Telemetric measurement of body core temperature in exercising unconditioned Labrador retrievers

T. Craig Angle, Robert L. Gillette

Abstract

This project evaluated the use of an ingestible temperature sensor to measure body core temperature (Tc) in exercising dogs. Twenty-five healthy, unconditioned Labrador retrievers participated in an outdoor 3.5-km run, completed in 20 min on a level, 400-m grass track. Core temperature was measured continuously with a telemetric monitoring system before, during, and after the run. Data were successfully collected with no missing data points during the exercise. Core temperature elevated in the dogs from 38.7 ± 0.3°C at pre-exercise to 40.4 ± 0.6°C post-exercise. While rectal temperatures are still the standard of measurement, telemetric core temperature monitors may offer an easier and more comfortable means of sampling core temperature with minimal human and mechanical interference with the exercising dog.

Résumé

Ce projet a permis d'évaluer l'utilisation d'une sonde thermique ingérable afin de mesurer la température corporelle centrale (Tc) chez des chiens à l'exercice. Vingt-cinq chiens de race Labrador en santé, non-conditionnés ont participé à une course extérieure de 3,5 km, complétée en 20 min, sur une piste gazonnée et nivelée de 400 m. La Tc a été mesurée de manière continue avant, durant et après la course à l'aide d'un système de surveillance par télémétrie. Toutes les données ont été amassées avec succès. La Tc s'est élevée chez les chiens passant de 38,7 ± 0,3 °C pré-exercice à 40,4 ± 0,06 °C post-exercice. Alors que la température rectale est encore la méthode de prise de température standard, la prise de température par télémétrie peut offrir un moyen plus simple et plus confortable de prendre la Tc du chien à l'exercice avec une interférence humaine et mécanique minimale.

(Traduit par Docteur Serge Messier)

Introduction

Core temperature is an important physiological measurement of thermoregulatory responses to exercise and environmental stimuli. Continuous monitoring of core body temperature can be valuable because it reflects transient and dynamic changes that may not be identified when using intermittent monitoring. Telemetric monitoring is valuable because it requires minimal human contact and can be used when interaction with the subject is not possible, such as when dogs are in constant movement and cannot be stopped to sample data.

Continuous monitoring of rectal temperature in exercising dogs can sometimes be difficult and invasive and often requires a wire connection for continuous monitoring between the sensor and recording device (1,2). Fecal matter in the anal canal can also affect rectal temperature readings. Another alternative to measuring continuous rectal temperature is to constantly stop the dog during exercise to manually sample rectal temperatures at the desired rate. Exercising dogs with tethered rectal probes can pull the probe out either with a paw or by scraping against vegetation or a wall while running. Invasive tethered and non-tethered measurement systems may therefore be unsuitable for physiological monitoring of exercising subjects.

For these reasons, ingestible temperature sensors may be more practical for use in exercising dogs. Studies of the use of a telemetric core temperature monitor have validated its use in humans (3–9). A telemetric core temperature monitor has also been used in beef cattle, dairy cows, pigs, and poultry (1,10). The system was found to be a viable alternative to other methods, such as rectal and tympanic, of monitoring core body temperature in a research setting. Specifically, the system performed well during short-term data collection (a few hours), providing consistent data with no cabling required (10).

As heat-related illness is common in many activities of athletic and working dogs, there is a need to study core temperature and its effects on safety and performance (11–18). The purpose of this project was to evaluate the use of an ingestible temperature sensor to measure body core temperature in exercising dogs.

Materials and methods

Twenty-five healthy, unconditioned Labrador retrievers (14 males and 11 females) participated in this study. The dogs had a mean age of 17.75 ± 3.4 mo and a mean weight of 22.18 ± 1.41 kg. As part of the general detection dog fitness test, the dogs were required to conduct an outdoor 3.2-km run in 20 min on a level, 400-m grass

Veterinary Sports Medicine Program (Angle), Animal Health and Performance Program (Gillette), Canine Detection Research Institute, Auburn University College of Veterinary Medicine, Auburn University, Alabama 36849, USA.

Address all correspondence to Dr. T. Craig Angle; telephone: (334) 844-5646; fax: (334) 844-6084; e-mail: angletc@vetmed.auburn.edu

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track. Dogs were considered unconditioned if they had participated in less than 20 min of endurance exercise 3 times a week for the 4 week before the study. The nature of the project, care, and use of the dogs were approved by an Institutional Animal Care and Use Committee.

For this project, the purpose of the 3.2-km run exercise bout was to allow sampling of data during exercise. The 25 dogs were divided into 7 random gender groups of 3 to 4 dogs. Each group of dogs was fastened to a modified golf cart that was fitted with 4 steel arms extending 0.9 m away from the front and rear of the cart (perpendicular to the sagittal plane of the cart). A 90-cm bungee cord lead was attached to a harness at the end of the steel arms. The harness was similar to that used in sled dog races and was made of leather and wool for padding. Four dogs were fastened to the cart by the harnesses at 1 time so that each steel arm had 1 harness and 1 dog. The cart kept all the dogs moving at a constant pace around a level, 400-m grass track. Speed was verified by a Garmin GPS Monitor (Garmin International, Olathe, Kansas, USA) that displayed speed in km/h so that the golf cart operator could set a pace for the dogs.

The core temperature of the abdominal cavity was sampled 5 min before exercise (pre-exercise), after the completion of each lap, 1 min after exercise (post-exercise), 5 min after exercise (5 min post-exercise), and 10 min after exercise (10 min post-exercise). The dogs were not allowed to stop after each lap so that they ran the 3.2 km continuously. Core temperature was easily sampled on all 4 dogs on the cart within 20 s of completion of each lap. In addition, 9 dogs were isolated and observed for mean COR-100 gastrointestinal transit time.

