Don’t get in a sweat about fever

Author : Rachel Marwood, Miguel Martinez

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ABSTRACT

Cats and dogs can maintain a narrow core body temperature range in a wide variety of environmental conditions and activity levels. A rectal temperature greater than 39.5°C is often considered elevated in the unstressed dog or cat, and clinicians need to decide if this rise in temperature is a result of hyperthermia or pyrexia due to pyrogens. Identification of the inciting factor is paramount in contemplating a treatment approach.

Thermoregulation, the balance of heat loss and gain, takes place in the CNS in the preoptic area of the anterior hypothalamus (AH).

The nervous system relays information sensed by the peripheral and central thermoreceptors to the AH.

If the core body temperature is below or above the set point of normal body temperature, the AH stimulates the body to either:

- increase heat production or conserve body temperature if the body is hypothermic (for example, shivering)
- lose heat through dissipation or behavioural changes if the body is hyperthermic (such as panting or moving to lie on a cold floor)

Table 1. Common differential diagnoses	
Hyperthermia	**True fever**
Respiratory obstruction leading to an inability to dissipate heat (laryngeal paralysis or oedema, obstruction or tracheal collapse).	Infectious disease (bacterial, viral, fungal or protozoal).
Heat stroke – inability to dissipate heat (for example, excessive environmental temperature and/or humidity).	Inflammatory disease – non-infectious (for example, pancreatitis).
Exercise-induced hyperthermia – excessive muscular activity (increased heat production).	Neoplastic disease or paraneoplastic disease.
Pathologic (for example, malignant hyperthermia) or pharmacologic (for example, hydromorphine in cats) hyperthermia.	Tissue trauma/necrosis.
Prolonged seizure activity.	Immune-mediated disease (for example, polyarthritis).

Table 1. Common differential diagnoses.

Hyperthermic patients warrant a different clinical approach from patients with pyrexia, both diagnostically and therapeutically (**Table 1**).

Hyperthermia is used to describe any increase in core body temperature above the accepted normal range for that species.

Clinically speaking, and in this article, hyperthermia is a non-febrile (non-pyrogen) increase in body temperature. It is not a result of the body attempting to raise its temperature, but pathological, pharmacological or physiological changes, which can cause heat gain to exceed heat loss and, therefore, is an abnormal inability to dissipate heat from a variety of causative factors. The organs most susceptible to damage from hyperthermia are the brain, heart, kidneys and liver.

Pyrexia or true fever (pyrogenic) is used to describe an increase in core body temperature, in which the set point in the AH has been reset to a higher temperature during the inflammatory response.

In true fever, exogenous pyrogens initiate the release of endogenous pyrogens (cytokines) from cells in the immune system, which trigger the febrile response (release of prostaglandins from the AH). This is a protective mechanism for fighting infection, for example, by slowing viral replication and increasing leukocyte function. Some neoplastic cells are also capable of producing cytokines that lead to a febrile response via stimulation of release of prostaglandins in the AH.

Clinical history and examination

At presentation, the temperature will be elevated, unless cooling measures have already been performed, in which case the temperature may be decreased or normal. Animals with heatstroke and excessive muscular activity may be dangerously hyperthermic (>41°C), and these animals will need a rapid history and cardiorespiratory assessment, and emergency treatment measures instituted immediately.

