Is Normothermia Maintained in the Operating Room?

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Keywords

Hypothermia · Operating room · Perioperative period · Nursing

Abstract

Background: Inadvertent hypothermia is one of the most common problems in the perioperative period. Providing and maintaining normothermia is very important in preventing inadvertent perioperative hypothermia as well as complications. **Purpose:** The aim of the study was to determine the knowledge and practices of operating room nurses to prevent hypothermia. **Methods:** A cross-sectional descriptive study was carried out in the operating rooms of 4 hospitals in Istanbul between July 2016 and September 2017. The sample consisted of a total of 95 participants who met the inclusion criteria. Data were collected by using a data collection form. Data collection forms were filled with face-to-face interview techniques. **Results:** According to this study, 84.2% of the participants did not receive any training to prevent hypothermia, 85.3% stated that it was very important to protect the patients from hypothermia, and 88.4% stated that there was no protocol on hypothermia in the hospital. **Conclusions:** The majority of the operating room nurses who participated in this study about determining the practices in maintaining normothermia in the operating room environ-

ment stated that they did not receive any training to prevent hypothermia, and the prevention of hypothermia was important. There was no common protocol used.

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Introduction

Inadvertent hypothermia, which is one of the most common problems (up to 70%) in the perioperative period, develops as a result of disruption of the heat regulation mechanism due to various factors during surgical interventions [1]. Inadvertent perioperative hypothermia is the decrease in body temperature below 36°C (96.8°F) from the preoperative period (1 h before anesthesia) to the postoperative period (first 24 h after anesthesia) [2–8]. Many patients experience hypothermia during their surgical procedures, and the incidence in surgical patients varies between 17 and 88.6% depending on the procedure (total hip arthroplasty and colorectal surgery) [1, 9]. Hypothermia in surgical patients can lead to negative consequences such as cardiac problems (ventricular tachycardia and angina pectoris), delayed wound healing, surgical site infection, acute lung injury, bleeding, increased blood and blood product transfusion require-

ments, prolonged duration of neuromuscular blocking agents' effect, tremor, nausea, decrease in patient comfort, prolonged extubation time, prolonged post-anesthesia care unit (PACU) and hospital stay, loss of life, and cost [1, 4–6, 8, 10–17].

Providing and maintaining normothermia is very important in preventing inadvertent perioperative hypothermia as well as complications. Various methods are used by anesthesiology and surgical team members (surgeon, scrub and circulating nurse, and PACU nurse) to reduce the complications of hypothermia [7]. Heating of intravenous (IV) fluids, blood and blood products, and irrigation fluids helps maintain normothermia. Heated and humidified anesthetic gases also play an important role in maintaining body temperature. In addition, the use of passive methods such as garments made of woolen or synthetic woolen materials, heating blankets, and insulation materials provides additional insulation [2, 3, 5, 6, 13, 17, 18]. In the literature, it is stated that the most effective active heating method to prevent intraoperative hypothermia is forced air warming devices that blow warm air into a blanket placed over the patient [3, 5, 6, 8, 13, 18–24].

Prevention of inadvertent hypothermia and providing and maintaining normothermia in the perioperative period is very important in improving clinical outcomes. For this reason, the risk factors of hypothermia should be known by the health professionals working in the operating room, the signs and symptoms of hypothermia should be evaluated, the body temperature of the patient should be monitored regularly, and appropriate heating methods should be determined and applied. As an integral part of the operating room team, nurses play a key role in maintaining normothermia [1, 4, 5, 11, 12]. The aim of the study was to determine the knowledge and practices of operating room nurses to prevent inadvertent perioperative hypothermia.

Research Question

This study consists of 1 research question: What are the knowledge levels and interventions of operating room nurses for inadvertent perioperative hypothermia?

