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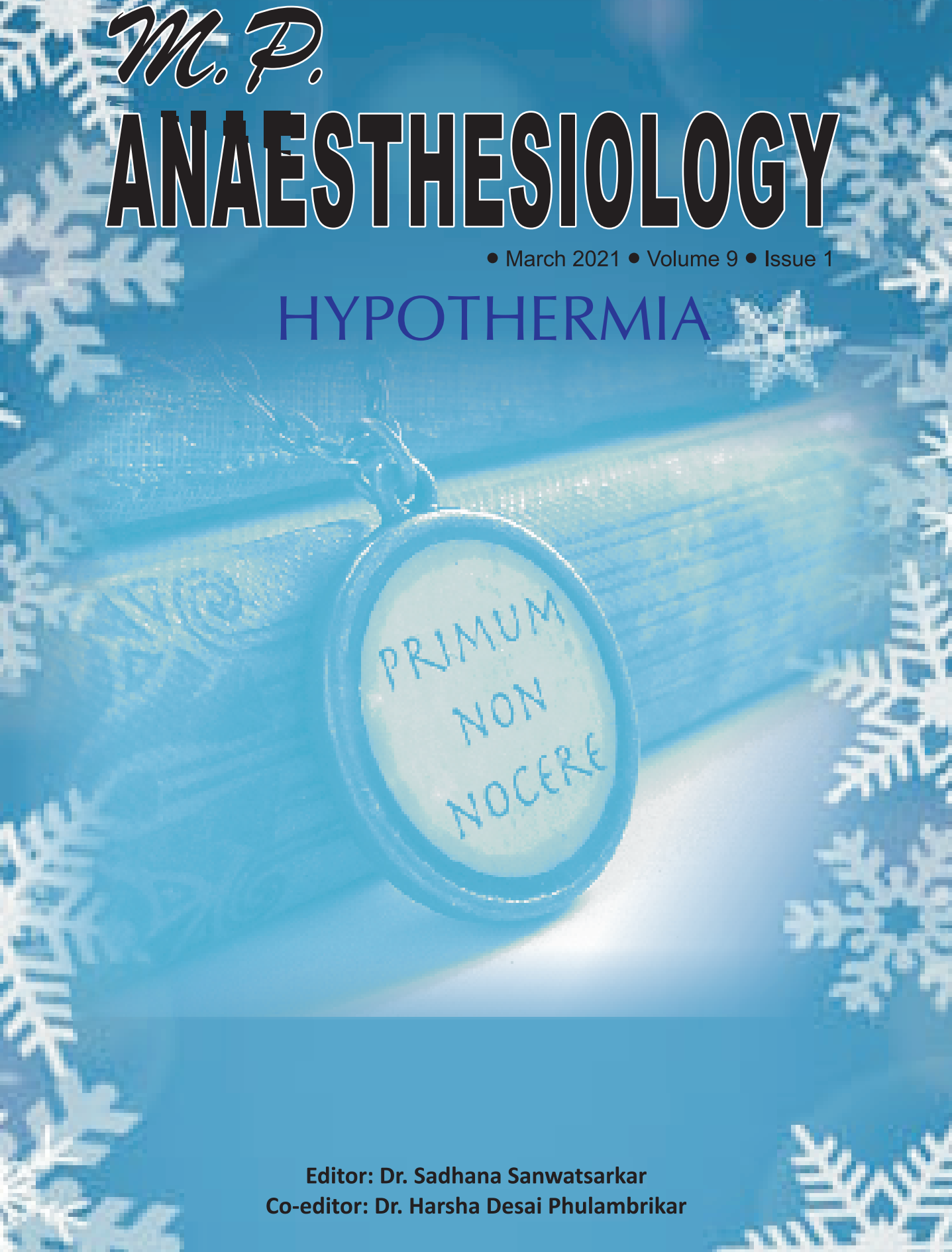
HYPOTHERMIA



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EDITORIAL

FIGHTING HEAT LOSS IN PRE-OPERATIVE PATIENTS

Hypothermia is defined as decrease in patient's core body temperature below 36.0°C. About 24%–90% of surgical patients suffer from inadvertent hypothermia. It results from anesthesia, temperature of the operating room, and the use of cold intravenous solutions and cold blood products. When anesthesia is administered, the factors increasing the risk of hypothermia are the application of a large and moderate-degree surgical intervention, inclusion in the American Society of Anesthesiologist (ASA) II–IV group, female gender, preoperative body temperature below 36°C, administration of sedation and premedication, the presence of coexisting cardiac and vascular diseases, application of combined regional and general anesthesia, age over 70 years, and systolic blood pressure above 140 mmHg.

