British Journal of Anaesthetic & Recovery Nursing
Vol. 10(2), 32–35
doi:10.1017/S1742645609000436
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Original Article

A Comparative Look at Forehead and Tympanic Temperatures: An Audit Report

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OBJECTIVE

To check the accuracy of forehead skin temperatures using Liquid-crystal Thermometry (LCT) strips compared with the Tympanic ear thermometer 'Thermoscan' previously in place in the reported anaesthetic unit.

BACKGROUND

It is widely accepted that it is essential to monitor a patient's temperature routinely in the anaesthetic room, theatre and recovery (Association of Anaesthetists of Great Britain, 2007; National Institute for Health and Clinical Excellence, 2008). However, in the author's department, it was noted that anaesthetic nurses were failing to monitor patient temperature pre- and intra-operatively on a routine basis due to lack of devices. In the same study, temperature was routinely monitored in the recovery department. Thus, the department realised the importance of monitoring patient temperature throughout the patient's journey through theatre. It was suggested to us that we standardise the Forehead LCT devices, which were cost effective and easy to apply in practice. However, the unit saw the opportunity to conduct an audit in order to test the effectiveness of the product for themselves and its suitability to their unit.

Forehead LCT is a non-invasive method of monitoring skin temperature which reports to both rapidly and accurately record the trends in core temperature fluctuation (Allen *et al*., 1990). This is a relatively new product for the UK market but it had been introduced in the United States almost twenty years ago, becoming the standard in intra-operative temperature monitoring (Takehiko *et al*., 1997). Dorsch and Dorsch (2007) also believes that LCT gives fast continuous readings and involves no electronic circuits. They can be applied before the induction of anaesthesia and easily transferred to the recovery area with the patient.

Maintaining a patient's optimal body temperature in the theatre suite is crucial to post-operative outcome (Mahoney and Odom, 1999). Due to the compromising effects of general and regional anaesthesia, the patients will easily drop their body temperature, often to below 36°C. Inadvertent perioperative hypothermia is a common but preventable complication of many surgical procedures, which is in turn associated with poor patient outcome. The prevention of hypothermia requires the use of simple, easily obtainable measures to keep the patient comfortably warm (temperature between 36.5°C–37.5°C). Regular measurement and documentation of temperature is key to the prompt identification and treatment of inadvertent perioperative hypothermia (National Institute for Health and Clinical Excellence, 2008).

There are a variety of measures available to monitor temperature. It is a practitioner's responsibility as to which one to choose according to their reliability, access to the route and cost effectiveness. A brief overview of the research immediately tells us that tympanic membrane (ear), distal oesophagus, nasopharynx and pulmonary temperatures are considered to be the most reliable routes of measurement, as opposed to the axillary, bladder, oral and rectal routes (Association of Operating Room Nurses, 2007).

METHOD

In all, 25 adult patients undergoing trauma and orthopaedics procedures, under general and regional anaesthesia, undertaken within a four-week period (02/06/2008–29/06/2008) were audited. After taking verbal consent from the patient, liquid-crystal temperature strips were applied to the patient's forehead by the

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https://doi.org/10.1017/S1742645609000436 Published online by Cambridge University Press

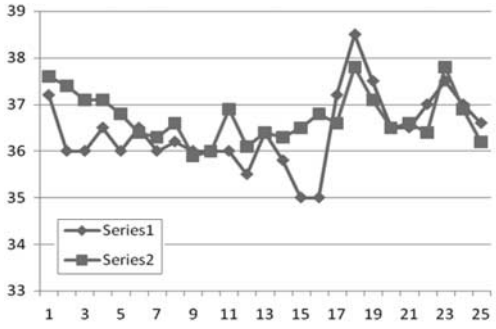
anaesthetic nurse pre-operatively, before induction of anaesthesia. Both forehead and tympanic temperatures were taken in pre-induction and then after 20–30 minutes of induction in theatre. Similarly, both temperatures had been recorded by recovery nurses in recovery. Demographic data was disregarded by this audit due to the main purpose being to compare the two devices. It is also vital to mention that theatre ambient room temperature was set between 21°C and 24°C.

RESULTS

After completing the audit, data was carefully analysed, comparing both temperatures. Difference of temperature between tympanic membrane 'Thermoscan' (ear) and liquid-crystal (forehead skin) temperatures were analysed between pre-induction, 20–30 minutes after induction and in recovery. These temperature differences were between similar or ±0.5°C to 1.5°C.

