

## Original Article

# Identifying the Knowledge and Applications of Nurses for Preventing Inadvertent Perioperative Hypothermia

**Ozum Mutluay, RN**

Clinical Nurse, Mersin University Hospital, Cardiovascular Surgery Department, Mersin, Turkey

**Gulay Altun Ugras, MSc, PhD**

Assistant Professor, Mersin University, Faculty of Nursing, Fundamental Nursing Department, Mersin, Turkey

**Tugba Cam Yanik, MSc, PhD, RN**

Research Assistant, Mersin University, Faculty of Nursing, Department of Surgical Nursing, Mersin, Turkey

**Correspondence:** Tugba Cam Yanik, MSc, PhD, RN, Research Assistant, Mersin University, Faculty of Nursing, Department of Surgical Nursing, Mersin, Turkey. E-mail: tugbacam@mersin.edu.tr

### Abstract

**Background:** The surgical nurse should identify patients at high risk of hypothermia. Considering the complications that hypothermia may cause; preventive measures should be taken before, during, and after surgery to prevent the development of inadvertent hypothermia.

**Objective:** To determine the knowledge and applications of nurses to prevent the development of hypothermia related to the perioperative period.

**Method:** This descriptive study consisted of 153 surgical nurses working in the surgical wards of a university hospital. Data collection form in the research; it consisted of questions that determined the demographic characteristics of nurses, their knowledge and applications to prevent hypothermia development during the perioperative period. Descriptive statistics, chi-square, independent samples t-test, repeated measures analysis of variance (ANOVA), Pearson correlation coefficient were used in data analysis.

**Results:** In the study, nurses reported that seven of the 20 high-risk patient groups with a high risk of hypothermia were at risk. The nurses stated that they knew and applied the methods of covering the patient, putting on socks and warming the bed among passive heating methods and the method of using a blanket with hot air blowing among active heating methods. In the study, a positive correlation was found between the preoperative, intraoperative, postoperative period and general knowledge score and the preoperative, intraoperative, postoperative and general practice score of the nurses ( $p < 0.001$ ).

**Conclusion:** The research showed that nurses do not know the majority of patients with high risk of hypothermia, and passive methods are known and applied more than active methods in the prevention of hypothermia. At the same time, the research revealed that with the increase in nurses' knowledge about the prevention of hypothermia, their practices also increased. As a result of this research, it is recommended that organize to training programs for the prevention of hypothermia in the perioperative process.

**Keywords:** Hypothermia, inadvertent, nurse, perioperative.

### Introduction

When the body's heat loss is greater than its heat generation, the decrease of its inner heat below 36°C is defined as hypothermia (Bucher, 2017; Link, 2020; Mohamed et al., 2022; Russell et al., 2022; Yuksel and Altun Ugras, 2016). It can either be controlled hypothermia applied during the perioperative

period or develop in an unplanned way independently of treatment. In some surgery and pathological conditions, controlled hypothermia is applied to reduce the metabolic rate of the patient (Honkavuo and Loe, 2020; Wang et al., 2020; Yuksel and Altun Ugras, 2016). Apart from controlled hypothermia, surgical patients are at high risk

of inadvertent hypothermia (IH), either arising due to the patient themselves or the surgery procedure (Yuksel and Altun Ugras, 2016).

Of patients undergoing surgery, 70% experience IH on average (Cavdar et al., 2021; Giuliano and Hendricks, 2017). IH is the condition in which the body temperature drops below 36°C within the period starting before the surgery (one hour before anesthesia) and lasting until 24 hours after anesthesia (ASPAN, 2016; Honkavuo and Loe, 2020; Yuksel and Altun Ugras, 2016). The perioperative IH can be estimated from the preoperative, intraoperative, and postoperative risk factors associated with the relevant surgery, in addition to the patient's own risk factors (Giuliano and Hendricks, 2017; Russell et al., 2022; Wang et al., 2020). Preoperative risk factors such as a cold bed or stretcher, inadequate/thin clothing, using wet clothes and duvet covers, a cold room, taking a shower in the morning of the surgery day, intravenous (IV) administration of cold fluids and blood products, performing the premedication application in a cold environment and failure to protect the patient's isolation, increase the likelihood of IH in patients (Durmaz et al., 2022; Isikli and Findik, 2022; Yuksel and Altun Ugras, 2016). Most patients develop IH as a result of a decrease in their body temperature through radiation, convection, and evaporation during anesthesia (Duman and Yilmaz, 2016; TARD, 2013). In addition, the risk of IH intraoperative increases depending on the age, gender, body surface area, type and duration of surgery to be performed, application of general and local anesthesia, temperature in the operating room (cold operating room environment) (Rauch et al., 2021; TARD, 2013).

## **Background**

The IH developing during the postoperative period may cause an increase in oxygen consumption and the incidence of complications after anesthesia (Durmaz et al., 2022; Rauch et al., 2021). Complications such as blood loss and the associated increase in the need for blood transfusion, prolongation of the extubation process, prolongation of stay in the post-anesthesia care unit and recovery process due to the increased risk of medical

complications, tremors, cardiac problems (myocardial ischemia, increase in cardiac morbidity, etc.), deep vein thrombosis, coagulopathy, increased wound site infection due to impaired immune system, increased metabolic requirements, decreased tissue oxygenation, impaired drug metabolism, decreased patient comfort, and increased mortality rates in trauma patients may be observed (Cavdar et al., 2021; Giuliano and Hendricks, 2017; Mohamed et al., 2022; TARD, 2013; Wang et al., 2020).