The hypothalamus coordinates increase in heat production (no shivering thermogenesis and shivering), increases in environmental heat loss (sweating), and/or decreases in heat loss (vasoconstriction) as needed to maintain normothermia. Hypothermia occurs when heat loss exceeds production. Anesthetic-induced vasodilation initially rapidly decreases core temperature secondary to an internal redistribution of heat rather than an increased heat loss to the environment. Both general and regional anesthetics impair thermoregulation, increasing the interthreshold range; that is, the range of core temperatures over which no autonomic response to cold or warmth occurs. Preinduction skin surface warming is the only means to prevent this initial redistribution hypothermia. Forced-air warming is the most effective method of rewarming hypothermic patients intraoperatively. Clinical doses of general anesthetics decrease the threshold for response to hypothermia from approximately 37° C (normal) to 33° C to 35° C. Anesthetized patients whose core temperatures exceed these values usually are poikilothermic and do not actively respond to thermal perturbations. Patients who become sufficiently hypothermic do trigger thermoregulatory vasoconstriction, and the vasoconstriction is remarkably effective in minimizing further core hypothermia. Hypothermia also decreases triggering of malignant hyperthermia, and it reduces the severity of the syndrome, once triggered. However, most consequences of inadvertent hypothermia are harmful. Major adverse effects include morbid myocardial outcomes, reduced resistance to surgical wound infections, increased blood loss and transfusion requirement,

prolonged duration of drug action, shivering, and decreased postoperative thermal comfort. Administration of sufficient volumes of cold intravenous fluid can produce substantial hypothermia. Fluids therefore should be warmed in patients requiring intravenous administration of more than several liters per hour; however, fluid warming should always be secondary to active cutaneous warming.

Core temperature can be estimated with reasonable accuracy using oral, axillary, rectal, and bladder temperatures, except during extreme thermal perturbations

Major outcome studies have shown that mild hypothermia (˜1° C to 2° C) (1) triples the incidence of morbid cardiac outcomes, (2) triples the incidence of surgicalwound infections, (3) increases surgical blood loss andthe need for allogeneic transfusions by approximately20%, and (4) prolongs post anesthesia recovery and the duration of hospitalization.

The objectives of temperature monitoring and perioperative thermal management are to detect thermal disturbances and to maintain appropriate body temperature during anesthesia. It include:

1. Measurement of core body temperature in patients given general anesthesia for longer than 30minutes as it usually decreases 0.5° C to 1.5° C in the first 30 minutes following induction of anesthesia.
2. Temperature measurement during regional anesthesia when changes in body temperature are intended, anticipated, or suspected.
3. Unless hypothermia is specifically indicated (e.g., for protection against ischemia), efforts should be made to maintain intraoperative core temperature higher than 36° C.

● **Dr. Sadhana Sanwatsarkar**
Consultant Anaesthesiologist indore

Editor MP-ISA

THERMOREGULATION APPLIED PHYSIOLOGY

● Dr. Neetu Gupta[1]

Humans have very efficient thermoregulatory system which maintaintheir body temperature within + 0.2 0C of normal value of 370C (98.60F). Even a slightest change in body temperature results in significant changes in the cellular functions. Body temperature is maintained within this narrow range by balancing the heat production and heat loss by behavioral and autonomic responses.Heat can be transferred from a warmer object to a cooler object by one of the four physical mechanism (conduction, radiation, convection, evaporation).

Physiology of temperature regulation

Thermoregulatory system uses negative feedback mechanism to keep the core body temperature fluctuation minimal. The principal site for temperature regulation is preoptic anterior part of hypothalamus (POAH). POAH Integrates afferent signals of temperature sensors from all over the body[1].The processing and regulation of thermoregulation occurs in three stages:

1.Afferent thermal sensing

2.Central controlling

3.**Efferent response**

Afferent thermal sensing:

Anatomically distinct warm and cold receptors are present in the periphery of the body (skin, oral and genitourinary mucosa) and deep receptors are located in close proximity to great vessels, viscera, abdominal wall, brain and spinal cord.

Peripheral thermoreceptors are mainly cold sensors and responsible for cold defense (heat preservation) while central thermosensors are predominantly warm sensors[2,3,4] .Skin contains approximately 10 times more cold receptors than warm receptors5, while the deep receptors are predominantly warm receptors.All the information from these peripheral receptors are conveyed to the POAH.

POAH itself contains temperature sensitive neurons (central thermoreceptors) with the predominance of heat sensitive neurons (4 times more than cold neurons)[6]. These central receptors take over the thermoregulation once the sensory input from peripheral sensors is disrupted(central neuraxial block, spinal cord transection) but it is less efficient than peripheral thermoreceptors[7].

Central processing:

All the thermal inputs from peripheral and deep sensors are integrated and processed in the POAH and transmitted to posterior hypothalamus, which controls the efferent pathway to the effectors.

Once the threshold is reached, hypothalamus triggers the mechanism of heat generation or heat dissipation, to maintain the body temperature within inter-threshold range.

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Threshold temperature: central temperature that elicits a regulating effect to maintain normothermia

Inter-threshold range: temperature range over which no thermoregulatory responses are triggered. This range changes from 0.4°C in awake state to approximately 3.5 °C during general anaesthesia.

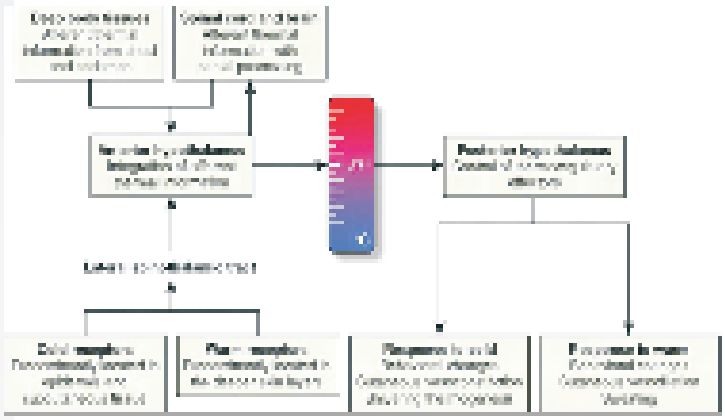

Fig: The Thermoregulatory Pathways

Efferent response:

Sensory signals of temperature from POAH are transmitted to the posterior hypothalamus from where efferent response are generated to control the heat production and heat conserving reaction of body. Efferent response to the temperature changes occurs via behavioral and autonomic mechanism.

