyperthermia. As ambient temperatures approach body temperature, heat cannot be dissipated by radiation or surface convection, and evaporative heat dissipation becomes more crucial. This is achieved in the dog via respiration, but evaporative heat loss is reduced as humidity in the environment increases.

The average pre-race body temperature was 39.2°C and the average post-race temperature was 41°C, with an average increase of body temperature of 2.1°C.

Following analysis of the data collected during this study the factors that did not have a significant effect on body temperature or body temperature change were humidity, race distance, sex, or comparative fitness.

Oddly, the dogs wearing cooling jackets had a significantly higher rectal temperature post-race than those not. Ambient temperature was significant in terms of whether or not dogs reached what is considered a critical temperature of 41.5°C (at which point a dog's health may be considered at risk due to hyperthermia), and this occurred at an average ambient temperature of 31.2°C.

Colour of dog did not have a significant effect on pre-race rectal temperature, but black, blue, and brindle greyhounds had significantly higher post-race temperatures as compared to fawn or white greyhounds. Unless conditions were fully overcast, in that case there was no significant difference based on colour of dog.

While all dogs were scored at 2 on the body condition scale, so subcutaneous fat is not a likely contributor, dogs with a larger body mass did measure a significantly higher temperature and increase in temperature post race. Possibly due to the increase in energy exerted to move a larger body mass.

The most notable conclusion from this study was the marked increased risk to these dogs at ambient temperatures of 38°C or more, and this may be considered the wise choice in threshold temperature for this type of dog engaging in this type of activity.

Gobi, a stray dog, decided to run more than half of a 155 mile ultra marathon across the Gobi desert in 2016. She may have ran the whole race, but officials decided the temperatures were too extreme for the stray's safety.

Robbins, P.J., Ramos, M.T., Zanghi, B.M., Otto, C.M., *Environmental and physiological factors associated with stamina in dogs exercising in high ambient temperatures* Frontiers in Veterinary Science, vol. 4, article 144, 2017.

This study looked at whether or not environmental factors or physiological dog specific variables were more limiting to exercise stamina in conditioned canine athletes. 12 dogs aged 8 - 23 months and regularly exercised were selected for use in this study. Dogs were evaluated with a maximum 30 minute exercise challenge on five separate occasions during a 19 day period. The challenge consisted of a warm up period of trotting and active stretching, followed by a 5 minute odour search, a 5 minute rest in shade, a 5 minute agility session, another 5 minute rest in shade, 10 minutes of retrieving, and then a cool down trot or quick walk for 5 minutes. Activity was stopped prior to the 30 minute mark if dogs showed decline in stamina, such as panting with a curled tongue or voluntary refusal or hesitation to participate in activity. Their actual activity was measured via the wearing of an accelerometer, and this data, coupled with exercise time was used to determine stamina. Ambient temperature and relative humidity were recorded during the exercise.

The following physiological and biochemical measurements were recorded before and immediately after the exercise challenge: Pulse rate, left and right eat temperatures, core body temperature (via ingestible telemetric core temperature monitor), venous blood samples (analyzed immediately for pH, gases, electrolytes, base excess in extracelluar fluid compartment, glucose, hemoglobin, hematocrit, and lactate.)

The average temperature during the testing period was 28.7°C and the average relative humidity was 49.6%.

The results of this study concluded that it was ambient temperature, not relative humidity, that had a significant effect on the stamina of the dogs being tested. As outdoor temperature increased, stamina decreased and these high ambient temperatures could acutely induce metabolic changes (specifically an increase in core body temperature, pulse rate, lactate, glucose, hematocrit, and hemoglobin) in the exercising dogs. But, the study also found that the limiting factor for stamina was not core body temperature increase itself, rather it was the ability to dissipate heat via efficient respiration without creating acid/base disturbances (respiratory alkalosis).