Methodology

Study Setting

The research was carried out as a cross-sectional descriptive study in the operating rooms of 4 hospitals (2 state and 2 university hospitals) in Istanbul between July 2016 and September 2017 in order to determine the knowledge and practices of operating

room nurses to prevent inadvertent perioperative hypothermia. The population of the study consisted of operating room nurses working in the operating room of 4 hospitals (2 university hospitals and 2 state hospitals). The sample consisted of a total of 95 participants who met the inclusion criteria. During the study, 24 participants who were on leave/sick leave and 56 participants who were not willing to participate in the study due to work intensities were excluded from the study, and only 54.2% of the population was reached. The criteria for inclusion in the study were determined to be working in the operating room for at least 6 months and to be willing to participate in the study.

Data were collected by using a data collection form prepared by the researchers in the light of the literature [2, 5, 7, 19–21]. The data collection form included items such as individual and occupational characteristics (such as gender, age, education level, experience, and how often) and interventions (in which way the body temperatures of the patients are measured in the operating room and which heating methods are used). A numeric scale developed by researchers was used to determine the importance level of protecting the patient from hypothermia. Responses marked on the scale were expressed as a number between 1 (not likely to be important) and 10 (most likely to be important). It was assumed that the level of significance increased as the responses approached to 10. A small group ($n = 12$) representing the sample was piloted, and the responses were evaluated by the researchers, and the unexplained questions were reviewed. The data obtained from the pilot study were excluded from the analysis. Data collection forms were filled with face-to-face interview techniques on working days of the operating room nurses and at intervals not to interfere with their work.

Data Analysis

For statistical analysis of data, the IBM SPSS Statistics 16 (IBM Statistical Packages for the Social Sciences Corp.; Armonk, NY, USA) program was used. While evaluating the data obtained from the research, descriptive statistical methods (mean, standard deviation, frequency, and percentage) were used. Bell-shaped numerical variables were summarized as mean $\pm$ SD, skewed numerical variables were summarized as min, max (median), and categorical variables were summarized as count (%).

Results

We distributed the survey to 175 operating room nurses who met the study eligibility criteria. Completed questionnaires were returned by 95 nurses, for an overall response rate of 54.2%. The mean age of the participants was 34.08 ± 6.05 , the median total working experience was 1–30 (12) years, and the median experience in the operating room was 1–28 (8) years. 81.1% of the participants were women, 64.2% were undergraduate, 57.9% were working in a university hospital, and 53.7% were working with a circulating nurse. It was found that 84.2% of the participants did not receive any training to prevent hypothermia, and 85.3% stated that the importance level

Table 1. Distribution of individual features of operating room nurses (*N* = 95)

Features	Min-max (median)	Mean ± SD
Age, years	21–50 (34)	34.08±6.05
Work experience, years	1–30 (12)	12.89±7.53
Operating room experience, years	1–28 (8)	9.91±7.21
Gender, <i>n</i> (%)		
Female	77 (81.1)	
Male	18 (18.9)	
Education, <i>n</i> (%)		
Medical vocational		
High school degree	4 (4.2)	
Associate degree	13 (13.7)	
Undergraduate degree	61 (64.2)	
Graduate degree	17 (17.9)	
Institution, <i>n</i> (%)		
University hospital	55 (57.9)	
Training and research hospital	40 (42.1)	
Unit of OR, <i>n</i> (%)		
Operating room	87 (91.6)	
PACU	8 (8.4)	
Working with a circulating nurse, <i>n</i> (%)		
Yes	51 (53.7)	
No	44 (46.3)	
Hypothermia training status, <i>n</i> (%)		
Yes	15 (15.8)	
No	80 (84.2)	
Hypothermia significance level, <i>n</i> (%)		
1–3	3 (3.2)	
4–6	11 (11.6)	
7–10	81 (85.3)	

OR, operating room; PACU, post-anesthesia care unit.

