TEMPERATURE MONITORING AND PERIOPERATIVE HEAT LOSS

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ABSTRACT

***Objectives**: To assess the temperature fall at various stages in the perioperative period and identification of contributing factors.*

***Material & Methods**: This observational study was carried out at Blackpool Victoria Hospital, UK from August 2005 – January 2006 on 32 patients undergoing major lower limb vascular surgery. Semi-structured data collection form was designed to record the time and tympanic temperature at different stages in perioperative period and the warming methods used.*

***Results**: A median fall of 0.1°C (0 - 0.5°C) in core temperature was recorded in ward and theatre reception area. The median fall of temperature in the anaesthetic room was 0.3°C (0-.8°C). Patients (n=16) spending more than ½ hour in the anaesthetic room had a significant (p=0.002) temperature drop recorded at 0.4°C as compared to 0.2°C for those spending less than 30 minutes. During operation, a median fall of temperature by 0.8°C (0.3 – 2.1°C) was recorded. Operations lasting for 2½ hours or more (n=16) resulted in a 1°C temperature fall as against 0.5°C for the rest. Seven patients, in whom a warming mat was used, had a temperature drop of 0.6°C compared to 0.35°C in patients who received warm touch. In the recovery unit, 23 patients had a further drop of 0.3°C, while 9 patients who were actively warmed gained 0.6°C.*

***Conclusions**: Significant heat loss occurs in the anaesthetic room relevant to the length of time consumed in anaesthetising the patient. Furthermore active warming measures in the perioperative period have a positive impact on maintaining core temperature.*

***KEY WORDS**: Perioperative hypothermia, Tympanic temperature, Anaesthesia, Prewarming, Active warming.*

INTRODUCTION

Thermal alteration manifesting as some degree of heat loss is a common sequel of a variety of surgical procedures. The body's homeostatic mechanisms normally regulate the core temperature to within a few tenths of a degree centigrade. However the temperature can fall by as much as 6 °C during anaesthesia[1] as a result of core to peripheral redistribution of heat. Other studies have shown that temp decreases by 2.8 +/- 0.5 °C after administration of general anaesthesia[2] and 1.2 +/- 0.3 °C after neuraxial anaesthesia[3]. This hypothermia activates cold defenses including arteriovenous shunt, vasoconstriction and shivering[4]. Based on the reported specific heat of humans, a 3 °C reduction in mean body temperature corresponds to a debt of approximately 175 kcal in a 70-kg patient. This is roughly the basal heat production for 3 hours[5]. Factors implicated in the aetiology of perioperative hypothermia include anaesthetic induced impairment of thermoregulatory control, a cool ambient temperature of the anaesthetic and operating room compounded by insufficient measures to combat heat loss, and factors inherent to the surgical procedure itself. A number of potentially harmful effects are unnecessarily incurred as a consequence of the changes in body physiology secondary to the inadvertent heat loss. The aim of this study was to;

1) Evaluate the temperature loss at successive stages in the perioperative period.
2) Assess the impact of various factors contributing to heat loss in this period.

MATERIAL AND METHODS

This was an observational study carried out in the surgical department of Blackpool Victoria Hospital, UK. For the purpose of our study patients of all ages and both sexes undergoing major lower limb vascular surgery over a 6 months period (August 2005 – January 2006), were included. The type of operations were limited to elective fem- pop and fem distal bypasses. Patients undergoing re-do operations and those admitted as acute emergencies were excluded from the study. Tympanic temperature was recorded noninvasively, using infrared tympanic thermometer (thermoscan LF 20). To avoid inter instrument and inter tester variations the same thermometer was used for the duration of the study, and successive readings recorded by the same individual. Reproducibility was ensured by measuring temperature of healthy volunteers (self and colleagues) before embarking on the study. The limited sensitivity of the tympanic thermometers in accurately predicting the core temperature was kept in consideration. Essence of the study therefore was estimation of the fall of temperature rather than absolute values. Ensuring the same range of ambient temperature at various stages further standardized conditions. Special data collection forms were designed to record the time & temperature at the following stages in the perioperative period;

i. Ward (before - premedication / changing into theatre gown)

ii. Reception (on arrival and departure)

iii. Anaesthetic room (on arrival and departure)

iv. Operating table (at the start and end of the operation)

v. Recovery (at the time of transfer to the ward)

vi. Various warming measures adopted at different levels were also noted.