Table 2. Clinical examination	
Heart rate	Increased as a result of compensatory sinus tachycardia in hyperthermia. This mechanism is not the same in pyrexia and heart rate may be normal.
Respiratory rate	Usually very rapid to improve heat dissipation with hyperthermia, although may be normal in pyrexia.
Pulse quality	Can be variable, but are often weak if hypovolaemic.
Blood pressure	Can be hypotensive due to hypovolaemia. If hyperthermia, usually normal in pyrexia.
Head examination	Check for abscesses, dental infection and purulent nasal discharge.
Examination of respiratory system	Important to identify any abnormality that may be contributing to poor heat dissipation, such as laryngeal paralysis or oedema, obstruction or tracheal collapse. Coughing/sneezing can also be important indicators of disease.
Gastrointestinal tract	Diarrhoea can cause pyrexia.
Cardiac	Abnormalities such as heart murmurs could indicate endocarditis.
Chest	Abnormal lung sounds could indicate pneumonia (may detect aspiration pneumonia in dogs with heat-induced illness that have been vomiting) or pyothorax.
Palpation of peripheral lymph nodes	Enlargement could indicate neoplasia.
Abdominal palpation/pain	Abdominal pain (for example, generalised – peritonitis, or focal pyelonephritis).
Hindquarters	Assess for vulval discharge (pyometra), anal sac pain (abscessation), prostatic pain (prostatitis).
Orthopaedic	Joint, spinal pain, bone pain (osteomyelitis).
Special feline considerations	Disease such as FIP/FeLV or FIP should be considered.
In patients where true fever is suspected, particular attention should be paid to any history that could indicate the source of the pyrexia, such as history of foreign travel and the animal's vaccination history.	

Table 2. Clinical examination.

True hyperthermia above 41.6°C often leads to increases in cellular oxygen consumption, which exceed oxygen delivery, causing deterioration of cellular function and integrity. Temperatures less than 41°C are not usually life threatening and a proper clinical examination should precede any further therapy.

Before the consultation, it may be worth obtaining a brief history over the telephone as, in one study, owners who cooled their animals before presentation to the vet had a survival rate of 62% while those animals that were not cooled had a 39% success rate (**Table 2**).

Diagnostic investigation

Depending on the severity at presentation, it can be very useful to gain some basic laboratory results as a prognostic indicator and to help guide the therapeutic approach. A minimum database, which in the authors' experience could include haematology, biochemistry and electrolytes, is recommended.

The most important further tests and considerations in severe cases, which could be included, are:

- PCV: to identify any degree of dehydration.
- BUN: to identify poor perfusion, renal damage and renal failure should be considered.
- Blood glucose should be assessed as the animal may be hypoglycaemic, due to early sepsis, hepatic dysfunction, or increased utilisation from hyperthermia. Hypoglycaemia at presentation has been associated with a poorer outcome in sepsis.

- Sodium and potassium should be monitored. A hypernatraemia can arise from excess panting or may be altered in severe cases of renal failure, acidosis, or vomiting and diarrhoea.
- Hepatic damage as a direct result of thermal damage can cause widespread hepatic cellular necrosis. Hypoperfusion and microthrombosis from coagulation abnormalities may also contribute to hepatic dysfunction.
- Electrocardiographic evaluation and monitoring should be performed on all patients with heat-associated illness; occasionally intermittent ventricular arrhythmias may occur, which are associated with a worse clinical outcome.
- Disseminated intravascular coagulation (DIC) is a possible sequela to heatstroke. Clinical signs, such as petechiae, ecchymoses or haematemesis, haematuria or haematemesis, may suggest DIC is present. Dogs with a diagnosis of DIC, based on the above parameters, have a poorer prognosis.
- Neurological abnormalities may be present and mentation can vary from alert to comatose. Usually, depression is the most common abnormality. Some dogs may be blind when they initially present, although this may resolve over several hours. In people, heatstroke is usually defined as hyperthermia with the presence of neurological dysfunction; however, it has been shown the CNS in dogs is intrinsically resistant to thermal injury, allowing for higher core body temperatures before manifestation of CNS abnormalities.

Treatment options for hyperthermia

Table 3. Treatment options for hyperthermia

Cooling options for the hyperthermic patient – those in red = first line therapies	
Oxygen delivered by flow-by, facemask or nasal catheter techniques to help improve oxygen delivery to tissues	**Cooled or room temperature isotonic crystalloids given intravenously should be administered to help support the cardiovascular system**
Surface cooling techniques – spray alcohol over the foot pads	Internal cooling techniques
Clip fur if indicated	Rectal administration of cool isotonic fluids
Tepid water applied to the skin or whole body	Gastric lavage
Fan	Open body cavity
Peritoneal dialysis	

Table 3. Treatment options for hyperthermia.

