Post Operative Shivering in Patients Undergoing Operations Under General and Spinal Anesthesia

Essay

Submitted for Partial Fulfillment of Master Degree in Anesthesia

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2018

First of all, thanks to Allah whose magnificent help was the main factor in completing this work.

No words can express my deep sincere feelings Towards Prof. Dr. Raouf Ramzy Gadalla, Professor of Anesthesia and Intensive Care and Pain Management, Faculty of Medicine-Ain Shams University for his continuous encouragement, guidance and support he gave me throughout the whole work. It has been a great honor for me to work under his generous supervision.

I would like to express my deepest appreciation, respect and thanks to Dr. Wael Reda Hussein, Assistant Professor of Anesthesia and Intensive Care and Pain Management, Faculty of Medicine-Ain Shams University, for his continuous guide in all aspects of life beside his great science, knowledge and information.

I would like to express my deepest appreciation, respect and thanks to Dr. Mostafa Mohammed Serry, Lecturer of Anesthesia and Intensive Care and Pain Management, Faculty of Medicine-Ain Shams University, for his continuous guide in all aspects of life beside his great science, knowledge and information.

Last but not least, sincere gratitude to *My Family* for their continuous encouragement and spiritual support.

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List of Abbreviations

5-HT3 : 5-hydroxytryptamine

AA : Aplastic anemia

BAT : Brown adipose tissue

BMR : Basal metabolic rate

COPD : Chronic obstructive pulmonary disease

ITP : Idiopathic Thrombocytopenia Purpura

MAO : Monoamine oxidase

NMDA : N-methyl D- aspartic acid

SNS : Sympathetic nervous system

TTP : Thrombotic Thrombocytopenia Purpura

Introduction

Most patients who undergo surgery experience intraoperative and postoperative hypothermia because of misregulated body temperature due to anesthesia in the cold temperature of the operation room. Although the reported incidence of shivering varies, the incidence is estimated to be 56.07% ***(Pawar et al., 2011).***

Perioperative shivering causes patient discomfort because of severe muscle movements. It also induces elevated blood pressure and tachycardia, aggravates wound pain by stretching incision, increases intra occular pressure and increases intracranial pressure ***(Guyton, 2010).***

Shivering may also increase tissue oxygen demand by as much as 500 % and is accompanied by increase in minute ventilation and cardiac output to maintain aerobic metabolism. This eventually leads to increased oxygen consumption, increased carbon dioxide synthesis that results in an increased

pulmonary ventilation capacity and cardiac workload, and an increase in the metabolic rate by up to 400%. This may be deleterious in patient with impaired cardiovascular reserve or a limited respiratory capacity ***(Lindhal et al., 2012).***

Shivering may also interfere with the monitoring of patients by causing artifacts of Electrocardiography, blood pressure and pulse oximetry ***(Matsukawa et al., 2011).***

Regional anesthesia can be simply and quickly induced and is more advantageous than general anesthesia, because it causes fewer systemic complications. Therefore, regional anesthesia is widely used for lower abdominal and lower limb surgery .The sympathetic flow to the lower limbs and lower abdomen, is blocked. This blockage re-distributes the body heat from the core of the body to the periphery. Core temperature stimulates the thermoregulation centre in the hypothalamus to induce shivering ***(De Witte, 2012).***

Various methods have been used to prevent and treat shivering in patients who receive general or regional anesthesia. Of these, meperidine appears to be the most effective treatment agent for perioperative shivering. Other drugs like tramadol hydrochloride, ketamine, granisteron, hydrocortisone and magnesium sulfate infusion were used ***(Guedes et al., 2012)***

Aim of the Essay

This study aims to discuss major causes of intraoperative and postoperative shivering, their mechanisms and recent methods of treatment.

Thermoregulation

Introduction:

The maintenance of normothermia is an important function of the autonomic nervous system in homoeothermic mammals such as man, as cellular and tissue dysfunction become evident at even minor deviations from normal core body temperature. In man, core temperature is normally maintained within narrow limits of 36.5-37.5°C even in the presence of adverse environmental temperature, by a combination of behavioral and physiological responses ***(Guyton, 2010).***

Anesthesia abolishes behavioral mechanisms and has the potential to disrupt the physiological mechanisms of thermoregulation ***(Schmid et al., 2012).***

Physiology:

Thermoregulation is achieved by a physiological control system consisting of peripheral and central

thermoreceptors, an integrating control centre and efferent response systems which take compensatory action ***(Sessler, 2013).***