The non-parametric Spearman rank correlation and Mann Whitney U test were used to ascertain any statistically significant difference (i.e p < 0.05%) between our observations at different stages.

RESULTS

During the 6 months of this study 32 patients (M=22, FM=10) underwent major lower limb vascular surgery for a variety of indications, under the care of two vascular consultants. Temperature loss and time spent at various stages was estimated by calculating the difference between successive observations.

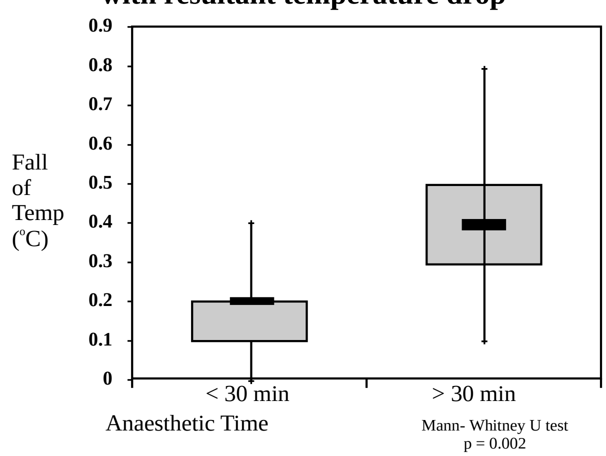
AGE DISTRIBUTION: Median age of these patients was 75 yrs (range 41- 85 yrs). Figure 1 shows the age distribution plotted against the overall fall of temperature. A trend towards a greater temperature fall is seen in the patients who were in the later decades of their life. This was statistically significant (p = 0.04 - spearman rank correlation). However, the scatter of observations suggests that factors other than age alone, affect the final outcome.

Figure 1: Fall of temperature in different age groups

WARD & RECEPTION: A median fall of 0.1 °C (range 0-0.5 °C) was recorded while the patient was waiting in the ward and theatre reception. This was calculated from the difference between the temperature recorded in the ward (before receiving any pre-medication and changing into theatre gown) and temperature taken on leaving the reception.

ANAESTHETIC ROOM: In the anaesthetic room the patients were found to loose an appreciable degree of heat, in the absence of any serious attempt to use warming measures. A median temperature loss of 0.3 °C (0-0.8 °C) was recorded in the presence of a constant ambient temperature. Interestingly half of the patients (n = 16) spent less than 30 minutes in the anaesthetic room and they had a median fall of temperature of 0.2 °C against 0.4 °C fall for patients spending more than 30 minutes (figure 2). This difference in

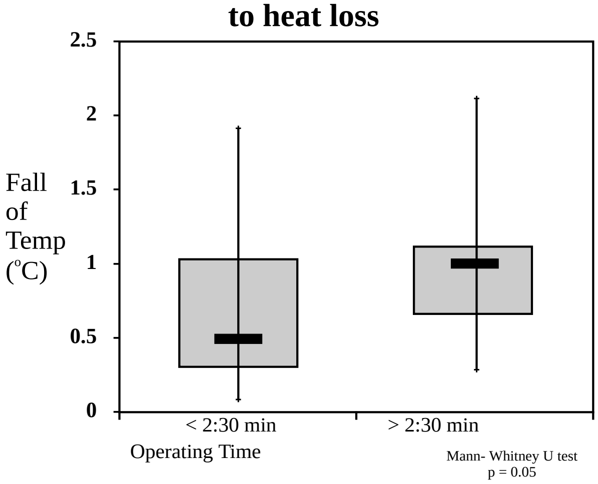
Figure 2: Time spent anaesthetising the patient with resultant temperature drop



temperature fall, related to the length of time spent in the anaesthetic room was highly significant (p = 0.002 – Mann Whitney U test).

OPERATION TABLE: Intraoperative temperature change and duration of operation were calculated from the respective readings at the start and end of the procedure. A median temperature fall of 0.8 °C (range 0.3 – 2.1 °C) was recorded at this stage. The duration of operation had some impact on the final outcome. Patients spending less than 2 ½ hours on the table, recorded a fall of 0.5 °C as against a temp fall of 1 °C for operations lasting beyond this length of time (Figure 3). Statistically this was just significant (p= 0.05 - Mann Whitney U test). There was however an obvious trend towards better heat balance being achieved secondary to the extent and type of heating measure adopted. Patients in whom warm touch was used on the table fared far better (median fall of temperature = 0.35 °C), than those using warming mat (median fall of temperature = 0.6 °C). Statistical significance of these differences could not be calculated because of the limited number of patients in each category.