Skin sensors senses environmental temperature and mainly triggers behavioral changes[8,9]. Contribution of thermal input from skin sensors on the thermoregulatory autonomic response is only 20%. Autonomic response mainly depends upon afferent signals from core (central) temperature sensors including brain[10,11,12].

When the body temperature goes beyond the inter-threshold range, hypothalamus triggers the appropriate temperature – decreasing or temperature – increasing mechanism.

Temperature decreasing mechanism when body is too hot;

1. Vasodilatation of skin blood vessels
2. Sweating
3. Decrease in the heat production

Temperature – increasing mechanism when body is too cold:

1. Vasoconstriction of skin blood vessels
2. Piloerection
3. Increase in thermogenesis (heat production): can be achieved by four mechanism

A. Non-shivering thermogenesis
B. Voluntary muscle activity
C. Involuntary muscle activity (shivering)
D. Dietary thermogenesis

Non-shivering thermogenesis is defined as an increase in metabolic heat production (above basal metabolic rate) not associated with muscle activity. It occurs mainly in brown fat tissue[13,14]. Non-shivering thermogenesis is a major contributor in newborn and infants whereas shivering thermogenesis is the main mechanism of heat production in older children and adults[15].

Shivering is characterized by involuntary, irregular muscular activity. It usually begins in the muscle of upper body

(commonly masseter). Itis triggered only after all other cold defense mechanisms - behavioral response, non-shivering thermogenesis (both are disabled under anaesthesia) and maximal thermoregulatory vasoconstriction – have failed to maintain body temperature within inter-threshold range[16,17]. Newborns and infants are unable to shiver because of general immaturity of musculoskeletal system and limited muscle mass.

Effect of anaesthesia on thermoregulation:

General anaesthesia interfere with thermal regulation at peripheral and central receptor sites. General anaesthesiaexpands the inter-threshold range of temperature over which no thermoregulatory response occurs. General anaesthesia lowers the threshold range to hypothermia by 2.50C while it increases the threshold range for hyperthermia by 1.30C18,19.Mild hypothermia is common during general anaesthesia due to :

1. Approximately 30% reduction in heat generation during anaesthesia[20]
2. Increased environmental exposure
3. Anaesthesia induced central inhibition of thermorgulation[21,22]
4. Redistribution of heat within the body[23]

Intraoperative hypothermia is associated with many adverse effects like delayed wound healing , increased wound infection, increased perioperative transfusion, adverse cardiac events, reoperations etc.

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TEMPERATURE MONITORING DEVICES AND WARMING DEVICES

● Dr. Nupur Chakraborty[1]

Abstract: Measuring body temperature and maintenance of normothermia is now an essential standard of care during prolonged general anaesthesia, and in patients having major operations under neuraxial anesthesia. This article will focus on methods of temperature monitoring and keeping the patient optimally warm during surgery and anesthesia.

Introduction: Temperature fluctuations have harmful physiological effects and can adversely affect patient outcome. Measuring body temperature and maintenance of normothermia is now an essential standard of care during prolonged general anaesthesia. Though temperature monitoring during neuraxial anaesthesia is not routinely practised,it should be measured in those patients prone to hypothermia,or those undergoing major abdominal surgeries.[1] Body heat content can be accurately estimated by measuring both core (deep thoracic, abdominal, and central nervous system) and mean skin temperature. Core temperature is considered to be the best single indicator of thermal status in humans.

Indications of temperature monitoring under anesthesia:

- quantification of intraoperative hypothermia (core temperature <36°C) which is the most common perioperative thermal disturbance, with an incidence of 6% to 90%.[2] Risk is higher with prolonged surgery, extremes of age, extensive burns, lower preoperative temperature, severe trauma, and major intraoperative fluid shifts.
- prevention of overheating and detection of malignant hyperthermia.

Sites for temperature monitoring:

The least invasive modality that gives a reliable assessment of core temperature is preferred. Measurements of body temperature using the tympanic membrane, nasopharynx, distal esophagus, and pulmonary artery are recommended for intraoperative use as providing the best combination of accuracy and precision.[3] Oral cavity, axilla, bladder, rectum, and skin surface can be used clinically, but they are not reliable during rapid thermal perturbations like malignant hyperthermia. Both core and mean skin-surface temperature measurements are required to determine the thermoregulatory effects of different anesthetic drugs[4] and estimate mean-body

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temperature.[5]Since the smallest difference that has been shown to be associated with hypothermia-induced complications is 0.5°C [6] it is postulated that the combined inaccuracy of a site/thermometer combination should not exceed this value.