Core temperature was measured using an ingestible CorTemp Disposable (single use) Temperature Sensor (COR-100; Human Technologies, St. Petersburg, Florida, USA). Each sensor weighs 2.75 g, measures 23 × 10.25 mm, is covered in a silicon-coated capsule, and has a battery life of 9 d. The COR-100 travels through the gastrointestinal system and is excreted in the fecal matter. The COR-100 contains a temperature-sensitive quartz crystal oscillator that uses near field magnetic link technology to send a wireless signal to the CorTemp Miniaturized Ambulatory Recorder (CT2000; Human Technologies) (5). The CorTemp system is FDA-approved for human use. Each CorTemp Disposable Temperature Sensor is individually calibrated at the factory and the calibration adjustment is entered into the CT2000 before use, ensuring a temperature accuracy of + 0.1°C (6). The accuracy of the CorTemp system has been tested in previous studies using heated circulated-water baths at temperatures ranging from 35°C to 45°C (1,10).

The dogs were fasted for at least 14 h prior to swallowing the sensor and water was withheld for 1 h pre-exercise. The COR-100 was administered 15 min before exercise by a veterinarian who placed the COR-100 in the back of the dog's mouth by hand. Measurements were taken from the COR-100 by a CT2000 which records Tc by receiving a signal from the COR-100 that is in the digestive tract.

The outdoor environment that the dogs were tested in was evaluated (19) using a Quest Temp° 32[e] WGBT (Quest Technologies, Oconomowoc, Wisconsin, USA). The WGBT (Wet Bulb Globe Temperature) individually measures ambient temperature (Ta), relative humidity (RH), wet bulb temperature (Twb), and global radiation (GR).

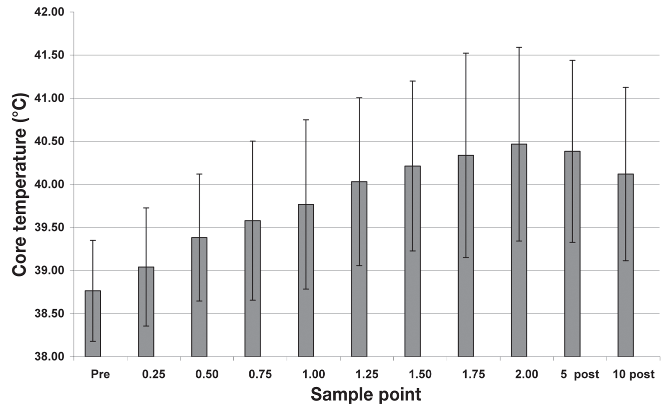

Figure 1. Core temperature during exercise. The graph illustrates core temperature (mean and standard deviation) of 25 detection dogs during a 20-min 3.2-km run. The sample points are in increments of 0.40 km and pre-exercise, 5 min post-exercise, and 10 min post-exercise samples are included.

Results

Data were successfully collected on all 25 dogs with no missing data points during the exercise. Mean and standard deviation *(s)* values for all the dogs pre-exercise, during exercise, and post-exercise are given in Figure 1. Values from the WBGT were collected and revealed a relative humidity of 63.6 ± 17%, a wet bulb temperature of 21.0 ± 3.7°C, a dry bulb temperature of 23.0 ± 3.6°C, a globe temperature of 30.3 ± 6.1°C, and a WBGT value of 23.0 ± 3.8°C. Nine dogs were isolated and observed for mean COR-100 gastrointestinal transit time, which occurred in 52 ± 20 h.

Discussion

Valuable continuous data were collected during exercise with relative ease using the described methodology and telemetric technology. The collected Tc data indicates a progressive increase in temperature from pre-exercise to post-exercise and a decrease in temperature from post-exercise to the end of the 10-min recovery period. These data illustrate the rate at which the core temperature of the dogs elevated in response to the exercise and the environment. There was an incremental increase in temperature with each sample during exercise and an incremental decrease in temperature during recovery. It does not appear that the dogs reached a steady state temperature during the 20 min of exercising. The core temperatures measured in this study while dogs were exercising are similar to rectal temperatures measured in other studies using sled dogs, greyhounds, and retrievers (13–18). Further research into conditioning status, mode of exercise, stomach temperature versus rectal temperature, and the environmental influence should be conducted in order to compare the temperatures in other studies.

The 8 data samples collected by the telemetric system during the 3.2-km run would not have been attainable with a rectal probe system unless the dogs were stopped and standing still or a tethered data logger was used. The telemetric system and the methodology used enhanced data collection by allowing Tc to be sampled without interrupting the exercising dogs.

Based on interviews with human subjects, there is better compliance to measuring protocols and subjects are more comfortable when using telemetric capsules than rectal probes (4). Telemetric core temperature monitors may prove to be a more comfortable way to measure core temperature than rectal probe methodologies in exercising dogs.

The ingestible sensor technology certainly has merit for use in metabolism and pharmacology studies. It was not within the scope of this study to evaluate the effects of water, food, and fecal matter on the performance of the COR-100. Food and water were withheld prior to and during data collection in the present study to negate their unknown effects on the COR-100 (20).

Absolute body temperature, generally measured rectally, is still the standard measurement for assessing heat stress in clinical and field research. Telemetric core temperature monitors, however, may offer a more comfortable and easier means to sample core temperature with minimal human interference on the exercising dog. Because there could be a divergence between core temperature and rectal temperature, more research needs to be conducted to explore this relationship in exercising dogs. As little is understood about the effects of food, water, and fecal matter on a telemetric pill, future research needs to be conducted in this area.

While the authors of this study do not endorse the use of the CorTemp Sensor, this system provided valuable and reliable data for this particular research project.

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