Therapeutic hypothermia

Essay

Submitted for partial fulfillment of master degree in **Anesthesia**

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LIST OF CONTENTS

LIST TABLES

LIST OF FIGURES

INTRODUCTION

Hypothermia is the accidental or intentional reduction of core body temperature below 36˚c ***(Kenley, 1999)***.

Normally, the body's core temperature represents a homeostatic balance between heat generation due to metabolic processes and the loss of heat through conduction, convection, evaporation, respiration and radiation. ***(Wong,1983)***

Intentional hypothermia is the decrease in core temperature that's induced for various surgical and therapeutic purposes.

The use of therapeutic hypothermia for a variety of therapeutic purposes has a long and erratic history. Ancient Egyptian treated high fevers; Hippocrates recommended the use of topical cooling to stop bleeding. Fay used cooling of the extremities for patients with tumors in the 1930s. it wasn't until 1950s,when the effects of hypothermia on systemic oxygen metabolism become better defined, that Systemic hypothermia become a commonly used modality particularly for cardiothoracic and neurological surgeries.***(Mackensen et al.,2009)***

The late Dr. Peter Safar and his colleague, the late Dr. Hurbert Rosomoff, played an instrumental role in the use of therapeutic hypothermia in the early 1960s in patients with acute neurological insults, ***(Mackensen et al., 2009)***.

Today, intentional hypothermia is primary employed during heart surgery. it also used in other procedures such as transplant surgeries, and is being used to treat devastating conditions such as

spinal cord injury. for over 50 years, this procedure has been used to preserve organs for transplant surgeries, from about 6 up to 48 hours, also it's used for a variety of insults, most of which have tissue ischemia as major component as cardiac arrest ,head trauma, asphyxiation, and stroke.

Hypothermia has been used preoperatively as a presumptive strategy to reduce cerebral and myocardial tissue sensitivity to ischemia, ***(Insler and Sessler, 2006)***.

Different levels of hypothermia have been defined ranging in depth from mild to ultra profound but because of the numerous complications of deep and ultra profound hypothermia and difficulty to achieve and maintain these temperatures mild and moderate hypothermia are becoming more attractable alternatives. ***(Pannen, 2007)***.

Intentional hypothermia is used in medicine in both regional and total body cooling .the body's metabolic rate decreases 8% with each 1˚c reduction in core body temperature. ***(Wong, 1983)***.

Cooling techniques can be very invasive without concern about long term risks in addition; cooling is often started either before or early during the insult. for therapeutic hypothermia to be taken to clinical trials and, further, to become part of standard clinical practice ,novel cooling techniques will be needed. The optimal technique for total body cooling should be easily applied, should cool the entire organism rapidly and should carry little risk.

In addition techniques for selective brain cooling may provide the same benefits without the systemic side effects. ***(Wang H, et al., 2004)***.

Hypothermia can cause multiple detrimental effects to individual organ systems and individual as a whole. As the use of therapeutic hypothermia is further explored in a Varity of patient populations, the potential risks of hypothermia, particularly when prolonged, need to be considered.

AIM OF THE WORK

Therapeutic hypothermia, uses, techniques, and how to set benefits from it.

PHYSIOLOGY OF HYPOTHERMIA

Definition and types of hypothermia:

Hypothermia is defined as the intentional or accidental reduction of core body temperature below 36˚c ***(Kenley, 1999)***.

Hypothermia is classified as accidental or intentional, primary or secondary, and by the degree of hypothermia.

Accidental hypothermia generally results from an unanticipated exposure in an inadequately prepared person.

Intentional hypothermia is an induced state generally directed at neuroprotection after an at risk situation (as after cardiac arrest) ***(Poldman, 2009)***.

Primary hypothermia is due to environmental exposure with no underlying medical condition causing disruption of temperature regulation.

Secondary hypothermia is low body temperature resulting from a medical illness lowering the temperature set point ***(Long et al, 2005)***.

Regulation and control of body temperature:

In a healthy individual, body temperature is kept constant in a very small range between 36.5°C and 37.5°C "thermo neutral zone" despite the big differences in temperature of the surroundings and also those in physical activity. very perfect regulation of body temperature, necessary for optimal progress of

enzymatic reactions, is developed in all homoiothermic animals. It doesn't apply to poikilothermic animals ***(Epstein and Anna, 2006)***.