Figure 3: Operating time contributing to heat loss

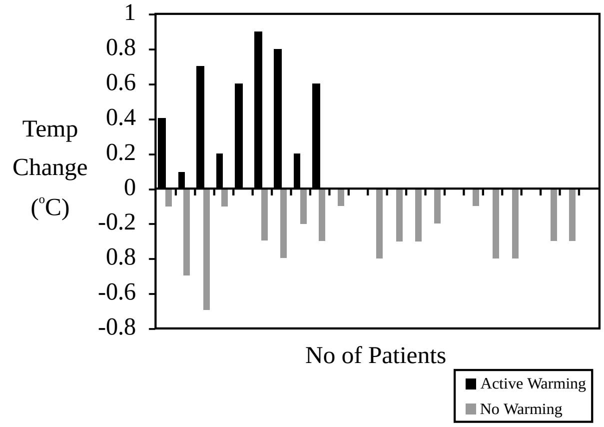


RECOVERY: In the post operative recovery unit patients who were not actively warmed (n=23) stood a further risk of becoming hypothermic with a median fall of 0.3 °C. Five patients in this group showed no change in temperature. In comparison, patients who received active warming (n=9) gained a median temperature of 0.6 °C. (Figure 4).

DISCUSSION

There is a regrowing interest in the role of anaesthesia and surgery in impairment of thermoregulatory mechanisms. Focus has mainly revolved around the core to peripheral redistribution of body heat and a net loss of heat

Figure 4: ACTIVE WARMING vs. NO WARMING AFFECTING HEAT LOSS/GAIN IN POST OPERATIVE RECOVERY UNIT



to the environment after induction of anaesthesia[2,3]. Effects of residual anaesthetic concentration in the brain obtunding the thermoregulatory mechanisms and opiods used for pain control account for a delay in return of the body temperature to normal, in the post operative period. Hypothermia once established is difficult to treat and can upset the body physiology with undesirable consequences. . These include reduced neutrophil phagocytosis and oxidative killing capacity as well as suppressed immune reactions causing wound infections, platelet dysfunction resulting in coagulation defects, elevated plasma catecholamines leading to myocardial ischemia and arrhythmias, and decreased drug metabolism.[6-8]. Prewarming by increasing the skin temperature and thereby decreasing the core to periphery redistribution of heat is an effective way of combating this inadvertent heat loss[9]. Moreover forced air warming, circulating warm garments and heating intravenous fluids are other effective ways of combating perioperative hypothermia[6].

Our study supports the observations that there is an appreciable heat loss intraoperatively and post operatively related mainly to the heating measures used. In addition however we noticed that a significant amount of heat is lost in the anaesthetic room in the absence of effective warming measures. Interestingly this temperature loss is significantly affected by the length of time spent at this stage. Adopting measures for prewarming in the anaesthetic room or even before this stage may be the only effective way of guarding against a temperature fall at later stages.

AGE DISTRIBUTION: Age and co morbid conditions have a major part to play in the overall outcome of a surgical procedure. Hypothermia can only act to compound some of the resulting ill effects. There is no convincing evidence that age per se has a major role to play in determining body heat loss, provided a reasonable ambient temperature is maintained[10]. Our observation in this regard was that while patients in the older age group do have a tendency towards greater heat loss (Figure 1), other factors (e.g the length of time spent in the anaesthetic room, the duration of operation and the type of warming method used in the theatre suite and recovery unit) which will be considered in successive stages have a part to play in determining fall of temperature in the perioperative period.

WARD & RECEPTION: Some degree of heat loss, though not appreciable sets in with the start of the patient's day for an operative procedure. The rather flimsy theatre gown and the premedication received on the ward, predisposes to this temperature fall. It is not unusual for these patients to have to wait for a prolonged length of time on the ward and in the theatre reception area in rather low ambient temperatures. Although the temperature fall may not be appreciable at this stage (0.1 °C, in our observations), this certainly pre-empts the patient to a fall of temperature in the stages to follow.

