Hypothalamic regulation of temperature:

The core temperature of the body is regulated primarily by negative feed back mechanisms operating chiefly through a temperature-sensitive area in the anterior hypothalamus.

Heat sensitive neurons located in the preoptic area increase their output as the temperature of the blood perfusing them increases. When the temperature decreases, the rates of discharge decrease. Impulses from preoptic area radiate to various other portions of the hypothalamus to control either heat production or heat loss.

A mere 0.01°C rise in hypothalamic temperature is sufficient to increase the dissipation of heat through sweating by 6 ml sweat per hour and to raise the blood flow through the skin by 1.5 ml/min *(Manery, 1979)*.

Some studies suggested that in addition to temperature receptors located in the skin and temperature sensitive neurons in the hypothalamus. There are "core" receptors also located deep within the body *(Hardy, 1972)*. Apparently the hypothalamus integrates the sensory information from all these sources and is also influenced by circulatory pyrogens and monoamines. The manner in which this integration is accomplished is unknown.

Stitt et al. (1974) and *Manery (1979)* conducted that little detailed attention will be given to mechanisms of heat production

Heat and Skin Disorders

Essay

Submitted For Partial Fulfilment of Master
Degree In Dermatology & Venerology

By

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بسم الله الرحمن الرحيم

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Shams Eldin Abdel Hafez

To

All My Family

Contents

INTRODUCTION

Introduction

Human skin is a natural target for both the beneficial and harmful effects of solar radiations, from the infrared to ultraviolet radiation, from heat and light to sunburns and carcinogenesis *(Barbara, 1990)*.

One main role of the skin is in thermoregulation, where cutaneous blood flow and hence skin temperature, vary widely in order to help preserve core body temperature. Several features make the cutaneous circulatory system well suited for its role in thermoregulation. Arteriovenous anastomoses are abundant in acral areas and allow a large volume of blood to pass through the skin. This results in a rise in skin temperature, with resultant heat loss. In addition, the parallel arrangement of large arteries and veins in the limbs allow counter current exchange of heat. Vaso-constriction results in shunting of blood from the superficial to the deep Venous system, and heat is transferred from arteries to veins. Thus, the blood going to the limbs is precooled and less heat is lost to the environment *(Page et al., 1988)*.

Change in temperature of perfusing blood are detected by neurons in the preoptic area of the hypothalamus. Also receptors for warmth in the skin play a secondary role.

These signals are integrated in the posterior hypothalamus where appropriate heat generating or dissipating mechanisms are put into effect.

When core temperature rises in a hot environment, inhibition of sympathetic output occurs, resulting in cutaneous vasodilatation. Cutaneous blood flow may reach 3000 ml/min, skin temperature rises and heat is lost in addition, sweating is initiated to aid in heat loss *(Ross, 1978 and Scheuplein, 1987)*.

In addition to physiologic response to extreme temperatures, abnormal reactions to heat may occur.

Burns result from exposure to extremes of heat. The lowest temperature at which a burn can occur is 44°C *(Zalar et al., 1985)*.

Prolonged exposure to moderate degree of heat can cause erythema ab igne and skin cancers. Also heat plays a direct role in some of physical urticarias such as cholinergic urticaria (generalized heat urticaria) and localized heat urticaria. Cholinergic urticaria is not triggered only by heat but also by exercise and emotions.

Erythermalgia is another disorder that might result from an increase in local skin temperature. Also exposure to heat source stimulates sweating which may induce sweat gland obstruction resulting in prickly heat and other sweat gland disorders.

Aim of the Work:

It is essential to review the effect of exposure to heat on the skin.

Temperature Regulation

Temperature Regulation

In the body, heat is produced by muscular exercise, assimilation of food, and all the vital processes that contribute to the basal metabolic rate.

It is lost from the body by radiation, conduction, and vaporization of water in the respiratory passages and from the skin. Small amounts of heat are also removed in the urine and feces. The balance between heat production and heat loss determines the body temperature. Because the speed of chemical reactions varies with the temperature, and because the enzyme systems of the body have narrow temperature ranges in which their function is optimal, normal body function depends upon a relatively constant body temperature *(Ganong, 1983)*.

"Normal" body temperature:

Most tissues and organs of the human function best when they are maintained at a relatively constant temperature near 37°. The usual range of rectal temperature is 37 ± 1°C but it is often a degree or two less in the morning and can increase several degrees after heavy exercise. Between environmental extremes of 15°C (60°F) and 54°C (130°F), the nude body is capable of maintaining indefinitely a normal body "Core" temperature very close to 37°C (98.6°F) *(Hammel, 1968)*.

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This is the temperature of the central organs of the body such as heart, lungs, abdominal viscera and the brain.

For clinical or experimental purposes the temperatures most often recorded are those of the rectum, mouth and axilla. Rectal temperatures are usually about 0.65°C (1.2°F) higher than the others, and there are variations of 0.1°C to 0.9°C depending on the placement of the instrument *(Hardy, 1980)*.

The temperature of the peripheral tissues (e.g. skin, muscles and subcutaneous tissues) are generally cooler than the visceral temperatures and are subjected to much wider fluctuations. The body surface temperature varies over different parts of the skin but normally lie between that of the body core and that of the surroundings, although rapid evaporation of sweat can lower it below both. Alcohol produces an elevation in skin temperature but a lowering of internal temperature. Smoking decreases skin temperature of the extremities from 2° to 7°C but removal of nicotine from cigarettes almost completely abolishes this fall. Skin temperature may fluctuate between 20° and 40°C without damage. However, prolonged exposures to cold or hot environments, causing local skin temperature as low as 18°C as or high as 45°C are usually associated with body pain and injury *(Scheuplein, 1987)*.

Thermal balance:

The core temperature is maintained by the balance between heat production and heat loss. When environmental thermal stress changes, heat production and heat loss are transiently out of balance and heat is added or lost to the body.

Approximately 58 Kcal are required to raise the temperature of a 70 kg adult by 1°C. Metabolic heat reaching the skin surface is transferred to the environment by radiation, conduction, convection and/or evaporation. Exchange by these processes depends not only on the physical conditions of the environments, temperature and humidity, but also on two physical conditions of the skin, its temperature and its wetness due to sweating *(Gagge et al., 1977)*.

Heat production:

As the energy foods are oxidized in metabolizing tissues, large amounts of energy are released. This is not thermal energy but chemical energy of higher quantity it is used to do muscular work, to concentrate solutes for glandular secretion, to maintain membrane potential, to transmit nerve impulses and for cellular synthesis.

But eventually most of this energy (at least 95 percent of the 3000 Kcal or so produced each day in humans) is degraded into random thermal vibrations and appears as heat. This heat is initially concentrated in the metabolic active tissues in the brain, in