Normal thermoregulation involves a dynamic balance between heat production and control of heat loss, with the aim of providing a constant core temperature. This is achieved in part by adjustment of central thermo genesis, and in part by maintaining a differential temperature gradient between the body core temperature and the peripheries directly exposed to the environment, the amount of heat gained from or lost to the environment is closely and rapidly regulated in response to changing circumstances ***(Macario and Dexter, 2003)***.

Physiological factors affecting body temperature:

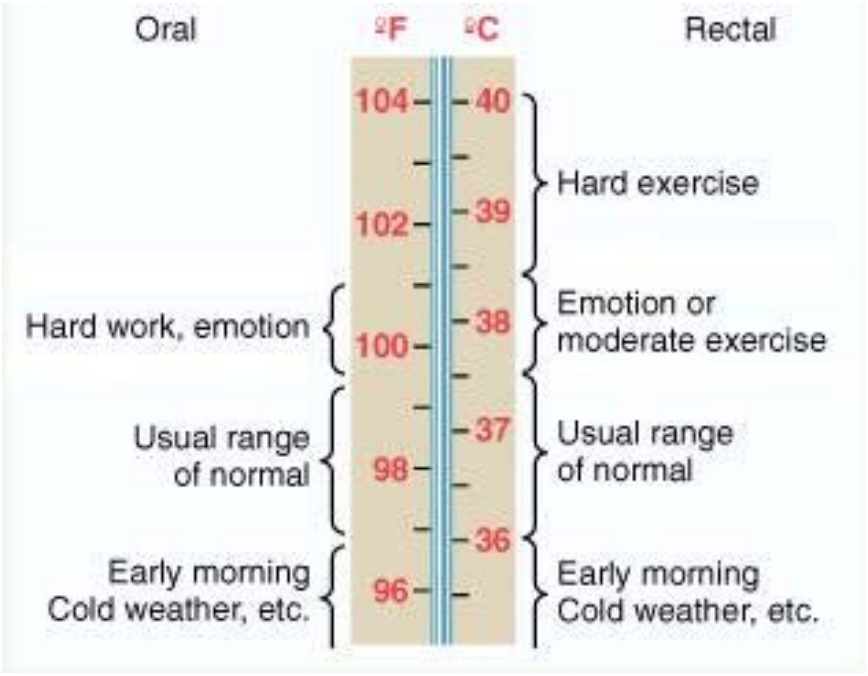

Figure 1: Physiological factors affecting body temperature, (***Guyton, 1996***).

In healthy individuals, the body temperature (oral temperature) is somewhere between 36˚c and 37˚c. It slightly increases during the day since the morning (from 6:00 a.m.),the peak reached at 6:00 to 10:00 p.m. the lowest temperature is between 2:00 and 4:00 a.m. Diurnal variations depend on the activity throughout the day. Diurnal variations don't change in persons that work at night and sleep during the day. Such a diurnal variation is also kept when fever occurs. Fever reaches the peak in the evening, and in the morning even a very sick patient may have almost normal temperature. Body temperature changes are more intensive in young person than in old people. The temperature may slightly or temporarily increase in hot environment. Physical activity may also increase the body temperature. In extreme effort, the increase may be very high. The temperature may increase slightly if vasodilatation, Hyperventilation and other compensation mechanisms fail. Small increase in temperature may occur if the surrounding temperature is lower or the jogging is done early in the morning ***(Guyton, 1996)***.

Pathological conditions affecting body temperature:

Central thermoregulatory ability can be impaired in such situations as stroke, CNS trauma, infection, tumor, or hemorrhage and in uremia. impaired control of peripheral vasculature through autonomic dysfunction can also play a part in diabetes. Reduced heat production occurs in endocrinopathies such as hypothyroidism, hypoadrenalism and hypopitutarism.

Also some pharmacological agents can cause central thermoregulatory failure for example: barbiturates, opioids, tricyclicantidepressants, and benzodiazepine.

Physiology of Normothermia:

Body temperature is the result of a balance between heat production and heat loss. Heat is a product of the body's natural metabolic processes, but as it is produced, it is also lost to the environment. Regulation of body temperature occurs through a negative feedback system in the central nervous system, primarily the hypothalamus. As a result, body temperature is maintained within normal range, ensuring a constant rate of metabolism, enhanced nervous system conduction, and optimal skeletal muscle contraction ***(Kelly et al, 2006)***.