National Institute for Clinical Excellence (NICE) guidelines define hypothermia as core temperature less than 36.0°C. They recommend temperature measurement at 1 h before induction, every 30 min intraoperatively, every 15 min in the postanesthesia care unit, and every 4 h in the ward or every 30 min, if active warming is required in the ward.[7]

Patient monitoring systems for measuring temperature:

1.Thermometers

(i) Mercury-in-glass thermometers:

- Very accurate but are slow and cumbersome .
- biohazard concerns due to spilt mercury
- useful for laboratory calibration of other systems.

(ii) Devices which are stand-alone, electronic, and continuously monitor temperature:

Electronic temperature probes for capturing data contain thermistors or thermocouples. Probes for rectal, esophageal, and nasopharyngeal measurements come in various sizes and have flexible tips. Some esophageal probes contain an audio-sensitive cuff and can be used to monitor heart and lung sounds. Thermistors are temperature-sensitive semiconductors. Thermocouple sensors consist of two dissimilar metals joined at a junction. The thermocouple generates a voltage that is proportional to the difference in temperature between the thermocouple junction (sensor) and the junction formed at the connection to the monitor. The monitor compensates for the temperature of this second junction so that it can display the temperature of the sensor, which is placed in or on the patient. Thermocouples are the most common temperature sensors. Thermocouple monitoring probes respond rapidly to temperature changes. They have the widest measurement range and are typically the least expensive but also have limited accuracy - typically ± 1-2 °F (±1 °C). Thermistors offer even more precise measurements, ± 0.1 °C or better, but have a very nonlinear response and therefore require a more advanced measurement system.

Advantages:

sufficiently accurate for clinical use and inexpensive enough to be disposable.

Disadvantages:

- signals need to be linearized by calibrated compensating units.
- Due to cross-contamination, temperature monitors may also become contaminated with various pathogens (e.g., blood, urine).

(iii)Infrared sensors: work by evaluating infrared energy that is emitted by all surfaces above absolute zero degrees.

- Can be used without actually touching the surface in question .
- accurate and relatively inexpensive.
- clinical models can measure temperature of the skin surface to within a tenth of a degree or so.
- too large to fit into the aural canal and thus cannot be relied upon to measure

tympanic membrane temperature accurately.[8]

- found to be lacking in accuracy even when used on forehead near temporal artery.[9]

Warming Devices:

1. Intravenous Fluid warmers:

Administration of 1 litre intravenous fluid at room temperature (21°C) decreases core body temperature by 0.25 °C.10 Use of fluid warmers which deliver fluid around body temperature (37 °C), has been recommended for all intra operative infusions e" 500 ml in adults.[7] Administration of warmed intravenous fluids in conjunction with standard heat conservation measures has been shown to reduce the incidence of accidental perioperative hypothermia significantly in gynaecological[11] abdominal[12] and associated complications in orthopaedic surgeries.[13] In obstetric practice, the use of intraoperative warmed fluid is also associated with significantly higher Apgar scores in the newborn infant following caesarean section.[14]

The ability of these devices to deliver heated fluid is dependent on the warming method, the flow rate and the length of tubing between warmer and patient.[15]

A number of safety concerns have been raised with the use of fluid warmers, particularly with regard to the risk of air embolus, delivery fluid contamination[16,17] and potential thermal damage to transfused blood cells. A potential problem with heating blood before administration to the patient is the risk of red cell thermal damage and haemolysis, resulting in a reduced oxygen carrying capacity and electrolyte disturbances.[18]

2. Cutaneous warming:

Cutaneous heat loss is roughly proportional to surface area throughout body

(i) Passive insulation (cotton blankets, surgical drapes, plastic sheets, space blankets) to skin surface.

- Single layer of each reduces heat loss by 30%.
- Insulation provided by layer of air trapped beneath covering.
- Amount of skin covered is more important than which surface is covered.
- Inadequate in large operations, in which active warming is required

(ii)Active warming:

- Forced air warming:

This is the most commonly tested body warming modality and is associated with significantly higher postoperative core temperatures when compared with patient control groups where no warming was used.[19] The dual benefit of transferring heat to the body and reducing radiant and convective heat losses[20] from the skin under the air warmer accounts for this finding. The surface area covered by the warming blanket also has a significant influence on forced air warming performance as greater coverage both reduces exposure and offers a larger interface for heat transfer. Current guidance advocates the use of active forced air warming as opposed to passive insulation methods for operations with an anticipated operating time of 30 min.[7]

Disadvantages:

Forced air warming systems can create significant temperature gradients within the operating room that have the potential to disrupt laminar airflow patterns[21] and

contaminate the surgical site with floor level air mobilised by convection currents.[22].

●Resistive heating

Resistive heating is a warming modality that utilizes a low voltage electric current that passes through semiconductive polymer or carbon fibre systems to generate heat. Heat transfer occurs primarily by conduction, and skin contact is achieved through either a mattress or blanket. As it is reusable, energy efficient easily cleaned and relatively silent, it has been promoted as a more cost effective and practical alternative to forced air warming.[23]

Disadvantages:

Resistive heating relies on direct skin contact to warm patients and, as a consequence, can cause significant burns if the mattress or blanket temperatures become inappropriately elevated.[24]

● Circulating water devices

Circulating water devices operate by passing heated water within mattresses, blankets or garments in contact with patients.