The American Association of Perioperative Registered Nurses (AORN) revised the guidelines for recognizing and preventing IH in 2019. The guideline emphasizes the importance of awareness of the risk factors for IH, associated complications, and preventive interventions on the part of nurses. Moreover, the guideline highlights the importance of surgical nurses having an adequate level of knowledge regarding the prevention of IH (AORN, 2020). Important institutions such as the AORN, American Society of PeriAnesthesia Nurses (ASPAN), Turkish Society of Anesthesiology and Reanimation (TARD), and National Institute for Health and Care Excellence (NICE) have published guidelines for the prevention of hypothermia in surgical patients.

These guidelines, which are constantly updated, recommend active and passive warming methods to prevent hypothermia and related complications (AORN, 2020; ASPAN, 2016; Link, 2020; NICE, 2016). Hypothermia control should start in the preoperative period and be maintained in the postoperative period to prevent/reduce complications due to hypothermia, thus maintaining quality care, increasing patient comfort, and accelerating the recovery process (Demirarslan, 2017; Link, 2020; Yuksel and Altun Ugras, 2016). The surgical nurse should determine the patients at high risk of IH and take preventive measures against the development of IH perioperative periods (for the entire perioperative period) taking into account the complications that IH may cause (AORN, 2020; ASPAN, 2016; Demirarslan, 2017; Durmaz et al., 2022; Tamer and Karadag, 2020). The literature reports that surgical nurses' knowledge and application levels regarding IH are insufficient (Durmaz et al., 2022; Tamer and

Karadag, 2020). This study aims to identify the nurses' knowledge and application levels for preventing the development of IH due to surgery.

### **Methodology**

**Design:** This study has a descriptive research design. The research was reported in accordance with the STROBE checklist (Von Elm et al., 2014). With a Type I error of 5% and within a confidence interval of 95%, the research sample was calculated using OpenEpi version 3 as at least 124 surgical nurses. The research was conducted with 153 nurses working in the surgical units of a university hospital [general surgery, orthopedics, thoracic surgery, otolaryngology, neurosurgery, cardiovascular surgery, ophthalmology, urology, plastic surgery, surgical intensive care unit (ICU) I and II, cardiovascular surgery ICU, anesthesia and reanimation ICU, special ward I and II, operating room] and meeting the research criteria. Twenty-eight nurses who were on leave or sick leave between these dates did not participate in the research. The inclusion criteria of the research was being a nurse working in a surgical clinic and caring for adult patients.

**Participants:** Inclusion criteria of the study were: (1) care for patients with COVID-19 during the study, (2) agree to participate in the study (sign the Informed Consent Form), (3) do not have an active COVID-19 infection, (4) do not use drug that affects the stress level (antidepressants, analgesics, beta adrenoreceptor antagonists, dopamine agonists) and (5) do not have any psychiatric diagnosis. Those who did not meet the inclusion criteria were excluded from the study.

**Instruments:** To gather the research data, a data collection form was prepared by the researchers by reviewing the literature (AORN, 2020; ASPAN, 2016; Link, 2020; NICE, 2016; NICE, 2017; TARD, 2013; WHO, 2016). After developing this form, the opinions of four specialists (*two lecturers and two experienced nurses, including a ward nurse and an operating room nurse*) were obtained.

The *first section* of the data collection form, which consists of three sub-sections, comprises six questions on the descriptive characteristics of nurses, including age,

gender, educational status, working years as a nurse, working years in a surgical unit, and the status of having received education on hypothermia.

The *second section* consists of three questions to reveal the nurses' knowledge about preventing hypothermia development in patients during the perioperative period and sub-items thereof. The nurses' *scores for their knowledge about preventing hypothermia* were obtained from their responses to the items related to determining the hypothermia risk before (8 questions), during (9 questions), and after (7 questions) the surgery and the items related to the passive and active warming applications. When calculating the nurses' knowledge score, the right option was calculated as one point and the wrong option as zero points. The nurses' preoperative, intraoperative, postoperative, and total knowledge scores were calculated by summing up the scores of their responses. The resulting scores were converted into the hundred-point system. The total score obtained by a participant ranged between 0 and 24.

The *third section* of the data collection form consists of two questions for revealing the nurses' applications to prevent the development of hypothermia in patients during the perioperative period and sub-items thereof. The nurses' *scores for their applications to prevent hypothermia* were obtained from their responses to the items related to determining the hypothermia risk before, during, and after the surgery and the items related to the passive and active warming applications. When calculating the nurses' application scores, the "Yes" option was calculated as one point and the "No" option as zero points. The nurses' preoperative, intraoperative, postoperative, and total application scores were calculated by summing up the scores of their responses. The resulting scores were converted into the hundred-point system. The researcher applied the data collection form to the nurses agreeing to participate in the study through face-to-face interviews. The data collection process took an average of 15 minutes.

**Data Collection:** Data were collected face-to-face by taking the necessary security measures due to the COVID-19 pandemic between November 2021 and January 2022 (T. C. Ministry of Health, 2021).