The afferent thermal input:

Afferent thermal input comes from anatomically distinct cold and warm receptors**.** The afferent thermal input may be central or peripheral ***(Hervey, 2013).***

Thermally sensitive receptors located in the skin and mucous membranes mediate thermal sensation and contribute to thermoregulatory reflexes ,Cold receptors in the skin are the major way the body protects itself against cold temperature, and afferent input from these cold receptors in the skin are transmitted to the hypothalamus**.** Although the skin contains both cold and warm receptors, there are 10 times as many cold receptors as warm receptors ***(Hervey, 2013).***

Central cold thermoreception is considerably less important than peripheral cold sensory input, but studies in patients with spinal cord transection have suggested that this thermoregulatory process becomes

active when the core temperature approaches the lower limit of its set-point range and is less sensitive than peripheral thermoreceptor. Neurons sensitive to local thermal stimuli also exist in the posterior hypothalamus, reticular formation, medulla, and spinal cord ***(Levin et al., 2014).***

The pre-optic area of the hypothalamus contains temperature- sensitive and temperature-insensitive neurones. The former may be subdivided into heat sensitive and cold sensitive neurones. The heat sensitive neurones, which predominate by four to one, increase their discharge rate in response to increased local heat and this activates heat loss mechanisms. Cold sensitive neurons conversely, increase their rate of discharge in response to cooling of the pre-optic area of the hypothalamus ***(Sessler, 2012).***

Central control mechanism:

The central control mechanism situated in the hypothalamus, determines mean body temperature by integrating thermal signals from peripheral and core

structure, and comparing mean body temperature with a pre-determined set-point temperature ***(Guyton, 2010).***

The efferent impulse:

In man, the efferent response to effect change in body heat content as required is by behavioral and autonomic means. The later involves control of cutaneous smooth vascular tone, shivering and non shivering thermogenesis when increased heat production is indicated, and sweating when heat loss is indicated ***(Lindhal et al., 2012).***

Behavioral responses are of importance in both warm and cold challenges, particularly the latter, where in man they are quantitatively more important than the autonomic mechanisms ***(Buggy and Crossley, 2012).***

The thermoregulatory responses are characterized by:

i- Altered behavior, quantitatively the most effective mechanism.

ii- A vasomotor response, consisting of vasoconstriction and piloerection in response to cold, and vasodilatation and sweating in response to heat.

iii- Shivering and increased metabolic rate ***(Buggy and Crossley, 2012).***

Heat balance:

Heat balance refers to the total amount of heat in the body ***(Cheshire, 2015).***

Heat gain:

Processes may be obligatory, that they occur without reference to thermoregulation; or facultative, that they can be manipulated by thermoregulatory

mechanisms to restore heat balance ***(Buggy and Crossley, 2012).***

Obligatory heat gain necessarily includes basal metabolic rate (BMR). It is increased in childhood, in the presence of sympathetic nervous system stimulation by fever and by hormones such as thyroxine, androgen and growth hormone. It declines with age and is reduced during sleep and malnutrition ***(Hervey, 2013).***

Facultative heat gain includes:

1- Physical exercise.

2- Shivering which can increase heat gain six folds above BMR.

3- Non shivering thermogenesis ***(Dawkins and Scopes, 2010).***

The motor center of shivering:

A motor center of shivering exists adjacent to the center in the posterior hypothalamus on which the

impulses from cold receptors impinge. It is normally inhibited by impulses from the preoptic heat- sensitive area in the anterior hypothalamus, but when the cold impulses exceed the rate at which the former may be received, this motor center for shivering becomes activated by 'spill-over' of signals and send impulses bilaterally into anterior motor neurones of the spinal cord. Initially this increases the tone of the skeletal muscles throughout the body, but when this muscle tone rises above a certain level shivering is observed. This is achieved by increasing sensitivity of skeletal muscles to stretch reflex ***(Umekawa et al., 2015).***

Non-shivering thermogenesis occurs mainly in brown adipose tissue (BAT). This subtype of adipose tissue contains large numbers of mitochondria in its cells and these are supplied by a strong sympathetic nervous system (SNS) innervation. When sympathetic stimulation occurs, oxidative metabolism of the mitochondria is stimulated but it is uncoupled to phosphorylation, so that heat is produced instead of generating the metabolic fuel, adenosine tri phosphate (ATP) ***(De Witte, 2012)***