Disadvantages:

Every warming device has the potential to cause burns.[25, 26]

CONCLUSION:

Temperature monitoring is a recommended standard of care during anesthesia. Accidental perioperative hypothermia is associated with numerous adverse outcomes, and there are many types of warming devices available to avoid this, which need to be tailored to the individual patient.

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Importance of Perioperative Normothermia during OPCAB

● Dr. Ashwin Soni[1]

Introduction

Extensive efforts to maintain normothermia during Off-Pump CABG(OPCAB) are both required and rewarding,more than any other surgery.It has major impact on both immediate and long term outcome.

A study over 2300 patients undergoingOPCAB, done at Newyork in 2007, revealed significant high in-hospital mortality not only in patient who had perioperative moderate/severe hypothermia,but also in patients exposed to mild hypothermia.

Perioperative hypothermia prolongs ventilation (due to decreased metabolism of drugs),prolongs recovery , increases risk of MI (due to shivering induced increasedBMR) , Coagulolopathies,wound infection (3 fold increased risk) and cardiac mortability (3 fold increased risk). Whereas Normothermia facilitates fast trackextubation& is associated with lower cardiac injuries & lower inflammatory response, resulting in better cardiac and vascular condition.

Classification	Temperature
Normothermia	36^0 C-38^0C
Mild hypothermia	C32^0 C-35^0
Moderate hypothermia	C28^0C-32.2^0 C
Severe hypothermia	<280c

Deleterious Effects Of Hypothermia

- Cardiac arrhythmias and ischemia
- Increased peripheral vascular resistance
- Left shift of the hemoglobin-oxygen saturation curve
- Reversible coagulopathy (platelet dysfunction)
- Postoperative protein catabolism and stress response
- Altered mental status
- Impaired renal function
- Decreased drug metabolism
- Poor wound healing, Increased incidence of infection

For better perioperative temperature regulation ,modern cardiac anaesthesia uses knowledge of mechanism of heat loss, physiology of thermoregulation, effect of GA and techniques of peri operative temperature monitoring and temperature control.

Mechanism of Intra operative heat loss

Mild intraoperative hypothermia is extremely common. The basic process is redistribution of core body heat to skin surface, due to vasodilation and Hypothalamic Thermoregulatory Centre depression, induced by anaesthetic drugs.

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60% heat loss occurs via Radiation(in form of infra red rays),22% by Evaporation(water vaporization) and 15% via Conduction and Convection.

There is much higher risk of hypothermia during Cardiac Surgeries because of longer duration of surgery,open thorax and exposed extremities (for vascular conduit harvesting).

Physiology of thermoregulation

Although patient's skin temperature rises and falls with surrounding temperature, the core temperature remains relatively contant (98-98.6°F) (37°C) due to a remarkable intrinsic thermoregulation system,which has central, afferent and efferent components.

1) **Afferent input** is triggered upon temperature variation, by thermal receptors present all over body, generating impulse which travels via A-delta nerve fibres (cold) and unmyelinated C-fibers (heat) to spinal cord and brain.
2) **Thermoregulatory centre** in Hypothalamus integradesafferent inputs and coordinates various efferent outputs to maintain normothermia.

Neurotransmitters involved are norepinephrine, dopamine, serotinine, acetylcholine, PGE1,etc.

Factors that alter its temperature threshold are circardianrhythm, exercise, food intake, menstruelcycle, anaesthetic and other drugs.

3) **Efferent output** from Hypothalamus regulates body temperature by altering subcutaneous blood flows, sweating, skeletal muscle tone and over all metabolic activity. Heat loss is promoted by vasodilation and sweating ,while heat is conserved by theirinhibition. Thermogenesis is promoted by shivering and increasing BMR.

Effect of General Anaesthesia over Body Temperature

Drugs given for GA cause inadvertent hypothermia by vasodilation (which results in direct heat loss) and direct supression of Hypothalamic Thermoregulatory Centre (which impairs threshold for cold and hot response). Opioids further suppress sympathetic outflow, there by inhibiting thermo-regulatory efforts. Nitrous Oxide has much lesser and BZDs have negligible influence on thermoregulation.

Patient's body temperature declines in 3 phases after induction of GA : —

1) **Phase I (first 30 mins)-** shows maximum decline in body temperature. Heat loss in primarily through radiation, following vosadilation and lowered cold threshold.
2) **Phase II (1-3 hrs post induction) -** Core temperature reduction is at a slower rate in a linear manner because of more heat loss than production.
3) **Phase III (3hrs post induction)-** Further decline in core temperature is not significant as heat production is in equilibrium to heat loss and thermoregulatory centre also commences functioning.

Peri-operative temperature Monitoring

Body temperature monitoring is essential part of standard monitoring during GA.The best single indicator of body temperature is core temperature. Usual transducers used are thermistors

and thermocouples. Recent ones are infrared emitting monitors (aural canal thermometers) and Liquid crystal sensors(skin thermometers)

Monitoring sites

(i) Pulmonary Artery Catheter (PAC): It is Gold Standard for core temperature monitoring , but not routinely used because of invasiveness and high cost. Here, the thermistor is located at the tip of distal end of PAC.

(ii) Oesophageal temperature– It's monitoring is done using thermistor or thermocouple located over an oesophageal stethoscope. It accurately reflects coretemperature,if placed properly i.e. ,45cm from nose. It is commonly used because of ease of placement, low risk and reliable site.