**Data Analysis:** The data analysis was performed using the MedCalc 16 Demo version (MedCalc Software, Ostend, Belgium) software program. The descriptive statistics used in the study were frequency, percentage, average, and standard deviation. Categorical variables were analyzed through the Chi-squared test. The normal distribution and homogeneity of continuous variables were analyzed using the Shapiro-Wilk test and the Levene test. Since the research data exhibited a normal distribution, the independent sample t-test was used to compare the averages of two independent groups, and One-way analysis of variance (ANOVA) was used to compare the averages of more than two independent groups. Pearson correlation coefficient (r) was used to examine the relationship between two continuous variables. A p-value of <0.05 was considered statistically significant (p<0.05).

**Permissions:** Before starting the research, ethics approval from the ethics committee (Date and Number: 22.11.2018 and 2018/455) and written permission from the university hospital (Date and Number: 10.12.2018 and 41993462- 774.03/00000905657), and informed consent from the nurses were received. The research was conducted in accordance with the rules of the Declaration of Helsinki (World Medical Association, 2013).

## Results

The mean age of the nurses participating in the study was 31.14±5.76. Of the nurses, 74.5% were female, and 80.4% had a bachelor's degree. Their mean working years as a nurse was 8.15±6.23, while their mean working years in a surgical unit was 5.65±4.52. Of the nurses, 22.2% stated that they received training on preventing hypothermia, 10.5% stated that they received such training as part of their undergraduate education, 7.8% as part of in-service training, and 3.9% as part of a certification program (Table 1).

Of the participants, 79.7% stated that patients whose surgery lasts two hours or more are at risk of hypothermia, 79.1% pointed out the patients with anemia in this regard, 75.8% indicated the patients for whom cold irrigation fluids are used intraoperative, 73.9% newborns, 69.9% patients aged 65 and older,

68.6% patients with a low preoperative body temperature, and 60.8% frail patients (Table 2).

The findings on the nurses' knowledge and application levels regarding identifying perioperative hypothermia or hypothermia risk are shown in Table 3. Considering the nurses' knowledge levels, for the preoperative period, 94.1% of the nurses indicated the need for identifying the patients with hypothermia risk, 93.5% pointed out the need for measuring the body temperature of the patient when they were admitted to the ward and 92.2% before being referred the operating room; for the intraoperative period, 91.5% of nurses indicated the need for measuring the body temperature of the patient before the administration of anesthesia; and for the postoperative period, 91.5% of the nurses indicated the need for measuring the body temperature when the patient returned to the ward. Considering the application levels of nurses, for the preoperative period, 90.8% stated that they measure the body temperature of the patient when they are admitted to the ward and observe them in terms of signs and symptoms of hypothermia for the period they are in the ward, 88.9% pointed out that they identify the patients at risk of hypothermia; for the intraoperative period, 77.1% of the nurses indicated that they measure the patient's body temperature and identify the patients at a high risk of hypothermia before the administration of anesthesia, for the postoperative period, 93.5% stated that they measure the body temperature of the patient when they return to the ward, 92.8% pointed out that they evaluate whether the patient has tremors, 90.8% indicated that they question whether the patient experienced chills, and 90.2% mentioned that they observe the patient's skin color (Table 3).

The nurses' knowledge and application levels regarding passive warming methods for preventing hypothermia are shown in Figure 1. As a passive warming method, 92.2% of the nurses stated that they know covering the patient, 80.4% having the patient wear socks, 78.4% warming the bed, 75.2% raising the room temperature, 73.9% warming the blankets and piques, and 56.9% using cotton blankets. As a passive warming method, 96.7% of the nurses stated that they apply covering the patient, 85.6% raising the room



temperature, 77.8% having the patient wear socks, 76.5% warming the patient's bed, blankets, and piques (Figure 1). The nurses' knowledge and application levels regarding active warming methods for preventing hypothermia are shown in Figure 2. As an active warming method, 90.2% of the nurses indicated that they are aware of the warm air blanket, and 75.8% stated that they use it as well (Figure 2).

The findings on the nurses' knowledge and application levels regarding passive warming applications during the perioperative period are shown in Table 4. Considering the knowledge level of nurses regarding passive warming applications, for the preoperative period, 81% indicated the need for the patient room not to be cold, for the intraoperative period, 85.6% emphasized the need for covering the patient's entire body outside the operating room, 83% replacing the covers wetted intraoperative with dry materials, and for the postoperative period, 87.6% pointed out the need for keeping the patient room warm, 86.3% having the patient wear pajamas and socks and covering them with a blanket or pique. Considering the passive warming application levels of the nurses, for the preoperative period, 86.9% of the nurses stated that they make sure that the patient room is not cold, 80.4% indicated that they have patients who will go to the operating room wear operating room gowns (cotton/synthetic) and surgical caps, for the intraoperative period, 69.9% of them emphasized that they cover the entire body of the patient outside the operating room, for the postoperative period 88.9% pointed out that they make sure that the patient's room is not cold (Table 4).

