Preoperative core temperatures in elective surgical patients show an unexpected skewed distribution

[Les températures centrales préopératoires affichent une distribution asymétrique inattendue chez les patients de chirurgie élective]

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Purpose: To document the preoperative core temperature of adult elective surgical patients.

Methods: A prospective audit obtained sublingual temperatures from 446 adult elective surgical patients on arrival in the preoperative holding area.

Results: Temperatures ranged from 35.7°C to 37.8°C with a mean of 36.5°C (0.4 SD). The median was 36.4°C and the mode was 36.1°C. There was a skewed distribution with a clustering of values at the lower end of the range. All recordings were within the accepted normothermic range.

Conclusion: The asymmetric distribution we observed differs from previously published normothermia data which shows a symmetrical distribution of temperatures. This skewed distribution has not previously been documented and we interpret it as being due to the effect of preoperative cooling factors.

Objectif : *Documenter la température centrale préopératoire de patients adultes en chirurgie élective.*

Méthode : *Un audit prospectif a fourni les températures sublinguales de 446 patients adultes en chirurgie élective au moment de leur arrivée à l'unité préopératoire.*

Résultats : *Les températures allaient de 35,7 °C à 37,8 °C selon une moyenne de 36,5 °C (écart type de 0,4). La médiane a été de 36,4 °C et le mode a été de 36, l °C. Il y a eu une distribution asymétrique et un regroupement des valeurs à l'extrémité inférieure de la distribution. Toutes les valeurs enregistrées se situaient à l'intérieur d'un intervalle normothermique accepté.*

Conclusion : *La distribution asymétrique observée diffère des données normothermiques publiées antérieurement et qui montraient une distribution symétrique des températures. Cette distribution asymétrique n'a pas été documentée antérieurement et nous croyons qu'elle résulte de l'effet de facteurs de refroidissement préopératoire.*

A reduction in perioperative core temperature is a very common occurrence in surgical patients. The effects of even mild intraoperative hypothermia include increased blood transfusion,[1–3] myocardial events,[4,5] wound infection[6] and prolonged hospital stay.[3,6] Intraoperative temperature changes due to anesthetic, surgical and environmental factors and the mechanisms responsible are well documented.[7–11]

If patient core temperatures are low preoperatively then this may be a contributing factor to the subsequent development of intraoperative hypothermia. However, information on preoperative patient temperature[1,4–6,12] is limited. The aim of this audit was to document the distribution of preoperative core temperatures of surgical patients.

Materials and methods

After institutional approval a prospective audit was undertaken. Sublingual temperatures were recorded preoperatively in 446 adult elective surgical patients during July and August 1999 (winter) in Christchurch Hospital, New Zealand. All data were collected between 08:00 and 16:00 on weekdays. Data collection was coordinated by the holding bay charge nurse. Recordings were obtained on 93% of elective patients in the audit period.

Temperatures were obtained with a single Welch Allyn Suretemp thermistor thermometer (Welch Allyn Inc., San Diego, U.S.A.). This thermometer uses disposable probe covers over a sublingual temperature probe. The probe is placed orally in the sublingual pocket and a temperature is recorded when the machine detects sustained pressure against the sublin-

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gual tissue for four seconds. This ensures that the temperature is obtained from the sublingual tissue not intra-oral air. The instrument was supplied new and had been calibrated by the manufacturer with a stated accuracy of ± 0.1°C over a range of 28.9°C to 42.2°C.

Sublingual temperature was recorded within a few minutes of arrival in the operating theatre holding bay. Patient demographic and surgical information were also recorded. The mean outdoor air temperature during the audit was 6.5°C with a mean daily range of 1.5°C to 11.4°C and an absolute range of -4.2°C to 19°C.[13,14] The ward temperatures were thermostatically controlled to a set point of 22.0°C.

Mean, median, mode and standard deviation were calculated.

Results

Data was obtained on 446 patients, 236 female and 210 male. The age range was 16 to 93 yr. The patients came from nine surgical wards. The largest single group (119 patients) was from the day surgical ward.

The range of temperatures was 35.7°C to 37.8°C with a mean of 36.5°C and a standard deviation (SD) of 0.4°C. The median was 36.4 and the mode was 36.1°C (71 patients). The frequency distribution of core temperature recordings is shown in the Figure. This graph shows an asymmetric distribution about the mean. The data was also separated into 327 inpatients and 119 day surgical patients. Results for the 327 inpatients for temperature range, mean, median, mode (55 patients) and standard deviation were identical to that of the whole sample. The skewed pattern of frequency distribution seen in the Figure remained unchanged. Results for the 119 day surgical patients also closely followed this pattern with identical mean, median and standard deviation. The mode was 36.4 (17 patients) with a range of 35.9°C to 37.7°C.

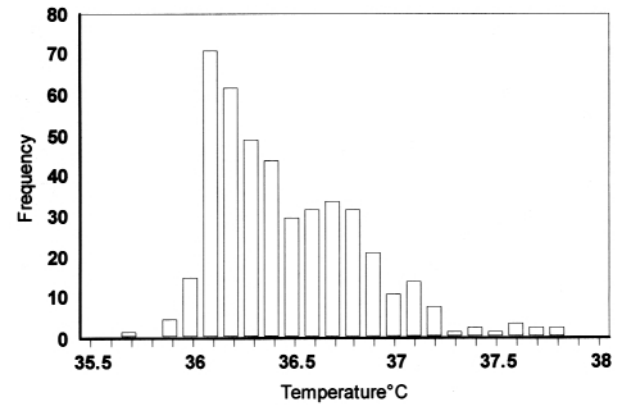

FIGURE Frequency distribution of preoperative sublingual temperature recordings in 446 adult elective surgical patients in Christchurch Hospital. The mean temperature is 36.5°C.

