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## Thermoregulation and fever: A brief review

Saeed Ahmad and Tayyeba Rehman

### Abstract

Thermoregulation is a homeostatic mechanism that maintains the body temperature at a prime level. Fever is produced when thermoregulation is not attained due to some reasons and is characterized by elevated body temperature above the normal range, associated with increased pulse, aches, chills, tissue destructions, restlessness and other symptoms. When infectious stimuli meet the body, it increases pro-inflammatory cytokines and consequently increased production of prostaglandins that in turn stimulate hypothalamus to raise body temperature. Treatment of fever is done mainly by antipyretic drugs that could have control fever efficiently however have serious side effects. So, attempts are made to find alternative medical fields that could treat fever with least side effects.

**Keywords:** Thermoregulation, fever, antipyretic

### Introduction

#### Thermoregulation

Heat is produced as a natural byproduct of metabolism. It is constantly produced and lost to the environment. Homeostasis maintains, when the amount of heat produced and heat lost is equal. Body temperature increase or decrease when the amount of heat produced is not equal to the quantity of heat loss.

Thermoregulation is regulated by homeostasis that maintains the body temperature at a prime level. The average oral temperature of the human being is 98.2°F or 36.8 °C, but it differs among individuals. However, no one always has the same temperature throughout the day. Temperature cycle fluctuates throughout the day. It can also change according to activities and external factors <sup>[1]</sup>.

#### Normal human body temperature

The average body temperature taken internally (vaginal or rectal) is usually believed as 37.0 °C (98.6°F), and oral (below the tongue) is accepted as 36.8±0.7 °C or 98.2±1.3°F. It showed that the average body temperature of the human body depends upon the site of measurement of temperature in the body, the time of the day and the activity level of the person. There is no single digit that can denote a normal temperature in all conditions at any site of measurement. The different parts of the body show diverse temperature measurements. Temperature inside the body cavity (Rectal and vaginal temperature) is slightly higher than the oral temperature and an oral temperature is higher to some degree than skin temperature <sup>[2]</sup>.

#### Regulation of body temperature

Different feedback mechanisms regulate body temperature. All these function through temperature regulating center present in the hypothalamus. Preoptic and anterior hypothalamic nuclei of the hypothalamus control the body temperature and are main temperature controlling centers. The anterior hypothalamic preoptic area comprises of many heat sensitive and cold sensitive neurons. These neurons act as temperature sensors for maintaining temperature of body. Although hypothalamus mainly controls the body temperature, the receptors in other parts of the body also play an important role in temperature regulation. These receptors are present in the spinal cord, in the skin, in abdominal viscera, and in and around great veins <sup>[2]</sup>. Body controls the temperature via different mechanisms like sweating, shivering, and vasoconstriction, vasodilatation, etc.

#### Body response to heat

When the heat level is above the set point, hypothalamus senses it and lowers the body temperature by increasing heat loss by vasodilatation.

In vasodilation, skin vessels dilates in almost all part of the body. Vasodilation improves the heat transfer rate to the skin as eight times.

### **Sweating**

Sweating starts when the body temperature increases above normal. Body causes enough sweating to eliminate basal rate of body heat production about 10 times.

### **Body response to cold**

When the heat level is below the set point, hypothalamus senses it and increases the body temperature by different mechanisms as described below.

### **Shivering**

Cold stimulate the shivering center in the hypothalamus. Shivering causes the increase production of heat.

### **Vasoconstriction**

Vasoconstriction occurs due to the stimulation of posterior hypothalamic sympathetic center. It causes the reduction in heat loss [2].

### **Fever**

Fever or pyrexia is a complex physiologic process that is characterized by elevated body temperature above the normal range, associated with increased pulse, aches, chills, tissue destructions, restlessness and other symptoms.

### **Causes and Pathophysiology of Fever**

Fever can be caused by many factor including factors effecting the temperature-regulating center, bacterial diseases, any abnormality in the brain as brain tumors and many environmental conditions like heat stroke [2, 3]. Hypothalamus regulates body temperature, an organ present in brain. Hypothalamus maintains the body temperature at a set point, and it regulates the temperature time to time. Body maintained the temperature via several mechanisms like cutaneous vasoconstriction, increased respiration, sweating, shivering, etc.

When an infectious agent in the body, natural defense system of body activates and form the environment unsuitable for the survival of an infectious agent or damaged tissue [4]. The infectious agent or damaged tissue causes the increase synthesis of pro-inflammatory mediators, cytokines like (interleukin  $\alpha$ ,  $1\beta$ ,  $\beta$ , and TNF- $\alpha$ ). These mediators raise the formation of prostaglandin E2. The prostaglandins act on the hypothalamus to raise the body temperature [5]. Nervous feedback mechanism controls the temperature of a living body. Whenever body temperature is raised, it causes vasodilation and increase perspiration to lessen the raised temperature. When the body temperature is decreased, vasoconstriction occurs to maintain the internal body temperature. When the temperature is high as in fever, there is rapid disease progression due to increased tissue catabolism, dehydration and persisting complaints [6].

### **Treatment of Fever**

The elevated body temperature is decreased by antipyretic drugs that inhibit cyclooxygenase 2 (COX-2) expressions, so inhibiting prostaglandin synthesis. However, these synthetic antipyretic drugs inhibit the COX-2 with high selectivity. These drugs may also have toxic effects on other organs like glomeruli, the cortex of the brain, hepatic cells

and heart muscles [7, 8]. Moreover the synthetic antipyretic drugs such as aspirin, paracetamol, etc., may have noxious effects on the many organs of the body [2, 9]. However, fever should be controlled with immediate attention as it could result in serious consequences [10, 11]. Several complimentary therapies like Homeopathy can also control fever when applied according to its philosophy and principles [12-14].

### **Consequences of fever**

Due to increased metabolism during fever, increased production of heat occurs and this causes the faster breakdown of protein. There is increased formation of acids and reduced production of urine due to the disturbed metabolism of carbohydrate and fats during fever. Some toxins and bacteria can also causes some alteration in blood cells. Continuous fever causes body weakness. Emaciations occur due to the destruction of proteins. Stores of fats and glycogen are decreased. There is fluid and electrolyte imbalance, weight loss and circulatory overload arrhythmias [15, 16].

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