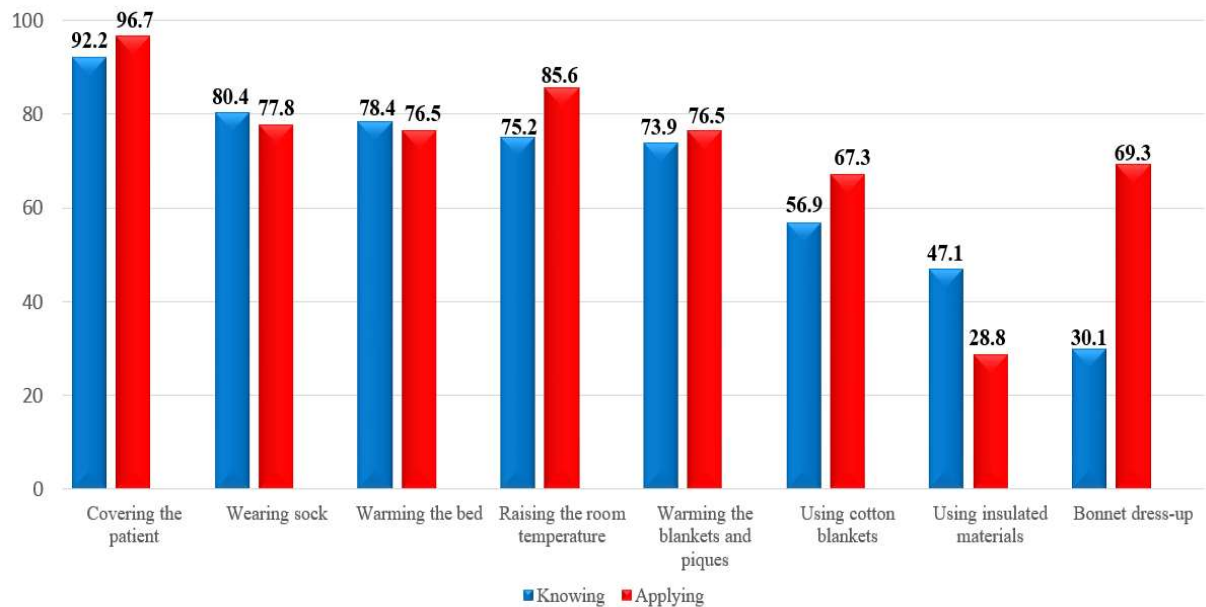
The findings on the nurses' knowledge and application levels regarding active warming applications during the perioperative period are included in Table 5. Considering the information levels of nurses for active warming applications, for the preoperative period, 77.1% of the nurses, for the intraoperative period, 78.4% of them, and for the postoperative period, 84.3% stated that the patients with a body temperature of  $<36^{\circ}\text{C}$  needs to be warmed through an active warming method. Considering the active warming application levels of the nurses, for the preoperative period, 71.9% of the nurses

stated that they pay attention to the fact that the transfusion fluids (IV, blood and blood products, etc.) are warmed and kept in the room temperature, for the intraoperative period, 58.8% of them stated that they warm all the patients whose anesthesia duration is longer than 30 minutes in the waiting room and warm the patients with a body temperature of  $<36^{\circ}\text{C}$  with a warm air blanket in the recovery room, for the postoperative period, 78.4% highlighted that if the body temperature is  $<36^{\circ}\text{C}$ , they warm the patient with one of the active warming methods (Table 5).

Table 6 includes the nurses' knowledge and application scores for preventing hypothermia. The nurses' mean scores for knowledge regarding preventing hypothermia were determined to be  $77.45 \pm 22.35$  for the preoperative period,  $67.25 \pm 23.73$  for the intraoperative period,  $81.70 \pm 24.61$  for the postoperative period, and  $74.86 \pm 20.36$  in total. The nurses' mean hypothermia-preventive application scores were  $69.49 \pm 24.17$  for the preoperative period,  $63.40 \pm 32.97$  for the intraoperative period,  $74.96 \pm 23.14$  for the postoperative period, and  $69.75 \pm 23.08$  in total (Table 6).

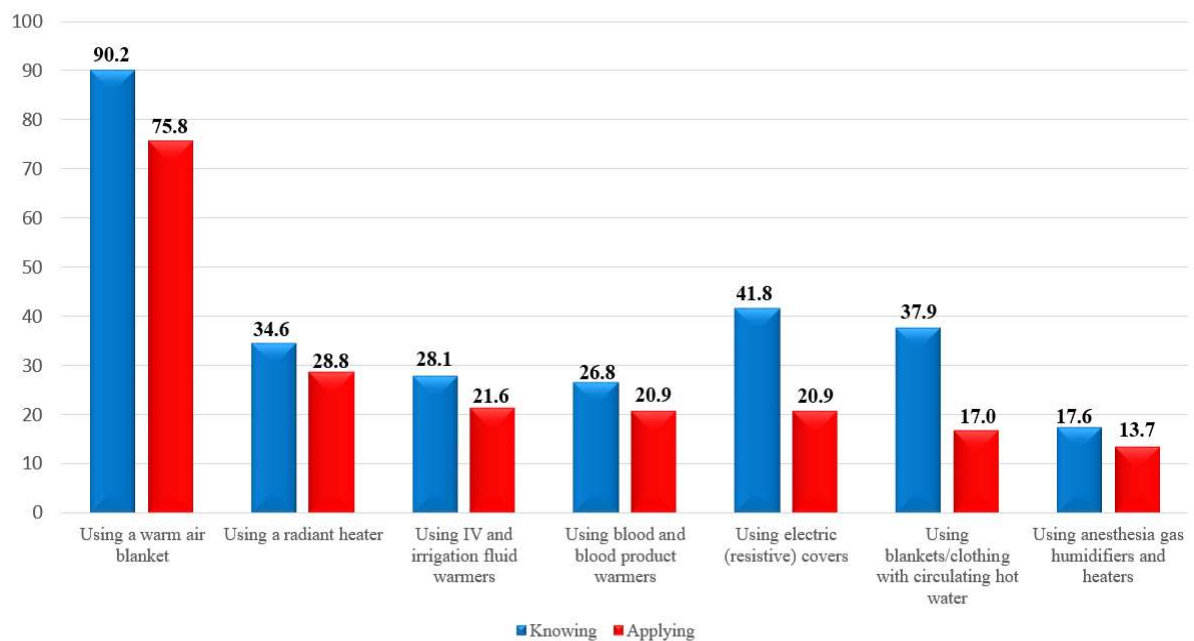
Table 7 shows the relationship between the nurses' knowledge and application scores for preventing hypothermia in the perioperative process. A positive relationship was determined between the nurses' score for knowledge regarding hypothermia prevention for the preoperative period and their preoperative, intraoperative, postoperative, and total application scores ( $p < 0.001$ ). A statistically significant positive relationship was found between the nurses' scores for knowledge regarding hypothermia prevention for the intraoperative period, and their preoperative, intraoperative, postoperative, and total application scores ( $p < 0.001$ ). A statistically significant positive relationship was determined between the nurses' scores for knowledge regarding hypothermia prevention for the postoperative period, and their preoperative, intraoperative, postoperative, and total application scores ( $p < 0.001$ ). It was determined that as the nurses' general knowledge scores for the preoperative, intraoperative, and postoperative periods increased, their preoperative, intraoperative,