Discussion

Mild perioperative hypothermia is a common and potentially preventable occurrence in surgical patients. There is now clear evidence from randomized prospective trials that perioperative core temperatures of 1–3°C below normal are associated with serious adverse patient outcomes. These problems include increased blood loss,[1,2] postoperative myocardial events[4,5,15] and wound infections.[6,9] Anesthetic recovery time is extended[3,16] with a longer overall hospital stay.[6] Mild hypothermia can also cause distress to patients through feeling cold and shivering.[6,12]

The etiology of perioperative hypothermia is multifactorial. The contribution of intraoperative anesthetic, surgical and environmental factors is well documented.[7–11] However, information on the contribution of preoperative temperature is limited.[1,4–6,12] In our clinical practice we have observed that patients often feel cold on arrival in the anesthetic room. This led to the hypothesis that preoperative core temperatures may already be low prior to surgery. The goal of this audit was to document the distribution of preoperative core temperatures of surgical patients to see if low preoperative core temperatures were potentially a contributing factor to perioperative hypothermia in our hospital.

Our sample of 446 patients is the largest published assessment of preoperative core temperature and, to our knowledge, it is the only paper that analyzes the distribution of temperatures. Other published data consist of mean temperatures as part of prospective trials on the effects of perioperative hypothermia. Our audit found a mean preoperative core temperature of 36.5°C (0.4 SD). All recorded temperatures were within the accepted normothermic range[17] which did not support our hypothesis that patients may have significantly hypothermic core temperatures prior to surgery. The notable new observation in this audit was the asymmetric distribution of temperatures within the range.

The mean temperature in our audit was at the lower end of published data on preoperative patient core temperatures. Kurz *et al.*[6] in a study of 200 colorectal surgery patients recorded a mean preoperative tympanic temperature of 36.8°C (0.4 SD). Just *et al.*[12] followed 16 total hip arthroplasty patients and recorded a mean preoperative tympanic temperature of

36.5°C (0.4 SD). Frank *et al.*[4] studied 100 lower limb vascular surgical patients divided into two groups and found mean preoperative sublingual temperatures of 36.6°C (0.7 SD) and 36.5°C (0.7 SD).

In a study to find the means and limits of the normal body temperature Mackowiak *et al.*[17] used 700 sublingual measurements in 148 healthy adult volunteers aged between 18–40 yr. This study reconfirmed the diurnal variation pattern where core temperature reaches its nadir of 36.4°C (0.4 SD) at 06:00 rising to a peak of 36.9°C (0.4 SD) at 16:00–18:00.The range of normothermia was found to be between 35.6°C to 38.2°C. The range of our data is similar with recordings of 35.7°C to 37.8°C. This audit collected temperatures between 08:00 and 16:00. Averaging the Mackowiak *et al.*[17] data for the times where data was collected for this audit gave a mean expected normal temperature of 36.7°C (0.4 SD) for this audit. This is slightly higher than our observed mean of 36.5°C (0.4 SD).

The major difference between our data and that of Mackowiak is in the distribution of recorded temperatures within the range. Mackowiak's normothermia data is symmetrically distributed about the midpoint of the range with a mean and median of 36.8°C and a mode of 36.7°C. This is the most common pattern for the distribution of biological variables. Our data showed a distinctly asymmetric distribution (Figure) with a clustering of values around 36.1°C to 36.4°C (mode 36.1°C, median 36.4°C). The asymmetric distribution was seen in both the 327 inpatients and the 119 day surgical patients. If the asymmetric distribution was seen only in the day surgical patients it would have suggested that recent exposure to cold external environmental temperatures may have biased the data. However, the asymmetric distribution was seen in both the inpatient and day surgical patients suggesting that hospital environmental factors are likely to be important in accounting for our findings.

Despite the surgical wing of our hospital being fully insulated, air conditioned and only ten years old, patients are exposed to a variety of preoperative factors that could cool them. A separate audit in our hospital found that 60% of patients were transported to the operating theatre uncovered, on top of their beds. Other cooling influences include travel to the hospital, ward temperatures of around 22°C, thin single layer surgical clothing and transport down long cool corridors. Core temperature in an individual is tightly regulated by thermoregulatory mechanisms.[18] However, one explanation for the asymmetric temperature distribution found in this audit would be that exposure to moderate cooling influences lowered the core temperature in many of our patients to their threshold for activation of heat conservation mechanisms. This occurs at around 36°C[18] and would limit further core temperature reduction and prevent the development of overt hypothermia. This explanation is consistent with our observation of a cluster of patients at the lower end of the normothermic range.

This audit assessed the preoperative core temperature of elective surgical patients and a skewed distribution was seen. Further investigation is warranted to document this phenomenon elsewhere and to assess its significance with regard to subsequent intraoperative temperature changes.

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