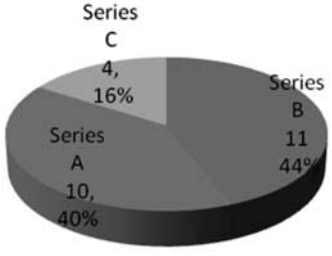
Graph 1

Pre-induction temperature differentiation between forehead skin and tympanic temperature.



Series 1 – Forehead (LCT) temperature
Series 2 – Ear (Tympanic) temperature

Pie Chart 1

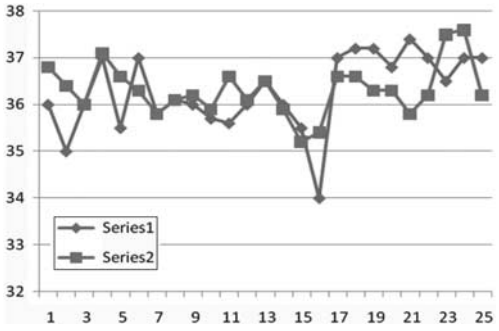


Series A = ±1–1.5°C
Series B = ±0.5–1.0°C
Series C = ±0.5°C or similar

- 44% (11 patients) of the temperatures show a ±0.5°C to 1°C difference between tympanic and forehead skin temperature in pre-induction, 40% (10 patients) shows ±1°C to 1.5°C difference and only 16% (4 patients) represent similar or ±0.5°C difference.

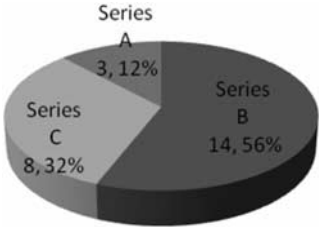
Graph 2

Temperature variation between tympanic temperature and forehead skin temperature after 20–30 minutes of induction.



Series 1 – Forehead (LCT) Temperature
Series 2 – Ear (Tympanic) Temperature

Pie Chart 2



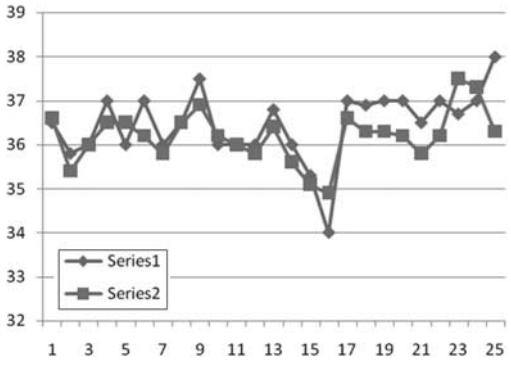
Series A = ±1–1.5°C
Series B = ±0.5–1.0°C
Series C = ±0.5°C or similar

- 56% (14 patients) of readings show a ±0.5°C to ±1°C difference between tympanic temperature and forehead skin temperature, 12% (3 patients) represents a ±1 to ±1.5°C difference and 32% (8 patients) shows similar or ±0.5°C difference after 20–30 minutes of induction of anaesthesia.

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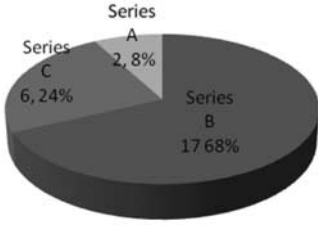
Graph 3

Temperature variation between tympanic temperature and forehead temperature in recovery.



Series 1 – Forehead (LCT) Temperature
Series 2 – Ear (Tympanic) Temperature

Pie chart 3

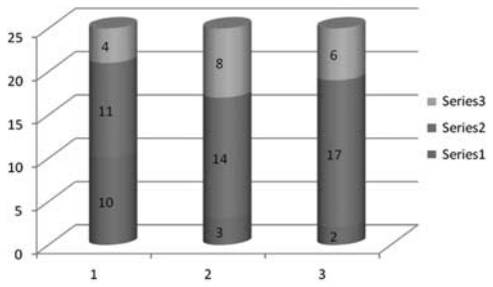


Series A = ±1–1.5°C
Series B = ±0.5–1.0°C
Series C = ±0.5°C or similar

- 68% (17 patients) of readings show ±0.5°C to ±1°C difference between tympanic and forehead skin temperatures, 8% (2 patients) shows, ±1 to ±1.5°C and 24% (6 patients) represent similar or ±0.5°C temperature difference in recovery.