(iii) Nasopharyngeal tempe- rature- It is close to brain and core temperature and measured by keeping oesophageal probe above palate.

(iv) Tympanic Membrane temp erature - It is a reliable measure of core temperature due to close proximity withcarotid artery and hypothalamus. It is measured byplacingtransducers in contact with tympanic membrane.

(v) Bladder temperature– It is Close to core temperature and is measured by attaching transducer with folys catheter.Low urine out put and lower abdomen surgeries can lead to its malfunctioning.

(vi) Rectal temperature- It is in approximation to core temperature, but may show higher temperature due to stool present in the rectum. Like bladder temperature,it fails in case of rapidly changing temperature.

(vii) Skin temperature-It is less reliable because of multiple factors affecting it under GA ,like core to peripheral redistribution.

(viii) AxillaryTemperature- It is close to core temperature if properly placed over axillary artery and patient arm is positioned by its side.

Temperature management during OPCAB

Maintaning normothermia requires extreme efforts in OPCAB surgeries because of open thorax and exposed extremities.Even the most effective clinical warmer do not prevent hypothermia during the first hr of anaesthesia.

Active thermal manipulations done to prevent hypothermia are-

(i) Airway heating and humidification- More effective in infants and children as less then 10% of heat loss is via respiratory tract .

Hygroscopic condens humidifiers and heat and moisture exchanging filters retain substantial amounts of moisture and heat within respiratory system.

(ii) Warm I/V fluids – Large amout of I/V fluid is admistrated during a OPCAB surgery. 1 litre of crystalloid solution at room temperature decreases mean body temperature by>0.250C fluid warming minimizes these losses.

(iii) Cuteneous Warming- As OT temperature is most critical factor influencing heat loss. Keeping OT

temperature more than>23°C is one way of minimizing heat loss,Which makes most OT personnel uncomfortably warm.

Passive insulation of skin surface by cotton blanket,surgical draps,plastic sheet and reflective composites reduces heat lost By 30%.

Combining passive insulation with active warming very well prevent hypothermia.Cutaneous warming alone can effectively prevent hypothermia.

Circulating water devices and forced air devices are also important systems to be considered. Circulating water mattresses are very less effective while forced air warming devices effectively maintain normothermia even during long duration surgeries.

CONCLUSION

We know that perioperative hypothermia during cardiac surgeries has significant detrimental effects including GI bleed, respiratory failure ,re-exploration , myocardial suppression, wound infection, coagulopathies, delayed recovery, etc.

Therefore temperature monitoring has to be integral part of basic peri-operative monitoring, not only during cardiac surgerybut alsofor other surgeries lasting for >1hr and for >30 mins under GA . Efforts should be made to maintain perioperative body core temperature >36°C to prevent complications and to improve quality and safety ofanaesthesia care for our patients.

HYPOTHERMIA IN GERIATRIC PATIENTS

● Dr. Mayank Massand[1]

Definition- Hypothermia s defined as low core body temperature (generally less than 35°C with more conservative perioperative threshold sof 36°C.There is no criteria of mild , moderate, or severe as the condition vary depending on the context ex trauma , environmental conditions etc .

CONDITIONS PREDISPOSING TO HYPOTHERMIA

1) EXTREMES OF AGE
2) SEPSIS
3) BURNS
4) SOME ENDOCRINE DISTURBANCES
5) INTOXICATION
6) MALNUTRTION
7) EXERTIONAL FATIGUE
8) ABDOMINAL SURGERIES
9) PROLONGED SURGERIES

As I mentioned that extremes of age are prone to hypothermia

WHY

Decreased arterial elasticity – Elevated after load if the hypothermia occurs there is further peripheral vasoconstrictiona and the muscle mass is less so the shivring is further reduced leading to load on heart and CHF .

More blood in central compartment due to peripheral vasoconstriction increased work of heart but the elderly population is having decreased resting heart rate , decreased maximal heart rate and decreased baroreceptor respone so since shivring is also less the cardiac output does not increase substantially leading to cardiac arrhythmias (atrial more) and ischemia.Early ventricular reporalisation (Osborn waves) in ECG .

TEMP less than 32oC highest incidence of cvs collapse.

Prevention is by gentle handling and and maintaining horizontal positioning .

RESPIRATORY SYSTEM

Geriatric pts have decreased alveolar surface are and increased chest wall rigidity that predisposes them to early deoxygenation.They also have reduced response to hypoxia and hyper capnia .As hypothermia ensues there is left shift of Hb & O_2 dissociation curves which leads to further acidosis as microvascular vasoconstriction occurs and there starts the vicious cycle of lactic acidosis and vasoconstriction .

NERVOUS SYSTEM

In this system there are two roles of hypothermia . Neuroprotection for CPB PTS but in pathological hypothermia there is some recipte for this systema as till 32oC they neurons remain protected there is some hallucinations , reflexs decline and there is delirium . Below 28° C

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there is LOC & complete obtundation of reflexes .

RENAL SYSTEM

Renal blood flow is increased in mild hypothermia as central blood volume increases simultaneously the ADH activity reduces resulting in dieresis .Diuresis is perisitent in hypothermia due to reduced tubular reabsorption of water. Slowly renal blood flow reduces and GFR reduces.