THE BIGGEST DRAWBACK TO SWEATING THROUGH YOUR TONGUE

Notes on hydration

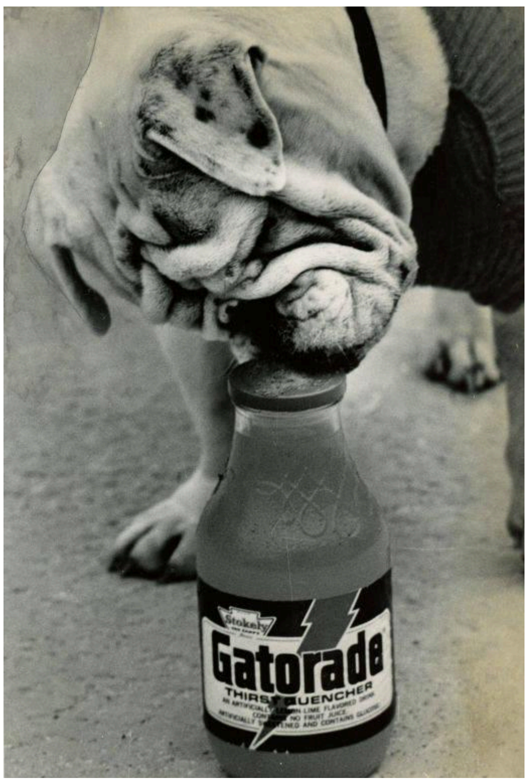
Otto, C.M., Hare, E., Nord, J.L., Palermo, S.M., et. al. *Evaluation of three hydration strategies in detection dogs working in a hot environment* Frontiers in Veterinary Science, vol. 4, article 174, 2017.

Hydration state is one of the factors thought to influences heat tolerance in dogs. There are three common strategies employed by working dog handlers to increase hydration: Free access to water, oral electrolyte solutions (OES), and subcutaneous fluid (SQ) administration. This study was meant to evaluate the effects of these three different hydration strategies on seven border patrol dogs screening vehicles during Texas summer weather.

The dogs were split into three groups based on what hydration strategy they would receive. Every 30 minutes during their shift all dogs across all groups were offered 10mL/kg of water.

If the dogs in the OES group drank less than 3mL/kg of water they were offered 10mL/kg of OES. Dogs in the SQ group were given 15mL/kg of SQ. If the dogs consumed all 10mL/kg of water during their 30 minute time interval they were offered a second 10mL/kg bowl. Data was collected at each hydration interval.

The data collected at 30 minute intervals included fluid volume consumed, internal body temperature, heart rate and EKG, qualitative assessments of activity, urination, and defecation. Environmental factors that were recorded were the ambient temperature, percent humidity, and wind speed.



Fluid consumption was the only dramatically influenced factor by hydration strategy. The OES group consumed the most fluid on average, and the SQ group consumed the least. The OES group was the only group given access to OES and they drank it in a ratio of total fluid intake ranging from 19-94%. However, there is a very strong possibility that this behaviour was due to the fact that the OES was chicken flavoured, and therefore more palatable than plain water. It's been suggested that since electrolytes are lost through sweating, and dogs sweat very little as part of their thermoregulatory process, that OES may in fact not be either necessary or possibly even safe. However this study showed no difference between the hydration groups in blood sodium concentrations, indicating that the dogs were able to regulate sodium despite increased input from the OES solution, there was no marked benefit to the electrolyte consumption, however.

Hydration method made no discernible difference in core body temperature or activity level. Analysis of urine and blood samples revealed a few significant differences. The OES group had less Creat in the blood in comparison to the water only group, and the SQ group had more Creat in the blood. Creat is associated with dehydration and muscle injury, indicating that the SQ group may have been less hydrated than the water and OES groups.

The study failed to show any significant difference in hydration of the dogs dependent on hydration method beyond the increased fluid consumption of the OES group. To account for the possibility that the dogs were responding to the flavour and not to the electrolyte content of the solution further study would be needed.

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