and postoperative application scores also increased ( $p < 0.001$ ) (Table 7).



\* More than one option is selected.

**Figure 1.** The Results Related to Nurses' Knowledge and Application of Passive Heating Methods in the Perioperative Period



\* More than one option is selected.

**Figure 2.** The Results Related to Nurses' Knowledge and Application of Active Heating Methods in the Perioperative Period

**Table 1. Descriptive Characteristics of Nurses (n=153)**

<i>Characteristics</i>	<b>Mean</b>	<b>Standard Deviation</b>
Age	31.14	5.76
Years working as a nurse	8.15	6.23
Years of working in the surgical ward	5.65	4.52
<b>Gender</b>	<b>Number</b>	<b>%</b>
Female	114	74.5
Male	39	25.5
<b>Education status</b>		
Health Vocational High School	7	4.6
Associate Degree	10	6.5
Bachelor's Degree	123	80.4
Postgraduate	13	8.5
<b>Status of receiving training on hypothermia</b>		
Yes	34	22.2
<i>Undergraduate education</i>	16	10.5
<i>In-service training</i>	12	7.8
<i>Certification program</i>	6	3.9
No	119	77.8

**Table 2. Distribution of Nurses' Knowledge of Risk Factors for Hypothermia (n=153)**

<b>Knowledge of Risk Factors*</b>	<b>Number</b>	<b>%</b>
Patients whose surgery lasts of two hours or more	122	79.7
Patients with anemia	121	79.1
Patients using cold irrigation fluids during surgery	116	75.8
Newborns	113	73.9
Patients 65 years and older	107	69.9
Patients with low body temperature before surgery	105	68.6
Frail patients	93	60.8
Patients with a long fasting period before surgery	74	48.4
Patients undergoing large open cavity or abdominal surgery	69	45.1
Patients undergoing skin preparation using volatile solutions	67	43.8
Burn patients	67	43.8
Trauma patients	67	43.8
Patients with anesthesia (ASA) risk classification II and above	59	38.6
Sedated and premedicated patients	58	37.9
Women	57	37.3
Patients with hypothyroidism	51	33.3
Patients with adrenal insufficiency	49	32.0
Patients with diabetes mellitus	40	26.1
Patients with brain tumors	40	26.1
Patients with chronic renal failure	28	18.3

\* More than one option is selected.

**Table 3. Distribution of Nurses' Knowledge and Practice Status for Determining Hypothermia/Risk in the Perioperative Period (n=153)**

Surgery Periods	Knowledge for Determining Hypothermia/Risk	Number	%
Preoperative period	Identify patients with hypothermia risk	144	94.1
	Body temperature should be measured when the patient is admitted to the ward	143	93.5
	The patient's body temperature should be measured before being referred the operating room	141	92.2
Intraoperative period	The patient's body temperature should be measured before the administration of anesthesia	140	91.5
	Anesthesia induction should not be started until body temperature is $\geq 36^{\circ}\text{C}$	71	46.4
Postoperative period	Body temperature should be measured when the patient returned to the ward	140	91.5
	In the early period after surgery, body temperature should be measured at 30 min intervals	114	74.5
<b>Practices for Determining Hypothermia/Risk</b>			
Preoperative period	Measuring body temperature when the patient is admitted to the ward	139	90.8
	Observing the patient in terms of signs and symptoms of hypothermia for the period who is in the ward	139	90.8
	Identify patients at risk of hypothermia	136	88.9
	Reporting patients at risk of hypothermia to the physician	127	83.0
Intraoperative period	Measuring the patient's body temperature before anesthesia is given	118	77.1
	Identify patients at risk of hypothermia	118	77.1
Postoperative period	Measuring body temperature when the patient return to the ward	143	93.5
	Evaluating whether the patient has tremors	142	92.8
	Questioning the patient's chill status	139	90.8
	Observing the patient's skin color	138	90.2
	Assess piloerection (goose bumps) in the patient	125	81.7
	Measuring the patient's body temperature at 30 min intervals in the early period	120	78.4

