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PERIOPERATIVE HYPOTHERMIA, PREVENTION AND MANAGEMENT TUTORIAL OF THE WEEK NUMBER 117

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The aim of this tutorial is to discuss the causes and management of hypothermia under anaesthesia. Please answer the following questions before reading the article.

- 1) What are the problems with hypothermia in theatre?
- 2) What are the mechanisms of heat loss under anaesthesia?
- 3) What are the different phases of heat loss under anaesthesia?
- 4) How can hypothermia be prevented?
- 5) How would you manage inadvertent hypothermia?

INTRODUCTION

Core temperature is one of the most closely maintained physiological parameters as enzyme systems in the body have narrow temperature ranges in which they function optimally.

The normal core temperature range of adult patients is between 36.5°C and 37.5°C and hypothermia can be defined as core body temperature less than 36°C.

Inadvertent perioperative hypothermia is a common but preventable complication. Regular measurement and recording of temperature is the key to prompt identification and its management.

CONSEQUENCES OF HYPOTHERMIA

- Increased perioperative blood loss/coagulopathy: the clotting cascade is enzymatic and platelet function is temperature dependent.
- Longer post anaesthetic recovery due to altered drug metabolism
- Postoperative shivering and increased oxygen consumption
- Thermal discomfort
- Cardiac events including myocardial ischaemia, arrhythmias
- Delayed wound healing
- Increased rates of surgical wound infection
- Longer hospital stay
- Death

CAUSES OF HYPOTHERMIA UNDER ANAESTHESIA

- Altered responses to heat loss due to anaesthesia (e.g. lack of shivering)
- Increased heat loss-environment exposure
- Cooling effect of cold anaesthetic gases and intravenous fluids
- Reduced heat production due to reduced metabolic activity

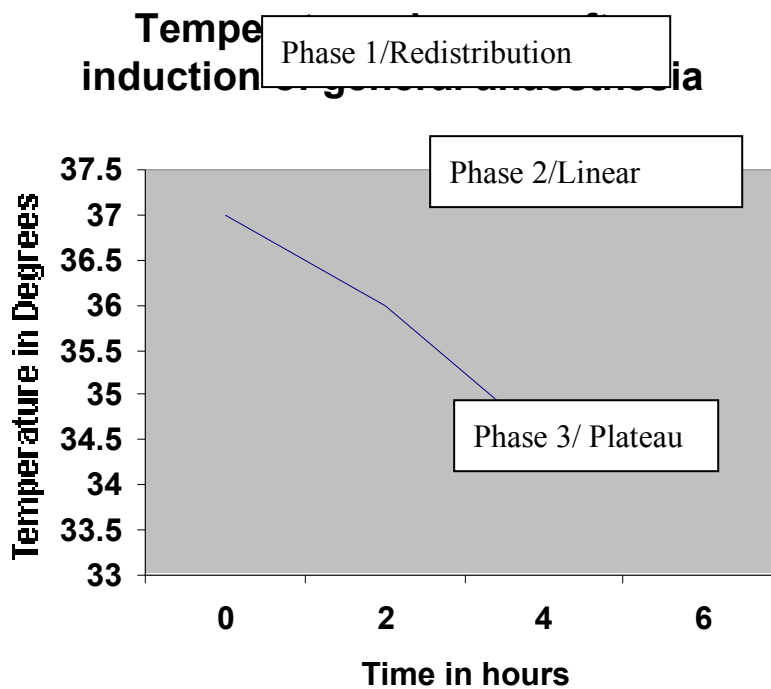


Figure 1. Temperature changes after induction of general anaesthesia

PHASE 1 / REDISTRIBUTION

This is due to vasodilatation causing redistribution of heat from core to periphery following induction of anaesthesia. Body heat content initially remains unchanged.

PHASE 2 / LINEAR PHASE

There is a more gradual reduction in core temperature of a further 1-2°C over the next 2-3hrs. This usually begins at the start of surgery as the patient is exposed to the cold cleaning fluids, and exposure to the cold theatre environment. Heat loss exceeds heat production. The various modes of heat loss are:

- **Radiation:** contributes to most of heat loss - approximately 40% and is proportional to the environment/core temperature difference (to the power of four).
- **Convection** up to 30% and is due to loss of heat to air immediately surrounding the body. It is proportional to the velocity of the air.
- **Conduction:** up to 5% and is due to heating surfaces in contact with the body such as theatre table or cold fluids.
- **Evaporation** contributes to 8-15% and occurs from cleaning fluids, skin, respiratory, bowel and wound surfaces.
- **Respiratory** 8-10% enhanced by cooling effect of cold anaesthetic gases.

PHASE 3 / PLATEAU

Once core temperature falls below the thermoregulatory threshold, peripheral vasoconstriction increases and acts to limit the heat loss from the core. When core heat production equals heat loss to the periphery, core temperature reaches a plateau. This may not be achieved in diabetics with autonomic neuropathy and impaired vasoconstriction and also during combined general and regional anaesthesia.

PREVENTION AND MANAGEMENT

High risk patients include:

- Children and elderly
- Pre-operative temperature $<36^{\circ}\text{C}$
- Combined general and regional anaesthesia
- Major or intermediate surgery
- Prolonged surgery
- Patients at risk of cardiovascular complications
- ASA 3-5 patients.

PRE-OPERATIVE

Keep the patient comfortably warm ($36.5\text{-}37.5^{\circ}\text{C}$) by providing sheets/warm clothes and by maintaining higher ambient temperature. If temperature is below 36°C commence forced air warming unless immediate surgery is imperative.

INTRA-OPERATIVE MEASURES

Maintain ambient temperature above 21°C . Cover the patient adequately with either sheets or cotton roll or any other passive insulating material. This traps air under the insulation material and may prevent heat loss by up to 30%.

Active warming using forced air warmers such as the “Bair hugger” illustrated below are devices that blow hot air into a blanket on top of the patient. It is more efficient than passive warming and prevents heat loss both by convection and radiation. These warmers must be used with the correct blankets to prevent thermal injury.



Figure 2. Forced air warming blanket



Figure 3. Intravenous fluid warmer

Use warmed irrigation fluids. Connect a blood and fluid warmer if large amounts of fluid and blood product use are anticipated. Warm and humidify Inspired gases may be warmed by using a heat and moisture exchange device.

POST OPERATIVE:

Continue to monitor temperature and use appropriate measures to prevent further heat loss and keep the patient comfortably warm. If the patient’s temperature is less than 36°C then commence forced air warming until thermally comfortable.

REFERENCES:

- 1) National Institute of Clinical Excellence inadvertent hypothermia guideline, web address <http://www.nice.org.uk/nicemedia/pdf/CG65Guidance.pdf>.
- 2) Oxford Handbook of Anaesthesia, Second edition, Pages 524-525
- 3) www.frcr.co.uk -
Web link: <http://www.frcr.co.uk/SectionContents.aspx?sectionid=167>