Table 2. Distribution of applications for the control of inadvertent hypothermia (*N* = 95)

Applications	<i>N</i> (%)
Controlling the risk of developing hypothermia	
Yes	45 (47.4)
No	50 (52.6)
Checking patient age	
Yes	79 (83.2)
No	16 (16.8)
Measurement of body temperature before induction of anesthesia	
Nurse	19 (20.0)
Anesthetist	76 (80.0)
Measurement of body temperature during surgery	
Nurse	39 (41.1)
Anesthetist	56 (58.9)
Measurement of body temperature in PACU	
Nurse	38 (40.0)
Anesthetist	57 (60.0)
Places where body temperature is measured	
Tympanic membrane	48 (50.5)
Nasopharynx	7 (7.4)
Lower end of esophagus	15 (15.8)
Skin/axillary	50 (52.6)
Bladder	21 (22.1)
Pulmonary artery catheter	7 (7.4)
Presence of unwanted hypothermia prevention protocol	
Yes	11 (11.6)
No	84 (88.4)

PACU, post-anesthesia care unit.

of protecting the patient from hypothermia was between 7 and 10 on the scale of 1–10 (Table 1).

When the applications for the control of inadvertent perioperative hypothermia were examined, it was found that 47.4% of the participants controlled the risk of developing hypothermia and 83.2% controlled the age of the patient. Body temperature was measured by the anesthesiologist before anesthesia induction, during surgery, and in the PACU (80%, 58.9%, and 60%, respectively). It was determined that 52.6% of the body temperature of the patients was measured from skin/axillary and 50.5% from the tympanic membrane and 88.4% stated that there was no protocol to prevent inadvertent perioperative hypothermia (Table 2).

When the interventions of the participants for the prevention of inadvertent perioperative hypothermia were examined, preoperative warm-up rates were 35.8%,

69.5%, and 62.1% in the waiting room, during surgery, and in the PACU, respectively. A total of 41.1% were using passive heating methods and 83.2% were using active heating methods. The most preferred method of passive heating (28.4%) was cotton blanket-green covers; among the active heating methods, the most preferred method (77.9%) was forced air warming devices (Table 3).

Discussion

In Turkey, there is no common protocol to prevent inadvertent hypothermia in hospitals yet. Minimizing perioperative hypothermia requires teamwork throughout the surgical process. Training and awareness raising of the whole surgical team including perioperative nurses, anesthesiologists, surgeons, and operating room tech-

Table 3. Distribution of interventions to prevent inadvertent hypothermia (*N* = 95)

Interventions	<i>N</i> (%)
Preoperative warming status in the waiting room	
Yes	34 (35.8)
No	61 (64.2)
Warming status during surgery	
Yes	66 (69.5)
No	29 (30.5)
Warming status in PACU	
Yes	59 (62.1)
No	36 (37.9)
Passive warming status	
Yes	39 (41.1)
No	56 (58.9)
Passive warming methods	
Cotton blanket-green covers	27 (28.4)
Socks	7 (7.4)
Active warming status	
Yes	79 (83.2)
No	16 (16.8)
Active warming methods	
Forced air warming devices	74 (77.9)
Electric covers/blankets	21 (22.1)
Radiant heaters	12 (12.6)
Warmed IV fluids	15 (15.8)
Heat and moisture exchangers	4 (4.2)
Negative pressure warming	2 (2.1)

PACU, post-anesthesia care unit; IV, intravenous.

nicians are very important in ensuring and maintaining normothermia in surgical patients [2, 5]. Nurses play a primary role in caring and monitoring patients during the perioperative period; therefore, a better understanding of nurses' knowledge of perioperative hypothermia is an important part of improving patient outcomes [1].

The perioperative nurse should evaluate and record hypothermia risk factors, signs, and symptoms of hypothermia, monitor the patient's body temperature at regular intervals, and identify and apply appropriate heating methods [4, 5, 11, 12]. The nurse should identify the risk factors for the development of hypothermia before the surgery and share them with the surgical team. Since preoperative hypothermic patients have a high risk of hypothermia during and after surgery, the nurse should plan and implement interventions to keep the patient's body temperature around 37°C (98.6°F) [2, 12, 22, 23]. In the literature, the preoperative use of a heating method and taking the patient into operation after having provided normothermia are known to be important for the prevention of inadvertent hypothermia development [24].

