Homeothermy is defined as a pattern of temperature regulation in which the variation in core temperature is maintained within ±2 °C in spite of much larger variations in ambient temperature [1]. Maintenance of homeothermy requires both peripheral and central activity continuously monitoring body temperature changes and activating specific responses. Thermal inputs are integrated at the level of the anterior hypothalamus, which compares information coming from the peripheral tissues with a threshold value, the so-called set-point. Temperatures higher than this set point will trigger responses to cool the body, while temperatures lower than this set point will activate reflexes to warm the body [1]. These specific responses include sweating, shivering, vasodilatation or vasoconstriction, and non-shivering thermogenesis.

Both general and regional anaesthesia are known to affect the efficiency of this homeostatic system and may result in different degrees of perioperative hypothermia [2]. Major conduction blockade significantly impairs the thermoregulation of body temperature by the inhibition of vasomotor and shivering responses and by redistribution of heat from the core to the periphery [3,4]. It has been shown that after central neuraxial blockade the threshold for vasoconstriction and shivering is reduced by nearly 0.5 °C [3,4]. In addition redistribution of heat occurs during regional anaesthesia directly related to the degree of peripheral vasodilatation induced by sympathetic blockade.

Evaluating the predictors of core hypothermia in 40 patients receiving spinal anaesthesia for radical retropubic prostatectomy, Frank et al [5] demonstrated that advanced age and high-level spinal blockade are associated with a significant decrease of thermoregulatory threshold. They found a 0.15 °C decrease of core temperature for each incremental increase in block level, and 0.03 °C decrease for each increased year in age.

On the other hand, the increase of the inter-threshold range produces a delay in the activation of responses to cold, which are triggered in non-blocked regions only when core temperature is significantly reduced [2-4].

During general anaesthesia body temperature usually decreases during the first 3-4 h after induction due to redistribution of heat from the core to the periphery, until a new equilibrium is reached between heat production and heat loss [2]. Time to a new equilibrium is delayed due to inhibition of peripheral vasoconstriction and, with a central neuraxial block, core temperature progressively decreases even further [4]. This effect continues until recovery of neuronal activity in the postoperative period further delaying the recovery of normothermia after surgery if the patient is not actively warmed. Therefore patients are often discharged from the post anaesthesia care unit to the surgical ward with a core temperature still below the normal value [6].

Another factor that must be considered in patients receiving a central neuraxial blockade is that prevention and treatment of sympathetic block-induced cardiovascular effects with IV fluid administration results in significant reduction of core temperature. Frank et al [5] reported that during the initial 30-45 min after spinal anaesthesia induction core temperature decreases rapidly to more than 1 °C below the preoperative baseline value. Therefore surgery might start with the patient already hypothermic.

When general anaesthesia and neuroaxial blockade are the effects of sympathetic blockade induced by epidural blockade amplifies the negative effects of general anaesthetics drugs on temperature control making intraoperative patient warming mandatory for such procedures [7]. It has been shown that the routine use of thermal care in the perioperative period easily allows the maintenance of core temperature around 36 °C in more than two thirds of patients undergoing anaesthesia procedures, while in one third only of patients core temperature drops below 35 °C [8].

The first step in the prevention of hypothermia is the use of a proper monitoring. However body temperature is often not monitored in patients undergoing regional anaesthesia and anaesthesiologists fail to accurately estimate whether their patients are hypothermic [9,10]. This makes significant, undetected hypothermia more likely. The gold standard for core temperature monitoring should be the use of a tympanic
probe. However this may be unpleasant in awake patients. Though rectal temperature monitoring appears more accurate, axilla and forehead skin surface temperature measurement tend to underestimate true core temperature [11].

Perioperative hypothermia not only increases patient discomfort during and after surgery [12], but is also associated with significant adverse clinical outcomes, including infection, bleeding, cardiac injury and shivering, potentially leading to a longer hospital stay in hypothermic patients as compared to those maintained normothermic during the perioperative period [13-16].

Environmental temperature and humidity of course play a very important role in the maintenance of core temperature. A relative humidity of greater than 45% with an operating room temperature ranging between 21 and 24 °C is usually advised for adult patients, while for children operating room temperature should be increased up to 24-26 °C.

Passive heat retention by means of metallized plastic blanket as well as cotton blankets have been used to reflect infrared radiation, reducing heat loss during surgery. However, several studies have failed to demonstrate any significant clinical effect during both general and regional anaesthesia [7,16].

Intravenous infusion of room-air temperature fluids may significantly decrease core temperature during surgery. Thus, blood and fluid warmers have been widely employed to maintain normothermia. Three different technologies for fluid warming are usually used, dry heat, water bath and counter-current heat exchange. However, the efficiency of actively increase body temperature using fluid warmers depends not only in the efficiency of the device but also on total amount of fluid infused per hour [1].

Active warming is the only efficient method to maintain peri-operative normothermia. Forced-air warming systems seem more effective than water mattress in both adult and children [1], and will prevent severe hypothermia even during combined epidural/general anaesthesia [7]. In patients with a major neuraxial blockade the forced-air warming blankets are usually placed at the lower part of the body. However reflex skin vasoconstriction in non-blocked regions activated by the induction of neuraxial anaesthesia could potentially reduce the efficacy of forced-air warming [17]. On the other hand vasodilatation induced by sympathetic block theoretically improves the efficiency of active cutaneous warming if applied to the lower limbs involved in spinal or epidural block [18,19]. However, in patients receiving total hip replacement under combined spinal/epidural anaesthesia (CSE), forced-air cutaneous warming will maintain intraoperative normothermia even if the convective blanket is placed on a relatively small skin surface with reflex vasoconstriction such as the two upper limbs [20]. Placing the warming blanket on the vasodilatated non-operated lower limb may be troublesome to the surgeons and does not offer clinically relevant advantages in terms of warming efficiency [20].

In conclusion, patients having surgery with major neuraxial anaesthesia are at similar risk of developing perioperative hypothermia as patients receiving general anaesthesia. Prevention of intraoperative hypothermia has been widely demonstrated an important factor in improving patients’ outcome after surgery. Therefore core temperature should be monitored in patients aftercentral neuraxial anaesthesia technique for major surgical procedures. Prevention of intraoperative hypothermia should bemultifactorial, including the maintenance of an adequate operating room temperature and humidity, warming of infused fluids and blood derivates, and active forced-air cutaneous warming.
REFERENCES