

ORIGINAL ARTICLE

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Perioperative temperature monitoring in general and neuraxial anesthesia: a survey study

Ahmet Yüksek* , Gamze Talih, Cigdem Unal Kantekin and Cevdet Yardımcı

Abstract

Background: Perioperative hypothermia is an unintended decrease in the core temperature of patients. Hypothermia has many proven complications. The aim of this study is to investigate the perioperative temperature monitoring rates and the difficulties encountered during monitoring, particularly in patients undergoing neuraxial anesthesia.

Methods: Two hundred anesthesiologists were included in the study who work in Turkey and actively work in an operating room. A questionnaire was applied to the participants via printed form or e-mail.

Results: In Turkey, the overall temperature monitoring ratio was measured as 5.5%. Temperature monitoring was the most frequently used for cardiovascular surgery patients group. In neuraxial anesthesia, temperature monitoring was only 1.5%. The most common reason for not using a temperature monitor was the lack of appropriate equipment (45%). The most common temperature monitoring area was the axillary zone (48%).

Conclusion: Participants were aware of the importance of temperature monitoring but concluded that it was not sufficient in practice. Where and how to measure core temperature in awake patients is a controversial issue. Furthermore, the accuracy of measurements in neuraxial anesthesia should be discussed. Interestingly, raising awareness about this issue was not effective in the resolution of the problem. Still, in order to keep this issue up to date, the importance of perioperative temperature monitoring should be emphasized more frequently in anesthesia meetings and education programs.

Keywords: Anesthesia, Perioperative hypothermia, Temperature monitoring

Background

Perioperative unintended hypothermia is defined as core temperature falls under 36° between preoperative 1 h and postoperative 24 h period (Sessler 2008). As a result of perioperative hypothermia, the patient's "thermal comfort" is impaired, oxygen consumption increases with the development of tremors, heart problems that may increase mortality may develop, blood transfusion requirement increases due to increased intraoperative blood loss, the

incidence of infection in the surgical wound site increases, and the incidence of postoperative nausea vomiting increases. In addition, the duration of action of hypnotic drugs and neuromuscular blockers is prolonged, and the recovery time after anesthesia is extended (Turkish Society of Anesthesiology and Reanimation (TSAR) 2013). Depending on the results, long-term hospital stay and all complications lead to an increase in mortality, morbidity, and cost (Hart et al. 2011; Billeter et al. 2014).

Although conduction, convection, and evaporation are effective in heat loss, the primary mechanism is radiation (Sessler 2016). Heat loss is commonly seen in patients with general and regional anesthesia combined (Arkiliç et al. 2000; Macario and Dexter 2002). The temperature

* Correspondence: mdayukse@hotmail.com
Faculty of Medicine, Anesthesiology and Reanimation, Bozok University,
Yozgat, Turkey

mentioned in perioperative hypothermia is the core temperature of the patient. It is practical and easier to measure the core temperature in patients under general anesthesia. But this is a challenge in patients undergoing neuraxial anesthesia.

Redistribution via peripheral vasodilatation under spinal anesthesia is already expected (Matsukawa et al. 1995). However, its effects often overlooked. In fact, neuraxial anesthesia patients may be more hypothermic than we think (Allen and Habib 2018). In our study, the attitudes and behaviors of anesthesiologists in general anesthesia and especially in neuraxial anesthesia to prevent perioperative hypothermia were examined.

Material and methods

After the approval of the ethics committee of Bozok University (2017-KAEK-189_2019.01.02_18), 200 anesthesiologists who work in Turkey and actively work in an operating room were included in the study. Informed consent for participation was obtained from all participants. Since the personal data were not published, the consent for publication was not applicable. More than 2000 anesthesiologists and residents are working in Turkey (Turkish Society of Anesthesiology and Reanimation (TSAR) *n.d.-b*). The number 200 in our study was adjusted to represent about 10% of 2140 anesthesiologists. For our study, a 30-day survey filling period was applied.

The questionnaire includes 3 chapters consisting of a total of 19 questions. These sections aim to measure general approaches to perioperative hypothermia, approaches at neuraxial anesthesia, and attitudes related to measurement techniques. Survey questions are presented in Table 1. In this study, neuraxial anesthesia expression was used for spinal, epidural, and combined spinal-epidural anesthesia applications. The surgical procedures were classified as major and minor. If a mesenchymal barrier is opened (pleural cavity, peritoneum, meninges), the surgery is considered major (Solimeno et al. 2018).

Statistical methods

The minimum number of participants for our study was determined as 200 by power analysis with taking into consideration the previous studies on this subject (İnal et al. 2017). Data obtained in the study were analyzed statistically using the Statistical Package for the Social Sciences software package (SPSS version 20.0, IBM). Data collected were analyzed, and the results expressed as percentages. Our results were compared with previous studies conducted in Turkey and different countries and the current literature.