**Table 4. Distribution of Nurses' Knowledge and Application of Passive Heating Practices in the Perioperative Period (n=153)**

Surgery Periods	Information on Passive Heating Practices	Number	%
Preoperative period	Patient room should not be cold	124	81.0
	The patient going to the operating room should wear an operating room gown ( <i>cotton/synthetic</i> ), cap and socks.	82	53.6
	Patients and their relatives should be informed that hospitals are a colder environment and that they should bring appropriate clothing ( <i>pajamas, socks, etc.</i> ) from home	104	68.0
	Patients with body temperature $\geq 36^{\circ}\text{C}$ should be warmed by passive heating	91	59.5
	Covering the patient with a blanket/pillow on the stretcher on the way to the operating room	82	53.6
	Intraoperative period	The patient's entire body should be covered outside the operating room	131
Wet drapes should be replaced with dry materials during surgery		127	83.0
If body temperature $\geq 36^{\circ}\text{C}$ ; heated in the recovery unit blankets should be used		73	47.7



	The room temperature in the operating room must be at least 24°C.	70	45.8
Postoperative period	Keeping the patient room warm	134	87.6
	Having the patient wear pajamas and socks and covering them with a blanket or pique	132	86.3
	Patients with a body temperature of 36-37.5°C should be warmed with passive heating methods	105	68.6
	<b>Passive Heating Practices</b>		
Preoperative period	Making sure that the patient room is not cold	133	86.9
	Dressing patients who will go to the operating room wear operating room gowns (cotton/synthetic) and surgical caps	123	80.4
	Informing patients and their relatives that hospitals are a colder environment and that they should bring appropriate clothing (pajamas, socks, etc.) from home	121	79.1
	Covering the patient with a blanket / pique on the stretcher on the way to the operating room	104	68.0
	If body temperature is $\geq 36^{\circ}\text{C}$ ; heating the patient with passive heating method	96	62.7
	Cover patients with a woolen/cotton blanket	95	62.1
	Dressing patients in woolen/cotton socks and clothes	88	57.5
	Sending patients to the operating room using insulating materials ( <i>bonnet, operating room shirt, etc.</i> )	84	54.9
	Sending patients to the operating room wearing socks	47	30.7
	Intraoperative period	Covering the patient's entire body outside the operating room	107
Ensuring that the operating room ambient temperature is 20-24°C		93	60.8
If the body temperature before anesthesia is $\geq 36^{\circ}\text{C}$ ; passive heating of the patient in the waiting room		89	58.2
If the body temperature is $\geq 36^{\circ}\text{C}$ ; covering the patient with a heated blanket in the recovery room		76	49.7
Postoperative period	Making sure that the patient room is not cold	136	88.9
	Heating the patient with a body temperature of 36-37.5°C with passive heating methods	107	69.9

**Table 5. Distribution of Nurses' Knowledge and Application of Active Heating Practices in the Perioperative Period (n=153)**

Surgery Periods	Information on Active Heating Practices	Number	%
Preoperative period	Patients with body temperature $< 36^{\circ}\text{C}$ should be warmed by active heating	118	77.1
	Transfusion fluids (IV, blood and blood products, etc.) should be heated/at room temperature	105	68.6
Intraoperative period	If the body temperature is $< 36^{\circ}\text{C}$ , a warm air blanket should be used in the recovery unit	120	78.4
	All patients with anesthesia duration $> 30$ min should be warmed by active heating in the waiting room	102	66.7
	Even if the duration of anesthesia is $< 30$ min, high-risk patients should be warmed by active heating in the waiting room	92	60.1
Postoperative period	Patients with body temperature $< 36^{\circ}\text{C}$ should be warmed by active heating	129	84.3
	Transfusion fluids ( <i>IV, blood and blood products, etc.</i> ) should be heated/at room temperature	121	79.1
<b>Active Heating Practices</b>			

Preoperative period	Paying attention to the heating of transfusion fluids (IV, blood and blood products, etc.)/at room temperature	110	71.9
	If body temperature is <36°C; warming the patient with active warming	106	69.3
	Warming patients with a warm air blanket before surgery	53	34.6
Intraoperative period	Heating all patients with anesthesia duration >30 min by active heating in the waiting room	90	58.8
	If body temperature is <36°C; warming the patient with a warm air blanket in the recovery room	90	58.8
	Active heating of high-risk patients in the waiting room, even if the duration of anesthesia is <30 min	84	54.9
Postoperative period	Heating fluids used during surgery	78	51.0
	If body temperature is <36°C; heating the patient with one of the active heating methods	120	78.4
	Warming the patient with a warm air blanket	109	71.2
	Heating transfusion fluids (IV, blood and blood products, etc.)/paying attention to room temperature	108	70.6

**Table 6. Nurses' Total Knowledge and Application Scores on Preventing Hypothermia**

Nurses' Scores for Preventing Hypothermia		Number of questions	Mean	Standard Deviation	Min-Max
Knowledge Scores	Preoperative	8	77.45	22.35	0-100
	Intraoperative	9	67.25	23.73	0-100
	Postoperative	7	81.70	24.61	0-100
	Total scores	24	74.86	20.36	0-100
Application Scores	Preoperative	16	69.49	24.17	0-100
	Intraoperative	10	63.40	32.97	0-100
	Postoperative	13	74.96	23.14	0-92.31
	Total scores	39	69.75	23.08	0-97.44

