Homeostasis Part 3: temperature regulation

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This article, part three of a four-part series on homeostasis, explores temperature regulation, the types of tools used for measurement and how an altered temperature can affect the body. Implications for nursing care and the management of patients with heat regulation disorders are also discussed.

Temperature regulation – also known as thermoregulation – is the maintenance of a particular body temperature, regardless of changes in the environment (Tortora and Grabowski, 2002). Fig 1 shows how heat is lost from the body.

Thermoregulation is a dynamic and constantly changing process, and understanding how it works is important, as is the accuracy of measurement and interpretation of body temperature (Closs, 2005).

Temperature within the body varies; in a body in homeostasis (normal health state) the ‘core’ temperature is maintained within a range of 36–37.5°C (Aun, 1997). In this state the body is said to be ‘normothermic’.

The core body temperature is set and closely regulated by the thermoregulatory centre of the hypothalamus. This comprises a group of neurons in the anterior and posterior portions, referred to as the preoptic area (Tortora and Grabowski, 2002), which works as a thermostat. The hypothalamus receives two kinds of signals: one from peripheral nerve receptors relating to external warmth/coldness; and another type from receptors that measure the temperature of the blood around the hypothalamus (Tortora and Grabowski, 2002).

When blood temperature increases or falls, the regulatory responses are triggered and the neurons in the preoptic area will increase or decrease the production of impulses (respectively) to adjust and regulate the normal body temperature (Cuddy, 2004). The balance between heat loss and heat production is regulated by a complicated and sensitive feedback system based on three necessary components:

- A receptor – the skin and hypothalamus;
- A control centre – the brain;
- An effector – a correct response, in this case a rise or a fall in body temperature.

When body temperature rises, the receptors in the skin and the hypothalamus sense a change, triggering a command from the control centre (brain). This command (an effector) effects the correct response – for example, increased sweating through the skin (the sweat vaporises and cools the body), vasodilation (blood diverted to skin to lose heat), skin hairs lowered, and a reduced metabolic rate. All of these responses will cause a decrease in body temperature (Cuddy, 2004).
Temperature monitoring
Clinical temperature monitoring is a vital part of nursing care. A person’s body temperature is an important indication of health or illness, and can often be a deciding factor in the implementation of treatment (Khorshid et al, 2005). Measuring body temperature will identify if the patient is normothermic, hyperthermic or hypothermic.

Temperature can be measured at a number of different sites, using different tools for measurement. When assessing body temperature it is important to consider the methods and the tool used for measurement. It is the nurse’s responsibility to ensure the thermometers are used correctly.

The normal body temperature in adult men and women alters according to the method used. The range for tympanic temperature is 35.4–37.8°C, while the range for axillary temperature is 35.5–37.0°C (Khorshid et al, 2005).

- **Tympanic temperature**: A probe is inserted into the auditory canal to measure the tympanic membrane temperature (Khorshid et al, 2005).
- **Axillary temperature**: There is a wide range of temperatures possible when taking an axillary measurement. This prevents the identification of a single figure that could be considered the ‘normal’ axillary temperature (Joanna Briggs Institute, 2004).
- **Oral temperature**: Although seen as the traditional method of temperature monitoring, different areas of the mouth can give higher recorded temperatures. However, no study has reported a clinically significant effect (Joanna Briggs Institute, 2004).
- **Rectal temperature**: Many studies have compared the different methods of temperature measurement, and commonly rectal temperatures are used as the standard comparison (Joanna Briggs Institute, 2004). Issues associated with rectal temperatures (especially in children) are rectal perforation and broken or retained thermometers. In response to this problem, axillary temperature measurements have been recommended in preference to the rectal measurements (Joanna Briggs Institute, 2004). With the advent of tympanic thermometers, these complications are likely to become less common.

Hyperthermia
Hyperthermia is defined as a core temperature of 35°C or less and is frequently undiagnosed (Aun, 1997). Hyperthermia may be classified as mild (32–35°C), moderate (28–32°C) and severe (less than 28°C) (Cuddy, 2004). It can occur in all ages and climates, but is most commonly due to exposure, hypoglycaemia and depressant drugs including alcohol (Aun, 1997).

Medical therapeutic hyperthermia is used for neuroprotection during coronary artery bypass surgery, cerebral aneurysm surgeries, treatment for acute brain injuries (Olson, 2005) and post cardiac arrest. Elevated temperatures increase the metabolic demands of the brain, which exacerbates problems in patients with acute brain injuries. Neurologically impaired patients are often unable to regulate their own temperature and, although an elevated temperature may not pose problems alone, nurse intervention and treatment to decrease the temperature is necessary to prevent secondary brain injury (Thompson, 2005).

Induced hyperthermia to a core temperature of 32°C can be beneficial, but lowering the temperature below this results in increased complications such as arrhythmias, coagulopathy, increased infection, cardiovascular instability, hyperglycaemia and electrolyte imbalances with an increased mortality and morbidity (Cerada and Maccioli, 2004). When the body temperature falls below 30°C, thermoregulation begins to fail (Aun, 1997).

Dependent upon the severity of hyperthermia different methods of warming apply. Active external rewarming is recommended when a patient has a core temperature of 34–36°C (Snyder, 2005). This may be achieved with the use of a fluid-circulating heat blanket, heated blankets, warmed infusions and forced air such as a bear hugger.

Core rewarming is recommended for a temperature of less than 30°C (Snyder, 2005), using inhaled warm humid oxygen, warmed gastric, colonic, mediastinal or peritoneal lavage, and or extracorporeal rewarming with cardiopulmonary bypass or haemodialysis (Snyder, 2005).

A raised body temperature is also strongly associated with a poorer outcome. For example, a mild increase in body temperature by 0.5°C in stroke patients can lead to a significantly poorer outcome than a normothermic patient (Olson, 2005). An increase in body temperature post cardiac arrest is also associated with a poor neurological outcome.

Since elevated temperature may be reflective of an infection, healthcare teams need to ensure that they maintain a high level of hospital hygiene, including handwashing, the use of personal protective equipment and the safe use and disposal of sharps, to reduce the infection risk to patients.

**REFERENCES**


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