Results

In our survey period, 221 participants completed the questionnaire. Twenty-one of them have been excluded because of missing answers. Forty-one and a half percent of the participants were specialist physicians, 36% were research assistants, and 22.5% were academic staff. The average experience of anesthesia was between 5 and 8 years.

Only 5.5% of the participants stated that they performed routine temperature monitoring for each patient. Those who performed temperature monitoring according to the patient group was 68%. However, 41% of the respondents thought that patients who were not followed up were hypothermic at the end of the operation.

The most frequent monitoring was performed in cardiovascular surgery patients with a rate of 87.5%. This was followed by pediatric patients (25.4%), major surgeries (19.3%), and surgeries longer than 30 min (14%). Geriatric patients were monitored with a rate of 6.5% (Fig. 1).

The nasopharynx was the most commonly used site for core temperature measurement in patients under general anesthesia with 71.5%. It was followed by the tympanic membrane with 34%. The least used were pulmonary arterial catheter and rectal measurements (Table 2). In patients who underwent neuraxial anesthesia, the most common temperature monitoring area was the axilla (48%). It was followed by the forehead (30%), tympanic membrane (26%), and chest skin 12% (Table 2).

Our participants thought that temperature monitoring is a part of standard monitoring with a rate of 58% of the respondents. However, the rate of temperature monitor usage in neuraxial anesthesia was 1.5%. The participants who did not conduct temperature monitoring for neuraxial anesthesia patients indicated that the most frequent reason was the lack of equipment (45%). Twelve percent of the participants believe that temperature monitoring for neuraxial anesthesia patients was unnecessary. Another important reason was to believe that it was a waste of time (15%). In contrast with the results, 30% of the participants stated that they always adhere to the guidelines.

Discussion

Perioperative hypothermia may cause many complications such as delayed recovery from anesthesia, increased coagulopathy, increased risk of infection, and increased cardiovascular complications (Díaz and Becker 2010).

Consistent with the previous studies in this area, our survey participants did not routinely use temperature monitoring for each patient (Allen and Habib 2018; Frank et al. 1999; Alluri and Wrench 2014). Even so,

Table 1 Survey questions

Part 1: General approaches (*mark only one oval)	
Q1: What is your professional position?	Research assistant, specialist doctor, academic staff
Q2: How long is your experience in anesthesiology?	1–5 years, 5–8 years, 8–12 years, 12 years and more
Q3: What kind of institute are you working on?	University hospital, public hospital, training and research hospital, private hospital/clinic
Q4: Do you apply body temperature monitoring to each patient?	I practice routinely, I never practice, I rarely do, According to the patient group (child, elderly, cardiac, etc.).
Q5: Do you think that patients who do not apply body temperature monitoring leave the operation room as normothermic?	Yes, no, most of the time, sometimes
Q6: What are the patient groups that certainly you do body temperature monitoring?	Pediatric patient group, geriatric patient group, cardiovascular surgery, major general surgical operations, all surgeries for more than 30 min.
Q7: Where do you prefer to monitor the core temperature under general anesthesia?	Tympanic membrane, rectal, nasopharynx, pulmonary artery catheter, bladder, others
Q8: Do you measure the temperature of your patients preoperatively?	Yes, no, sometimes
Q9: What would you use as the heating method in the preoperative waiting room? Check all that apply.	Cotton blanket, socks, hot air blowing systems, radiant heaters, others
Q10: Which of the heating methods do you use during the operation?	Cotton blanket, socks, hot air blowing systems, radiant heaters, IV fluid and blood product heaters, heat dehumidifier filters, hot water bag, I use them all
Q11: What do you use as a heating method in the recovery room? (*check all that apply)	Cotton blanket, socks, hot air blowing systems, radiant heaters, IV fluid and blood product heaters, heat dehumidifier filters, hot water bag, I use them all
Part 2: Approaches in neuraxial anesthesia	
Q12: Do you think that heat monitorization is necessary during neuraxial anesthesia?	Yes, no, sometimes
Q13: Do you perform temperature monitorization during neuraxial anesthesia? (*check all that apply)	I always practice routinely, I never practice, I rarely do, according to the patient group (child, elderly, cardiac, etc.)
Q14: Which area do you use for the temperature monitoring in the awake patient or under neuraxial anesthesia? (*check all that apply)	Any skin temperature, temperature of the chest front wall, atemperature, distal temperatures in the lower extremity, fingertips, forehead area, others
Q15: What are the reasons why you do not follow body temperature for each patient?	Lack of equipment and materials, I consider it a waste of time, I think it is not necessary for any patient, I think the application is not necessary except for the critical patients, others
Q16: Do you observe hypothermia in patients with neuraxial anesthesia? (mark only one oval)	Yes, no
Part 3: Attitudes related to measurement techniques	
Q17: Do you think that temperature monitoring is within standard monitoring? (*mark only one oval)	Yes, no
Q18: How often do you experience perioperative hypothermia-related complications? (*mark only one oval)	In long-term operations, rarely, with elderly, pediatric patient groups
Q19: How much do you adhere to the recommendations of national and international guidelines on preventing perioperative hypothermia in your operating room? (Europe; NiCE 2008, America; ASA 2015 and Turkey; TSAR 2013)	Sometimes, never, always