ANAESTHETIC ROOM: Patients are prone to considerable heat loss in the anaesthetic room while they are being worked up for the anaesthesia having lines (arterial, peripheral & central venous and epidural) set-up and optimised otherwise before being intubated and shifted to the operating table. With studies focussing mainly on intraoperative heat loss, the temperature lost in the anaesthetic room has usually surpassed any serious consideration. It is an established fact that treating hypothermia can be a very tiring and difficult job and the best approach to the problem is to adopt preventive measures. Prewarming is now being realized as an important part of preinduction management, and the anaesthetic room may be the best opportunity to affect any such measures. The optimal duration and temperature of pre warming is debatable but generally ½ to 1hour of skin-surface warming and a temperature of around 38 degree C is effective in preventing core hypothermia[11-13].

We recorded a median fall of 0.3 °C in our patients while they were in the anaesthetic room. In the absence of any active warming measures, time duration was found to have a significant impact on the overall temperature fall. Patients spending less than half an hour in the anaesthetic room lost.

0.2 °C as against 0.4 °C for patients who spent longer than 30 minutes. Statistically this was highly significant alluding to the importance of adapting warming measures if the patient is to spend an appreciable amount of time at this stage.

Half an hour of forced air warming which can conveniently be affected in the anaesthetic room increases the peripheral tissue heat content to more than the amount normally redistributed during the first hour of anaesthesia[14].

OPERATION TABLE: Our study fortifies the general observation that the major drop in temperature occurs intraoperatively. Studies have shown that a temp fall after General Anaesthesia follow a characteristic 3 – phase pattern. In the first hour after induction, core to peripheral redistribution of heat occurs as a result of inhibition of tonic vasoconstriction by the anaesthetic agent. This is followed over the next 2-3 hours by a linear fall of temperature determined by the balance between heat production and loss. Finally there is a plateau phase in which the temperature is maintained by the constraint of metabolic heat[6].

A median fall of 0.8 °C (range 0.3 – 2.9°C) on the operating table was recorded in our series of patients. A recent study encompassing major open and laparoscopic urological procedures fortifies our finding of a definite correlation between duration of the operation and intraoperative core temperature [15]. In addition to the duration of operation, the type of warming measure used seems to have an impact on the eventual temperature drop. In our observation, patients receiving active warming via Warm touch had a median fall of temperature of 0.3 °C, while those having a warming mat recorded a fall of 0.6 °C. This conforms with the observation that compared to routine thermal care, forced air warming (Warm touch) results in higher core temperature both intraoperatively as well as postoperatively [16,17], with a lower incidence of shivering and higher thermal comfort scores[18].

RECOVERY: Especially dedicated nursing staff is essential to any post anaesthetic recovery unit. One of their duties is to ensure that the patient's body temperature is as near normal as possible before they are transferred back to the ward. Our study concludes that active warming measures should be instituted at this level to attain a favourable temperature. Nine of our patients received warm touch in recovery resulting in a temp gain of 0.6 °C. A recent study has established the effectiveness of forced airwarming in preventing hypothermia when applied for a period ranging from 30 minutes before anaesthetic induction to 120 minutes after anaesthetic induction[19]. As a final stage in the perioperative period, it is very important to ensure here that the patient does not leave the theatre in a hypothermic state.

In summary inadvertent hypothermia in the perioperative period can occur at various stages starting with the patient dressing into an operative gown and receiving premedication & iv fluids on the ward, and progressing through exposure to low temperatures in the anaesthetic and operating room, systemic effects of the anaesthetic agent and operative procedure, and finally the environment in the post anaesthetic care unit (recovery). The anaesthetists and the nursing staff are mainly responsible for ensuring that measures are taken to keep this heat loss to a minimal level. These include pre induction skin surface warming to prevent the initial rapid redistribution hypothermia after anaesthetic administration, warm intravenous fluids and irrigating solutions, forced air warming (e.g. warm touch) and increased ambient temperatures. A review of various randomised controlled trials of cutaneous warming systems, while establishing the efficacy of these measures has stressed upon the need for assessing the costs of these competing systems[20]. Consideration to maintaining a normothermic patient through all stages of the perioperative period should however be of foremost importance, in overall patient management.

CONCLUSION

This study concluded that significant heat loss in the perioperative period experienced in the anaesthetic room and during operation is directly related to the length of time spent in these stages. Furthermore patients subjected to active warming measures demonstrate better heat conservation as against those who are not.

In light of this information any undesired practices eg unnecessary prolonged exposure of the patient in the anaesthetic room and use of ineffective warming measures intraoperatively, contributing to heat loss in the perioperative period should be avoided. Adoption of active warming measures starting at the time of anaesthetic induction and continuing into the intraoperative and recovery phase is thereby proposed.

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