**Table 7. The Relationship Between Nurses' Knowledge Scores and Application Scores on Preventing Hypothermia in the Perioperative Period**

Nurses' Application Score for Prevention of Hypothermia	Nurses' Knowledge Score for Prevention of Hypothermia							
	Preoperative period		Intraoperative period		Postoperative period		Total scores	
	r	p*	r	p*	r	p*	r	p*
Preoperative period	0.539	<0.001	0.601	<0.001	0.546	<0.001	0.652	<0.001
Intraoperative period	0.380	<0.001	0.541	<0.001	0.463	<0.001	0.539	<0.001
Postoperative period	0.642	<0.001	0.643	<0.001	0.648	<0.001	0.744	<0.001
Total scores	0.585	<0.001	0.671	<0.001	0.621	<0.001	0.726	<0.001

\* Pearson Correlation analysis was used in data analysis.

## **Discussion**

Although studies investigating the incidence IH due to the surgical process (Duman and Yılmaz, 2016; Vural et al., 2018) in which active (Alderson et al., 2014; Bender et al., 2012; Lee et al., 2018; Soysal and İlçe, 2018) and passive warming methods (Alderson et al., 2014; Bender et al., 2012; Lee et al., 2018) for preventing hypothermia have been used have been reported in the literature (Alderson et al., 2014; Demirarslan, 2017; Duman and Yılmaz, 2016; Lee et al., 2018; Soysal and İlçe, 2018), a limited number of studies aiming at determining the nurses' knowledge and application levels for preventing IH occurring during the perioperative period have been found (Durmaz et al., 2022; Giuliano and Hendricks, 2017; Healey et al., 2018; Tamer and Karadag, 2020). This reveals the need for further research on the knowledge and application levels of nurses regarding IH.

### ***The Nurses' Knowledge Levels Regarding Risk Factors***

The hypothermia risk is especially higher in some patients, and this condition is stated in the guidelines (ASPAN, 2016; TARD, 2013; WHO, 2016). In the present study, the nurses indicated seven patient groups as risky among the 20 risky patient groups mentioned in the guidelines. In addition, one of the important results of the study is that patients reported as risky by the guidelines were not reported as risky by all nurses. Most of the nurses in the research stated that the patients undergoing a surgery lasting two hours and above are at risk of hypothermia, as reported in the literature (Bolt and Stannard, 2015; Steelman et al., 2015; TARD, 2013). Prolongation of the surgery duration causes excessive temperature loss in patients, and the use of general anesthesia and laminar air flow also increases the risk of IH (Akers et al., 2019; Yang et al., 2015). In the present research, one of the groups that the nurses considered risky was the patients with anemia. In their research, Billeter et al. have found that patients with anemia are a risky group in terms of hypothermia and that this condition is associated with insufficient amounts of hemoglobin in the blood (Billeter et al., 2014). The majority of the nurses in the present study indicated the patients for whom cold irrigation

fluids are used emphasized the need for covering the patient's entire body outside the operating room, 83% replacing the covers wetted intraoperative with dry materials as the patient group who is risky in terms of hypothermia. A systematic review has emphasized that the temperature of the fluids to be used in surgical patients must be 37-41°C (Cambell et al., 2015). Another patient group indicated by the nurses in the present study as having an IH risk is patients with low preoperative body temperature. Studies in the literature have determined that the intraoperative and postoperative hypothermia risk is high in patients with preoperative hypothermia (Duman and Yılmaz, 2016; Healy et al., 2018; Xu et al., 2019). More than half of the nurses stated that the groups that are risky in terms of hypothermia are newborns, patients who are 65 and above, or frail patients. The increased volume-to-surface ratio in newborns, low vasoconstrictor capacity at an advanced age, and decrease in the subcutaneous fat tissue in frail patients are among the factors that increase the risk of hypothermia (Aktay et al., 2017; Hart et al., 2011; Koksall et al., 2013).

The literature emphasizes that nurses should identify the patient groups at risk of hypothermia (Billeter et al., 2014; Durmaz et al., 2022; Steelman et al., 2015; TARD, 2013). In the present study, it was determined that most of the patients at risk of hypothermia were inadequately known by nurses. To prevent the development of complications in the patient due to hypothermia during the perioperative period and to increase patient comfort, surgical nurses need to identify the group of patients at risk of hypothermia and risk factors.

### ***The Nurses' Knowledge and Application Levels for Active and Passive Warming Applications in the Preoperative Period***

The fact that the nurses knew and applied passive warming methods more than active warming methods is one of the important results of the research. Guidelines and existing research recommend that patients with a preoperative body temperature of >36°C be warmed through passive warming methods (AORN, 2020; AST, 2015; ASPAN, 2016; Lee et al., 2018; Mohamed et al., 2022; NICE, 2017; TARD, 2013). In the present

study, more than 50% of the nurses stated that they are aware of the fact that having the patient wear an operating room gown and surgical cap and ensuring that the environment is not cold prevents hypothermia, while most nurses indicated that they perform these applications. The guideline issued by TARD in 2013 recommended that patients be dressed in operating room gowns, socks, and surgical caps. The fact that passive warming methods are accessible and are a routine part of the preoperative preparation may have caused nurses to apply these methods more often. In addition, the number of nurses who carry out these interventions is greater than the number of nurses who know that the said interventions prevent hypothermia. This suggests that these interventions are practiced unconsciously.