ELETROLYTE IMBALANCE

Hypokalemia initially followed by hperkalemia with progressive cooling .Hyponatremia later and normal sodium levels initially .

Hperglycemia due to decreased insulin sensitivity and decresed secretion

One important point as hypothermia increases the sensitivity of heart to hyperkalemia reduces .We have to be careful in blood transfusions and scoline administrations.

HEPATIC

Reduced blood flow leading to decresed clearance of lactate and lactic acidosis

Reduced pharmacological clearance of drugs leading to increased sensitivity and reduced requirements .

HAEMATOLOGIC SYSTEM

Increased blood viscosity , sludging of tissues and reduced microcirculation leads to reversible coaguopathy till a temperature of 32Oc but below that the risk is equal for both bleeding as well as coagulation depending upon liver function and platlet function . Blood products transfusion should be guided by ABG analysis and TEG values . Requirement of blood transfusion is more as due to imcreased bleeding .

As evident in geriatric pts the margin of safety is extremely low .

STAGE OF FALL OF TEMPERATURE IN GENERAL ANAESTHESIA

- Core temperature falls by 1 to 2°C in 1st hour of general anaesthesia . (REDISTRIBUTION)
- Gradual decline of temperature over next 3to 4 hrs (HEAT LOSS)
- Then a steady state phase 3 (EQUILIBRIUM) .

In geriatric pts the loss is rapid from stage one to two as protective mechanisms of metabolic heat production is hampered .

In regional anaesthesia there is a mismatch in vasodilatation resulting in hampering of protective mechanism further producing greater chances of hypothermia . Hypothalamus is not able to register temperature loss from anaesthesized dermatomes causing heat loss to be continuous and no metabolic heat production .

TEMPERATURE MONITORING

Location –

1) Where there is good tissue perfusion which promotes thermal equilibriation with other body sites
2) That is insulated from external environment or peripheral tissues which may be cooled to agreater degree than core tissues
3) As adjacent to the organ of interest ex tympanic membrane and nasopharnyx for brain

PA temperature for blood temperature. Esophageal temp as blood temperature due to proximity to centrqal circulation .

INTRAOPERATIVE CONSIDERATIONS FOR PREVENTION

Prewarming the pt with convective forced air warming blankets prevents phase one hypothermia .

Phase 2 hypothermia

1. Forced air warming blankets
2. Warm water blankets
3. Heated humidification of inspired gases
4. Warm intravenous fluids
5. Increasing ambient ot temp
6. Maintaining concentrations of inhaled anaesthetics

Invasive methods are also used but they are with complications .In some pts ECLS (Extracorporeal life support) for circulatory support and rewarming with temp less than 30°C. Rewarming guidelines

1. Temperature gradient between blood return and pt blood of greater than 10°C to avoid generation of gaseous emboli when blood is returned to the pt
2) Upper threshold of 37°C for outlet blood temp to avoid cerebral hyperthermia .

Intraoperative ABG analysis should be done to consider for electrolyte and acidic changes with each phase of rewarming

Fluid should be guided by central venous pressure in extreme hypothermia . During rewarming the urine output may fall initially due to activation of ADH.

Geriatric pts can there fore present with these challenges in terms of temp management and treatment .

HYPOTHERMIA OUTCOME

It depends on whether there is a cardiac arrest , coincidental trauma ,significant hypoxia .

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THERAPEUTIC HYPOTHERMIA

● Dr. Mayank Kulshreshtha[1]

Therapeutic hypothermia is a technique used during a patient care pathway (Surgery/ Intensive care) to protect vital organs from ischaemia and/or secondary injury. *(Lancet 2000)*

