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Short communication

Perioperative heat exchange in surgical patients – measurement and treatment☆

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Hypothermia is a common problem in surgical patients resulting from intraoperative heat loss due to low temperature in the operating room, high-volume fluid administration, and anesthetic-induced impairment of thermoregulatory control [1]. The initial cause of hypothermia is a redistribution of body heat from the core to the periphery followed by a slower, linear decrease in core temperature. Hypothermia occurs in 50–70% of patients during general anaesthesia and major regional anaesthesia and surgery [2].

Controlled randomized trials have proven that occurrence of mild hypothermia (34–36 °C) is associated with numerous major hypothermia-induced complications. Beside the thermal discomfort hypothermia impairs coagulation and increases intraoperative blood loss [3,4], and immune function [5], increases the incidence of surgical wound infection [6], causes postoperative shivering [7], and prolongs the duration of hospitalisation [6]. Moreover, hypothermia increases the incidence of cardiac morbidity [8].

Because hypothermia causes unwanted side-effects and a worsened outcome of critically ill surgical patients we need a better understanding of the mechanism of heat loss in the operation theatre and, consequently, more efforts for maintaining intraoperative normothermia (36.2–37.5 °C) unless therapeutic hypothermia is indicated. As mild hypothermia is common after induction of general or regional anaesthesia mechanisms to avoid heat loss or to gain heat with sophisticated devices are necessary. However, unfortunately there are only few data available regarding the efficiency of the different devices.

Perl and coworkers (see this journal) describe the mechanisms and the physical principles of heat exchange and heat transfer (convection, conduction, radiation, evaporation) and therefore mediated an understanding of the physical principles of heat exchange. They describe the possibility of measurement of heat exchange between the skin and the environment using heat flux transducers and determination of a heat exchange coefficient.

In the second part of their work, the authors describe the two principles for prevention of hypothermia in the clinical setting, i.e., insulating procedures and active warming.

Thus, the authors investigated a variety of insulating materials. They concluded, that it is impossible to avoid heat loss completely by insulation and, that most of the materials used during surgery are not highly efficient.

On the other hand, the authors describe several devices for active warming like forced air warming systems, conductive heat transfer achieved by electrical heated mattresses, or heated water mattresses, and radiative warming. The data suggest, that effective warming, especially when using these devices in combination, is possible and efficient. Nevertheless, as demonstrated in Perl's paper, there is a strong correlation between the temperature gradient (ΔT, temperature of the skin and the temperature of the environment) and measured heat flux. By increasing the temperature in the operating theatre, which is one of the most critical causes of hypothermia, heat loss determined by radiation and convection from the skin and by evaporation from the surgical incision can be reduced. Therefore, normothermia can be maintained in many cases by providing ambient temperatures >21 °C [9].

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Moreover, infusion of warm fluids using fluid warmer devices could be helpful to prevent hypothermia especially in combination with skin-surface warming [10]. Further recommendations regarding the prevention of perioperative hypothermia are low-flow delivery of anesthetic gases and the use of passive airway humidifiers in order to prevent heat loss due to evaporation [11].

In summary, the authors describe different methods and materials for preventing hypothermia. However, in the clinical setting, the anesthesist must decide which method for prevention of hypothermia may be best used for the specific clinical situation (regarding patient, surgery, operation theatre, and also the cost-benefit analysis). Insulation techniques may be an excellent approach for preventing hypothermia in head surgery, but not in patients undergoing open abdominal surgery. In case of neurosurgical operations, for example, insulation of a great surface area of the body could be sufficient for reduction of heat loss and may be also beneficial regarding the cost-benefit setting.

It is important that prevention of hypothermia should begin when the patient enters the surgical suite by maintaining a comfortable ambient temperature, by reducing radiant heat loss due to application of a blanket covering as much surface area as possible and by infusing warm fluids. Preoperative prevention of hypothermia must be continued intraoperatively as well as postoperatively by using active or passive warming devices as described by the authors. Postoperative shivering, which is uncomfortable for patients and creates a substantial metabolic cost [12], is triggered by an inverse relationship between skin temperature and core temperature. If shivering is not being prevented by normothermia intraoperatively it should be effectively treated by active cutaneous warming and intravenous or epidural drug administration. Pethidine, clonidine, sufentanil, ketanserin, and physostigmine are agents that have been proven to be effective [13–15].

Prevention and treatment of hypothermia in surgical patients may improve patient comfort and patient safety in a cost-effective manner. Moreover, in critical ill patients as well as in children it may reduce morbidity and mortality and improve patient outcome. Therefore, guidelines for preventing and treatment of hypothermia should be implemented for the majority of surgical patients.

Finally, heat exchange is not only used for prevention of hypothermia but also for induction of therapeutic hypothermia mainly for cerebral protection. Although no published human trials are currently available which support the beneficial use of mild hypothermia in surgical patients, some data suggest a trend towards improved outcome in hypothermic patients with acute subarachnoid haemorrhage [16], stroke [17] and at least in some populations of patients with severe head injury [18,19]. Moreover, hypothermia has proven to be beneficial for neurological outcome after cardiac arrest [20].

Thus, the data of Perl et al. highlight a major challenge to the anesthesiologist and provide substantial understanding in the underlying causes of hypothermia and its prevention. The present data may also basically be important regarding the induction of therapeutic hypothermia in a special population of patients.

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