In order to prevent perioperative hypothermia, awareness and training of the whole surgical team is very important. Prevention and management of hypothermia focuses on the correct assessment of the patient's risk of hypothermia, the application of protective strategies, routine monitoring of the patient's body temperature in the perioperative period, and the use of appropriate heating strategies. Thermoregulation is a fundamental aspect of nursing practice, and nurses are primarily responsible for these aspects of care [2, 5, 25]. In this study, the majority of nurses involved in the study had not received any training to prevent hypothermia and were aware of the importance of protecting the patient from hypothermia. In the study by Hegarty et al. [25], the nurses were not sure of the correct definition of hypothermia and normothermia. These contradictory definitions are considered as a result of the absence of a standard definition of hypothermia in the literature. This uncertainty emphasized the need for standardized guidelines by the NICE, the Association of Operating Room Nurses (AORN), and the American Society of PeriAnesthesia Nurses (ASPAN) for use by nurses in practice and the development of continuing education programs to keep practitioners' knowledge up to date with the best available evidence.

The American Association of Nurse Anesthetists (AANA) recommends routine monitoring of body temperature during local, regional, and general surgical procedures. Similarly, the American Society of Anesthesiologists (ASA) and the ASPAN emphasize the importance of continuously evaluating the body temperature in the perioperative period if clinically significant changes in body temperature are predicted or suspected. Body temperature should be measured as a standard practice in major surgeries or in patients undergoing general anesthesia for >30 min [2, 3, 5, 7]. Although it is the responsibility of the entire surgical team to maintain the normal body temperature of the patient under anesthesia in the perioperative period [2, 17], it is the duty of the anesthesiologist to monitor and alert the team [26]. However, it is stated that perioperative nurses should first evaluate and prevent the development of hypothermia risk factors, determine the appropriate heating methods when it develops, adjust the heating devices, check the settings, evaluate the thermal comfort of the patient, and monitor the side effects such as sweating [4, 5, 12, 14, 27, 28]. In this study, it was found that approximately half of the operating room nurses involved in the study control the risk of developing hypothermia and the majority control the age of the patient but less than half measure the patient's body temperature before induction of anesthesia. It was found that the body

temperature control of the patients during the surgery and in the PACU was mostly performed by the anesthesiologist. Torossian et al. [29] reported that in Europe, operating room workers do not monitor intraoperative temperature frequently during each operation and do not use active heating methods such as forced air warming devices to prevent hypothermia. This may be the result of lack of temperature monitoring and inadequate evaluation of patients. According to the AORN, the perioperative nurse should establish expected outcomes and collaborate with anesthesia care providers in the selection of appropriate temperature monitoring technology and interventions to reduce the risk of unplanned hypothermia [24].

Many different methods and areas are used to measure body temperature in the perioperative period. In the literature, preoperative and postoperative body temperature is commonly measured from the tympanic membrane and oral areas; it is stated that the oral area is the most reliable approach in noninvasive temperature measurement, but it is difficult to use because of numerous limitations in the intraoperative period. ASA states that the body's tympanic membrane, nasopharynx, esophageal lower end, skin/axillary, bladder, and pulmonary artery catheter can be used for temperature monitoring in risky patients who are expected to undergo temperature changes under anesthesia [5, 7, 20]. According to the AORN, there are 4 reliable sites for measurement of core temperature: tympanic membrane, distal esophagus, nasopharynx, and pulmonary artery [24]. In this study, the finding that the body temperature of the patients was measured most frequently from the skin/axillary and tympanic membrane area is consistent with the literature [5, 7, 20, 24].

