TEMPERATURE REGULATION


The temperature regulation pathway can be divided into 3 phases; afferent input, central control, and efferent responses.

In the afferent input phase information is collected from thermally sensitive cells throughout the body. These cells are divided into warm and cold receptors. The skin surface, hypothalamus, spinal cord, and deep abdominal and thoracic tissues contribute to the total temperature input to the central regulatory system.

Temperature is regulated mostly by the hypothalamus. However, most of the input is “pre-processed” in the spinal cord and other parts of the CNS. It has been seen in animal models that the spinal cord alone can provide, at least some, thermoregulatory response alone.

Temperature thresholds are highly variable on a daily basis and between the sexes. Temperature thresholds are also altered by food intake, exercise, infection, thyroid disturbances, alcohol, sedatives, nicotine, and anesthetic drugs. Central regulation is intact in infants, but is impaired in the elderly and in extremely ill patients.

After receiving information from afferent inputs, the CNS then reacts by producing an efferent response. Efferent responses consist of mechanisms that increase metabolic heat production or alter environmental heat loss. Each thermoregulatory effector has its own specific threshold. It is for this reason that there is an orderly progression of responses and response intensity in proportion to need. An example of this is vasoconstriction, which is energy efficient, is maximized before the more metabolically demanding response of shivering is initiated.

Efferent responses consist of cutaneous vasoconstriction, nonshivering thermogenesis, shivering, sweating, and active vasodilation.

Cutaneous vasoconstriction is the most commonly used mechanism because heat is mostly lost via conduction and radiation from the skin surface. Vasoconstriction minimizes this loss.

Nonshivering thermogenesis increases metabolic heat production without producing mechanical work. It doubles heat production in infants, but only slightly in adults. Skeletal muscle and brown fat are the major sources.

Sustained shivering increases metabolic heat production by only 50-100% in adults (in contrast to exercise, which can produce a 500% increase). Newborn infants are unable to shiver.

Sweating is mediated by postganglionic cholinergic nerves and is very effective. Therefore, sweating is prevented by nerve block and atropine administration. Athletes can sweat as much as 2L/hr and even non-athletes can sweat up to 1L/hr. Sweating is the only mechanism by which the body can dissipate heat in an environment exceeding core temperature.

Active vasodilation is mediated by an unknown factor that is released from the sweat glands. Active vasodilation requires an intact sweat gland and is inhibited by nerve blockade. Maximum cutaneous vasodilation does not occur until after maximum sweating is achieved.