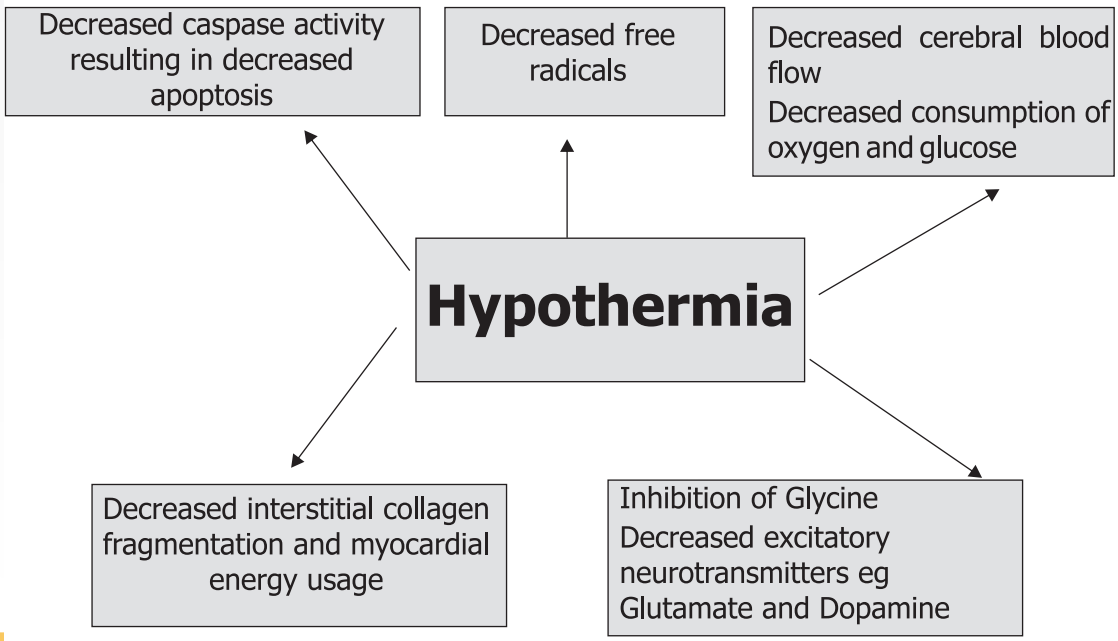
Indications

- Neuroprotection
- Coronary Artery Bypass graft Surgery
- Surgical repair of thoraco abdominal or intracranial aneurysms
- Pulmonary thromboendarterectomy
- Arterial switch operations in neonates

Physiology

Thermoregulation involves Afferent and efferent pathways with central regulation in Anterior Hypothalamus. The Afferent pathway comprises of A delta (for cold) and C fibers (for heat). Efferent response comprises of Behavioral and autonomic response

Side effects of therapeutic



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hypothermia

Cardiovascular

Increase in catecholamine may cause increased cardiac ourput but subsequently leads to Decreased cardiac output, hypotension , bradycardia and prolonged QTc interval (making patient prone for VF and VT). ECG changes include increased PR interval, wide QRS, J' waves and increased risk of AF and refractory VF.

Coagulation

Hypothermia results in impairment of coagulation cascade and prolongation of bleeding time. It has been shown to increase blood loss resulting in nearly 22% increased chances of transfusion.

[Rajgopalan S, Mascha E, Na J, Sessler DI. The effects ofmild perioperative hypothermia on blood loss and transfusion requirements. Anaesthesiology 2008; 108(1):71-7]

Infection

Hypothermia results in vasoconstriction, impaired tissue healing and impaired immune function leading to pneumonia in patients who are hypothermic for more than seven days. These changes are less common if the duration of hypothermia is less than 24hrs.

Renal

Intracellular shifting of Potassium , magnesium and Phosphate results in lowering of serum concentrations. Impaired absorption at loop of Henle results in dieresis. Hypothermia induced insulin resistance and impaired insulin release also results in hyperglycemia

Acid base

Hypothermia results in increased solubility of gases in blood. The samples can be interpreted by either adding CO2 to correct pH or without correction (pH stat/ Alpha stat)

Pharmacological

Hypothermia adversly affects hepatic clearance, plasma protein and enzymes resulting in prolonged duration of action of anaesthetic drugs including muscle relaxants and inhalational anaesthetics.

Techniques

Pharmacological: Paracetamol and Non steroidal anti inflammatory drugs

Non pharmacological: Blankets, ice packs, cold iv fluid, endovascular cooling and extracorporeal circuits

Non operative indications

Cardiac Arrest

Hypothermia after cardiac arrest *(Haca 2002)* trial looked into the benefits of hypothermia for neuro protection. The results published in NEJM showed improved survival and neurological outcomes. Later on in 2013 TTM trial showed no difference in neurological outcome of patients cooled to 33C vs 36C. The present practice in most of the units is to have 36C as target temperature.

New born hypoxic ischemic encephalopathy

HIE is a major cause of mortality and morbidity. Different RCTs have shown that there is a significant reduction in adverse outcome in newborns with intermediate abnormal amplitude EEG. Selective head cooling is a more preferred method of cooling. AHA neonatal guideline2010 have recommended therapeutic hypothermia in infants born

at> 36weeks of gestation with moderate to severe HIE.

Traumatic brain injury

EUROTHERM3235 was a large RCT which compared hypothermia to standard care in traumatic brain injury. Unfortunately increased mortalty in hypothermia group resulted in early stoppage of recruitment. A Cochrane review in 2017 also did not show any high quality evidence that hypothermia is beneficial in treatment of patients with TBI. Although therapeutic hypothermia has not been shown to effect patient outcome in TBI but it does reduce the intracranial pressure and therefore should be used as an adjunct to the ICP reducing therapy rather than a sole method. The current practice is to use therapeutic hypothermia to maintain normothermia as a part of the multi modal approach towards maintaining ICP and cerebral perfusion.

Acute ischemic stroke, intracerebral haemorrhage and Sub arachnoid haemorrhage

Most of the RCTs have not demonstrated any significant advantages of hypothermia in reducing mortality or long term morbidity in above conditions. The current expert consensus in intracerebral haemorrhage is 'managent of early fever' and 'one should consider hypothermia in comatose patients with spontaneous ICH'.

Operative indications

Every degree decrease in core body temperature decreases cerebral metabolism by 5%.Hypothermia has also been shown to induce burst suppression. There have been numerous studies demonstrating the neuroprotective effects of hypothermia during cardiac surgery. A core temperature 32-36°C results in less side effects and maximizes the neuroprotection. Deep hypothermic circulatory arrest can be used in Aortic arch repairs, tumors invading vena cava and pulmonary thromboendarterectomy.

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sadhanasanwatsarker@yahoo.com,
harshaphulambrikar@gmail.com

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