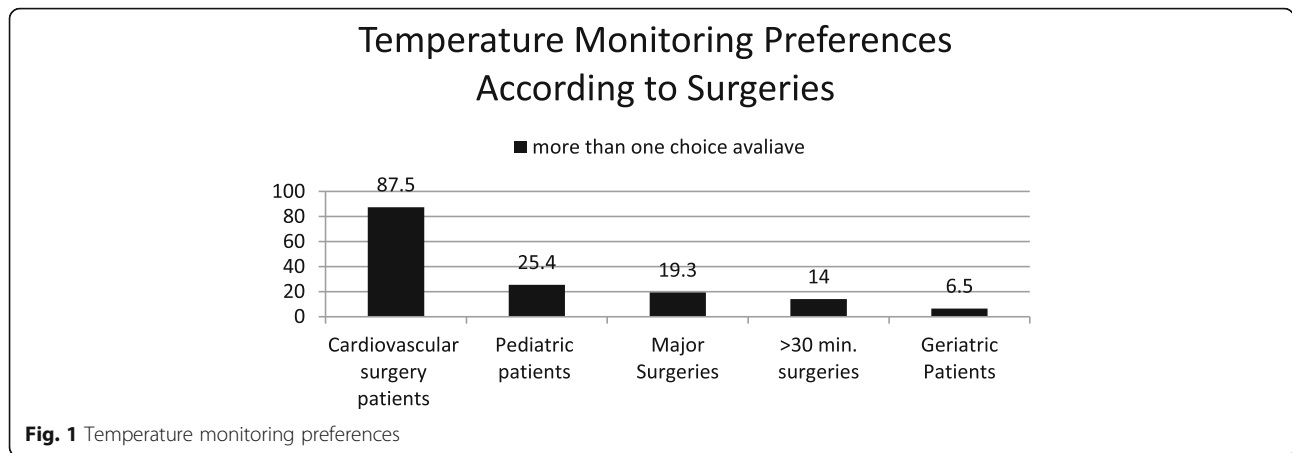


Fig. 1 Temperature monitoring preferences

58% of the respondents thought that temperature monitoring is a part of standard monitoring. The majority of the participants preferred temperature monitoring according to the characteristics of the patient group under general anesthesia. Temperature monitoring was most commonly used in cardiovascular surgery. Cooling and rewarming periods are important parts of coronary artery bypass graft surgery, so temperature monitoring is essential; 87.5% ratio temperature monitoring can be expected. Although 15% of the participants think that temperature monitoring is a waste of time, monitoring the temperature in general anesthesia will probably take less time than a delayed recovery after surgery.

For patients under neuraxial anesthesia, the most frequent reasons to not follow temperature perioperative was the lack of equipment (45%). Even if the temperature probe is available in all operating rooms, these probes are only suitable for use in core temperature measurements under general anesthesia. Where and how to measure the core temperature in awake patients is a controversial issue. It is known that skin temperature monitoring is not an acceptable temperature monitoring (Arkiliç et al. 2000). In this case, a practical monitoring method may be needed in neuraxial anesthesia patients. Forty-five percent of the participants stated the the lack of equipment is the reason for not monitoring the temperature in neuraxial anesthesia.

Table 2 Monitorization sites

Temperature monitorization sites			
General anesthesia (multiple choice available)		Neuraxial anesthesia (multiple choice available)	
Nasopharynx	71.5%	Axilla	48%
Tympanic membrane	34%	Forehead	30%
Rectal	1%	Tympanic membrane	26%
Pulmonary arterial catheter	0.5%	Chest skin temperature	12%