Graph 4

Temperature difference between ±0.5–1°C in recovery, in theatre and pre-induction, respectively.



Series 1 = ±1–1.5°C
Series 2 = ±0.5–1.0°C
Series 2 = ±0.5°C or similar
Bar 1 – Pre-induction temperatures
Bar 2 – Temperatures after induction
Bar 3 – Temperatures in recovery

DISCUSSION

Monitoring a patient's body temperature in the theatre suite is essential, not only to prevent hypothermia, but also the consequences of hypothermia (Mahoney and Odom, 1999). These consequences include wound infection (Melling *et al.*, 2001), immune suppression (Beilin *et al.*, 1998), adverse cardiac events, increased blood loss and altered medicine metabolism (NICE, 2008). The risk of hypothermia is greater with trauma patients, the elderly (AORN, 2007) and in patients with a pre-operative temperature of less than 36°C. A temperature drop less than 1°C can increase blood loss by 16%, according to Rajagopalan *et al.* (2008). It is therefore very important to choose a reliable devise to monitor body temperature in the theatre suite.

According to the audit, there was no significant difference between the tympanic and forehead skin temperatures. Only 4%, 12% and 8% of patients showed ±1°C to ±1.5°C difference in pre-induction, after induction and recovery, respectively, but a large number of patient's temperatures were different between ±0.5 to ±1°C, such as 44%, 56% and 68% in pre-induction, after induction and in recovery. The rest of the 40%, 32% and 24% forehead temperatures were similar or less than 0.5°C

Numerous studies exist regarding the accuracy of LCT. Most studies support the effectiveness, however, according to Marsh and Sessler (1996), hypothermia may be difficult to evaluate using LCT, as skin temperatures are 1–4°C less than core temperatures. It also fails to detect clinical fevers.

According to studies by Takehiko *et al.* (1997), forehead skin temperature is more accurate than neck temperature. Core-to-neck temperature difference frequently exceeds 1°C, whereas two-thirds of the core-to-forehead differences were only 0.5°C. However, studies by Frank *et al.* (1999) have reported that forehead skin temperature are 70% more reliable than axillary, but the accuracy of liquid-crystal temperature has an inbuilt offset between 2–4°C. This offset estimates temperature derived from skin, rather than core. As surface-warming methods may directly heat the skin temperature, they may be unreliable during active warming.

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It has also been reported by anaesthetic nurses during the audit, that when a patient was wearing an upper body Bair Hugger device, LCT was showing higher temperatures than the tympanic. It was also reported that when the ambient temperature was below 20°C, LCT indicated a lower body temperature; similarly when ambient temperature was in between 22–24°C, LCT displayed a higher temperature than actual body temperature. Takehiko *et al.* (1997) believe that skin surface temperature is determined by a complex interaction among the core temperatures, ambient temperatures, air speed, tissue thermal conductivity, subcutaneous insulation and tissue perfusion.

Allen *et al.* (1990) were positive about the liquid-crystal temperatures; according to their studies, LCT successfully paralleled rapid changes in core temperature but could not replace the invasive core temperatures. Frank *et al.* (1999) reported LCT to be 70% reliable and axillary, 40% reliable but these techniques are likely to underestimate temperatures, especially the lower values, which may result in undue concern about hypothermia.

CONCLUSION

Forehead temperature monitoring did not show similar temperatures to the tympanic measurement. Half a number of patients showed a ±0.5 to ±1°C temperature difference in pre-induction and after induction as well as more than half a number of patients showed the same in recovery. Variation between ambient temperatures will affect skin temperature as well as surface warming methods, which directly heat the skin temperature monitors, resulting in unreliable readings during active warming. All the available research is against the effectiveness of LCT, mirroring the findings of the audit report. Conversely, almost all the research is in favour of 'Tympanic Thermoscan' as it monitors the core temperature, which is accurate and reliable. Thus, it was not recommended replacing the use of the 'Thermoscan' temperature reading devices, due to the lack of core temperature readings. Therefore, the author has drawn the attention of management for ordering more 'Thermoscan' which definitely gives the opportunity to anaesthetic/recovery nurses to maintain the care standard of the patient.

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