Anatomy of hypothalamus: *(Witte and Sessler, 2002)*

It lines the wall of third ventricle, above the pituitary. It is divided into medial and lateral regions by the fornix, bundles of fiber tracts that connect the hippocampus to the mamillary bodies.

The hypothalamus is limited at the anterior by the optic chiasma and anterior commissure and at the posterior by the mamillary bodies.

The Para ventricular nucleus is of particular importance as it controls both endocrine and autonomic processes.

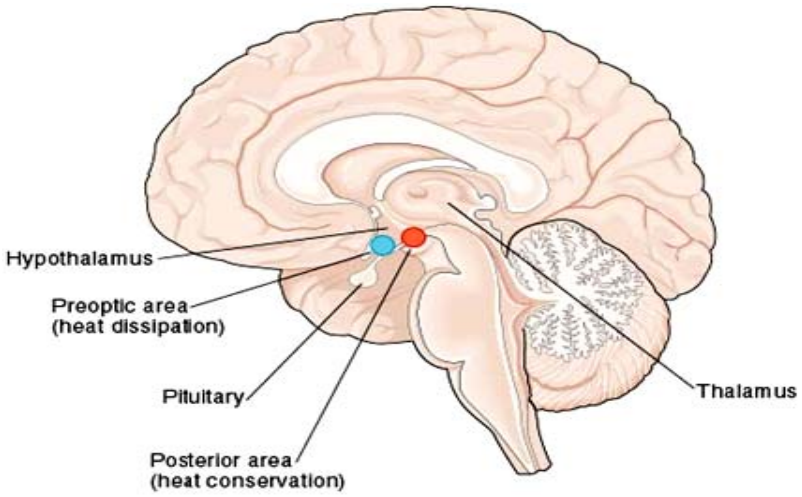

Figure 2: Anatomy of Hypothalmus (1) (***Witte and Sessler, 2002***).

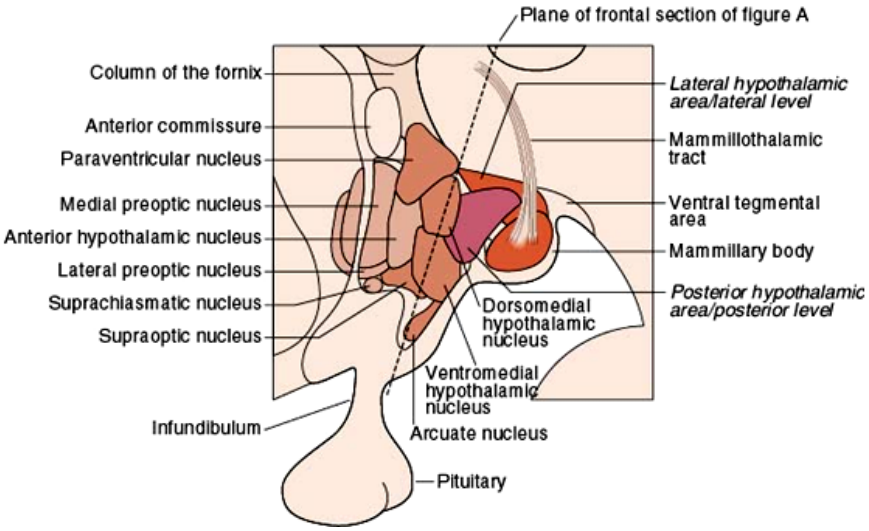

Figure 3: Anatomy of Hypothalamus (2) (***Witte and Sessler, 2002***).

Distinct regions of the hypothalamus mediating heat dissipation and heat conservation: (***Witte and Sessler, 2002***).

- A) The anterior hypothalamus (preoptic area) mediates decrease in heat.
- Lesions in anterior hypothalamus cause chronic hypothermia.
- Electrical stimulation of anterior hypothalamus causes:
  - Dilatation of blood vessels in the skin
  - Suppression of shivering,
- B) The posterior hypothalamus mediates heat conservation.
- Lesions cause: hypothermia if an animal is placed in cold environment.
- Micro stimulation of posterior hypothalamus causes:
  - Shivering
  - Constriction of blood vessels in the skin

Physiology of thermoregulation *(Guyton, 1996)*.

Control of homeostasis is achieved through feed back system-cycle of events in which the status of a body condition is continually monitored, evaluated, changed, re-monitored, re-evaluated, etc.