However, it is not clear whether the equipment mentioned here is a direct thermocouple or infrared measurement tool which is known to be unreliable. In fact, the presence of equipment that could properly monitor the temperature was perhaps an issue that should be questioned. For neuraxial anesthesia patients, most commonly used site was axilla (48%). The forehead was 30%. The tympanic membrane was 26% and chest skin 12%. For these areas, the tympanic membrane can be the most accurate site for temperature measurements. The axillary temperature measurement is only reliable if it is done with the appropriate technique (Sessler 2016). Infrared aural canal temperature measurement is insufficiently accurate for clinical use. Tympanic membrane temperature can be measured by thermocouples with high accuracy (Merry et al. 2010). Alternatively, a double-sensor thermometer can be used to measure the temperature. It has been emphasized in some studies that the double-sensor thermometer is significantly correlated with core temperature and is an alternative measurement method in neuraxial anesthesia patients (Kimberger et al. 2013). In our survey questions, 45% of the participants emphasized the lack of appropriate equipment for temperature monitoring in patients under neuraxial anesthesia. It is an accepted fact that the measurements made from the external ear by infrared methods are also considered to be low reliability. At this point, it should be mentioned the spot-on core temperature monitor, which has started to be used recently. This device measures from the skin with an adhesive tape, and according to studies, it has a high correlation with the core temperature values. Its use is practical and accurate, especially in patients who are awake, such as neuraxial anesthesia patients, whose internal temperature is difficult to measure (Eshraghi et al. 2014; Boisson et al. 2018).

There was no information on the technique used by the respondents to measure the tympanic membrane.

Therefore, we have no idea how much temperature is accurately measured in patients undergoing neuraxial anesthesia. Despite all difficulties, temperature monitoring in neuraxial anesthesia with an acceptable method will reduce the complication rates.

European and American Society of Anesthesiologists guidelines recommended the routine use of temperature monitoring (National Institute for Care and Health Excellence 2008; American Society of Anesthesiologists Guidelines 2015). The Turkish Anesthesia Society recommends the use according to the patient group. It recommends the use in risky patient groups even in operations lasting less than 30 min (Turkish Society of Anesthesiology and Reanimation (TSAR) 2013).

Arkiliç et al. (2000) Investigated hypothermia in neuraxial anesthesia in 120 patients. Seventy-seven percent of these patients were found to be hypothermic. Even in 22%, core temperature was found to be <35 °C. These results emphasize the high rate of hypothermia in neuraxial anesthesia. The rate of temperature monitor usage in neuraxial anesthesia was found to be 1.5% in our study. This rate was 27% in Arkiliç's study. In a survey conducted in European countries, the use of temperature monitors was found to be 25% in general anesthesia and 6% in neuraxial anesthesia.

There are a limited number of previous studies on the rate of temperature monitoring in Turkey. In a study conducted in 2017, 26% of the participants stated that they always use temperature monitoring (İnal et al. 2017). In this study, there was no data on the use of temperature monitoring in patients under neuraxial anesthesia. However, we found this rate to be 5.5% under general anesthesia and 1.5% at neuraxial anesthesia. These rates are less than the results of Frank's survey in 1999. In this study, the rate of conducting temperature monitoring in the USA under regional anesthesia was found to be 33% (Frank et al. 1999). These results show that there has been no improvement in the behavior of anesthesiologists in the last 20 years. This issue should be considered by anesthesiologists.

Limitations

Although the results of our study are similar to those conducted across Europe, the number of participants in this study may not reflect the attitudes of all anesthesiologists in Turkey. However, still it is important to be informative. The lack of an electronic correspondence environment accessible to all specialists made it difficult to reach more participants. With a larger number of participants, a more precise conclusion can be reached.

Conclusion

In our study, the approaches of the anesthesiologist to perioperative hypothermia in neuraxial anesthesia were investigated. It is understood that the anesthesiologists have enough idea about the guidelines and the negative effects of hypothermia. However, although 20 years have passed since important publications on the subject and national and international guidelines emphasized the importance of this issue, no improvement was observed in our approaches.

Many national and international associations have published guidelines on the prevention of perioperative hypothermia and emphasized the importance of the subject. Interestingly, raising awareness about this issue was not effective in the resolution of the problem (Merchant and Chartrand 2016; Checketts et al. 2016; Australian and New Zealand College of Anaesthetists A 2015). Still, in order to keep this issue up to date, the importance of perioperative temperature monitoring should be emphasized more frequently in anesthesia meetings and education programs.

Acknowledgements

Not applicable.

Authors' contributions

AY and GT contributed to the conception and design of the study. ÇÜK and CY performed the data collection and organized the data preparation. All authors actively discussed the manuscript, critically reviewed its comprehensive content, and finally approved the final version to be submitted for publication.

Funding

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study protocol was approved by the Bozok University Research Ethics Committee with reference no. 2017-KAEK-189_2019.01.02_18. All procedures were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The aim of the research was explained to the participants and obtained informed consents.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 2 November 2019 Accepted: 23 March 2020

Published online: 10 April 2020

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