In patients who develop hypothermia during surgery, it is important to maintain the thermal balance after the intervention as it requires approximately 2–5 h before it occurs, regardless of the depth of hypothermia. Nurses, who are indispensable members of the operating room teams, play an important role in maintaining normothermia. Accordingly, the AORN emphasized the importance of using appropriate heating devices to prevent the development of hypothermia in surgical patients and reported that the most effective heating system should be determined by evidence-based studies [12, 24].

In the literature, guidelines for the prevention of inadvertent perioperative hypothermia indicated that passive heating methods should be applied to prevent hypothermia in patients with body temperature above 36°C (96.8°F); it is stated that cotton-wool blankets, socks, and headgear can be used in the ward and PACU, and surgical

and metal-doped plastic covers can be used in the operating rooms. Forced air warming devices, which are active heating methods, reduce heat loss by radiation and provide heat transfer by convection and increase body temperature approximately 0.75°C (33.35°F)/h during the intraoperative period; it is reported that it is a cost-effective tool to actively warm up patients who develop hypothermia in the preoperative period [5, 20, 22, 27, 28].

NICE guideline recommends forced air warming for people with a core temperature below 36°C (96.8°F), those considered at high risk of hypothermia, and those undergoing surgery lasting >30 min [18]. Meyancı Köksal et al. [19] found that nearly half of the participants used forced air warming devices as a patient heating system, and some of them used hot water bags. In this study, it was found that the majority of the participants did not warm the patient in the waiting room before the operation, but routinely warmed the patient during the operation and in the PACU; it was found that active heating methods were the most commonly used methods. It was determined that cotton blanket-green covers were the most preferred method of passive heating methods, and forced air warming devices were used the most among the active heating methods. This result is consistent with the results of the study in the literature [5, 19, 20, 22, 27, 28]. However, the fact that patients are not heated in the preoperative waiting room reveals the importance of raising the awareness of health professionals working in the operating rooms through training and establishing common protocols to prevent perioperative hypothermia in order to ensure standardization in care.

Limitations of the Study

The sample size of the study was limited to the operating room nurses of 4 hospitals. The small sample size, missing data, and low response rate are other limitations of this study. Therefore, the generalizability of our findings may be limited. A larger sample size with a higher response rate may yield results that would be more representative of the general population of nurses working in perioperative settings. Another limitation is that the validity of the data collection form was evaluated only with the pilot study, and expert opinions were not consulted.

Conclusions

This study enables us to evaluate the nurses' knowledge related to hypothermia. The majority of the operating room nurses who participated in this study about deter-

mining the practices in maintaining normothermia in the operating room environment stated that they did not receive any training to prevent hypothermia, and the prevention of hypothermia was important. There was no common protocol used. It was determined that body temperature was measured mostly by the anesthesiologists before anesthesia induction, in the operating room, and in the PACU, from the skin/axillary and tympanic membrane areas, and forced air warming devices, which are active heating methods, are the preferred methods of heating.

Our results support the idea that surgical nurses should be aware of the risk of perioperative hypothermia. In line with these results, by including inadvertent perioperative hypothermia to in-service training programs of operating room nurses, their awareness should be increased about regular monitoring of body temperature to prevent the development of hypothermia and using appropriate and effective methods during the perioperative period to maintain normothermia.

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Statement of Ethics

In order to carry out the research, necessary institutional permissions were obtained from the relevant units, and the ethics committee permission was obtained from the ethics committee

(No. 19/07/2016-261008). Since human use requires protection of individual rights, informed consent requirement was fulfilled as an ethical principle, and written and oral permissions were obtained from the participants who met the sampling criteria.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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Author Contributions

We confirm that all listed authors meet the authorship criteria, and all authors are in agreement with the content of the manuscript. I.C., D.K., E.S.A., and N.A. designed the present study. D.K. and E.S.A. collected, analyzed, and interpreted the data. D.K. wrote the first draft of the manuscript. I.C., D.K., E.S.A., and N.A. revised the manuscript. All authors read and approved the final manuscript to be published.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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