Refer to **Table 3**.

Treatment options in cases of true fever

As part of the acute phase response, true fever may be beneficial to the host, as many studies have shown a fever can reduce duration of morbidity and mortality from many infectious diseases. Therefore, treatment modalities for pyrexic patients, such as total body cooling, may actually be counter-productive, as the patient will expend energy trying to maintain the raised core temperature, and should be reserved for afebrile hyperthermia, or if fever exceeds 41.6ºC.

In cases of true fever with unknown origin the treatment approach will depend on the severity of other signs. If an animal is quite bright and has a short, 24 hours to 48 hours history of pyrexia, empirical therapy with antipyretics could be justified.

If the patient is painful, opioids/gabapentin can be considered, but, if possible, avoiding NSAIDs is ideal as they can affect synovial fluid cell counts and give false-negative results for polyarthritis if further investigation is later warranted.

If another drug is required paracetamol could be used in dogs if pyrexia is severe, as this may have less effect on cell counts (**NOTE**: **paracetamol is poisonous to cats**). Administering glucocorticoids will also reduce a fever, but also will block the inflammatory reaction and, as such, is not recommended without trying to establish the underlying cause.

It is important to understand the mechanism for the temperature elevation, as assuming the fever is caused by an infectious agent can lead to the inappropriate use of antibiotics. Further investigations should be considered initially as described previously.

Antibiotics should be avoided if at all possible, as most cases of pyrexia of unknown origin will not have an infectious cause. Obviously, there are exceptions to this – for example, if there is a suspicion of severe sepsis (low glucose, low neutrophil count), then urine should be collected via cystocentestis, the body cavities checked for fluid and the fluid sampled if present, and blood cultures should be considered before starting the patient on antibiotics.

Conclusion

Identifying the inciting factor of the cause of the pyrexia or hyperthermia is paramount in contemplating a treatment approach.

Hyperthermic patients should be identified quickly to avoid any further potentially fatal deterioration. True fever will most probably require further investigations depending on presenting signs and clinical examination.

If an underlying disease is not identified using facilities within the practice, referral could be considered for advanced procedures such as echocardiography, joint taps, cerebrospinal fluid taps

or bone marrow biopsies.

- References are available from the authors on request.
- **This article was amended on 22 January 2016 to add a note clarifying paracetamol is poisonous to cats.**

CASE STUDY

Molly, a 10-month-old boxer has presented to the hospital with a history of acute onset lethargy. On clinical examination, Molly's temperature is 39.9°C, but you are also able to localise some cervical pain and rigidity, and a stiff gait when you eventually get her to walk.

You decide to admit Molly for further investigations and ask your nurse to take some basic in-house bloods (haematology and biochemistry) and put her in a kennel.

Later that day you go to assess Molly, and your nurse has set up a fan in front of Molly's kennel and applied ice packs to try to bring down her temperature. It has had no effect and Molly now is looking subjectively worse than at admittance this morning. In-house bloods showed Molly had a neutrophilia, otherwise bloods were unremarkable.

You are not sure at this stage whether to give NSAIDs and antibiotics given these findings.

Q: Why has this method failed to improve Molly's high temperature, and what treatment should we give?

A: In this case, Molly's high temperature is due to a protective mechanism employed by the body, as a result of an inflammatory process. Further testing revealed Molly had a steroid-responsive meningitis, and so it was also important to wait for results before starting Molly on empirical therapy such as antibiotics, which would have been unnecessary in her condition.

In addition, the use of ice packs applied directly to the skin is heavily contraindicated as it will cause a peripheral vasoconstriction, which results in further elevation of core body temperature and should be avoided at all costs.
More importantly, it will make Molly more uncomfortable and cause her to start shivering to try to maintain a
high temperature.