Another important study result is that active warming methods are less known and applied by nurses than passive warming methods. For patients with a body temperature of  $<36^{\circ}\text{C}$ , ASPAN recommends warming them with warm air blankets, warming the transfusion fluids used (*IV, blood and blood products, etc.*), and keeping them at room temperature (ASPAN, 2016). In their study, Jo et al. (2015) have found that the warm air blankets used in preoperative warming do not affect the intraoperative hypothermia incidence. Whereas the same study has reported that moderate/severe hypothermia development has been prevented in patients in the recovery unit after surgery (Jo et al., 2015). The literature reports that warm air-blowing devices are among the most effective methods for preventing hypothermia (Alderson et al., 2014; Giuliano and Hendricks, 2017), but their use rate is lower as in the present study (Durmaz et al., 2022; Koksall et al., 2013; Tamer and Karadag, 2020).

#### ***The Knowledge and Application Levels of Nurses for Passive and Active Warming Methods Used in the Intraoperative Period***

In the present study, the nurses indicated that they know covering the areas outside the surgical site and raising the ambient temperature among the passive warming methods applied during the perioperative period. However, it was determined that fewer nurses apply these interventions. The

literature reports that the hypothermia risk during surgery is high (Lee et al., 2018; Soysal, 2018; Vural et al., 2018), and this increases the risk of postoperative hypothermia (Lee et al., 2018; Vural et al., 2018) and associated complications (Akers et al., 2019). Therefore, hypothermia must be prevented by applying the relevant interventions. Although passive warming methods alone are not sufficient for maintaining and raising body temperature, they reduce hypothermia incidence when used in combination with active warming methods (AORN, 2020; Duman and Yilmaz, 2016; Mohamed et al., 2022; Vural et al., 2018). The literature reports that body temperature can be maintained better using newly developed passive insulation materials. In the study conducted by Koenen et al. (2017), 50% of the 328 patients who received general anesthesia and with whom the duration of surgery lasted less than an hour were covered with a cotton blanket, while the other half were covered with a thermal blanket before the surgery. In the said study, the thermal blanket was found to be more effective in reducing hypothermia compared to the cotton blanket (Koenen et al., 2017). On the other hand, in another study comparing the cotton blanket with a newly developed insulated passive warming material (Barrier® EasyWarm®), it was reported that with the new insulation material, the internal body temperature was preserved better during surgery than with the cotton blanket, preoperative and postoperative thermal comfort was increased, and the IH incidence was reduced (Torossian et al., 2016). In the current study, on the other hand, less than 50% of the nurses stated that they know that insulation material reduces hypothermia, and even fewer nurses indicated that they apply that method. This study result seems to have arisen from the lack of insulation materials in the hospital where the nurses worked. The present study also reveals that nurses were unable to provide appropriate care in accordance with the guidelines during the surgery. Since the reasons for the nurses' inability to perform their applications in accordance with the guidelines were not examined specifically, the low frequency of these applications can be said to have arisen from the insufficiency of materials, nursing staff, not caring about hypothermia or lack of

decision makers to introduce such applications.

In a study by Koksall et al. (2013) aiming at determining the applications of physicians for preventing hypothermia during surgery, 42.3% of the physicians stated that they warm the participants with a preoperative body temperature of  $<36^{\circ}\text{C}$  with a warm air-blowing device. In a study by Cavdar et al. (2021), 77.9% of the operating room nurses stated that they use warm air-blowing devices. In another study, on the other hand, it was found that actively warming patients shortened the transition to normothermia by an average of one and a half hours compared to using an unwarmed cotton blanket and was more effective in preventing chills in the patient (Campbell et al., 2015). In the present study, the majority of nurses stated that they know the warm air blanket from active warming applications, but fewer of them stated that they use it. This may have arisen from the absence of the warming device in all units and material deficiency.

#### ***The Knowledge and Application Levels of Nurses for Passive and Active Warming Methods Used in the Postoperative Period***

In the present study, the majority of nurses reported that the patient room must not be cold, the patient must be dressed in pajamas and socks, and they must be covered with a pique or blanket in the postoperative period, while the same percentage of nurses stated that they apply these measures. In the postoperative period, measuring the patient's body temperature is one of the necessary care applications. In the present study, the high number of nurses who reported monitoring the hypothermia signs in the postoperative period might have resulted in the more frequent application of interventions for preventing hypothermia. In addition, patients indicating that they are cold could be another factor for more frequent application of passive and active warming interventions.

In the present study, more than half of the nurses stated that they knew and fulfill the need for warming the fluids to be administered to the patients. Similar to the present research, in the study by Tamer and Karadag (2020), it has been reported that the method of administering the IV fluids by warming, which is one of the active warming

methods, is accurately known by the majority of nurses. On the other hand, the study by Cavdar et al. (2021) has reported that the number of operating room nurses who administer IV fluids by warming is quite low. In the studies comparing the irrigation fluids kept at room temperature or warmed ( $21^{\circ}\text{C}$  or  $37^{\circ}\text{C}$ ), the irrigation fluid administered by keeping at room temperature has been found to cause hypothermia more than those administered by warming. In addition, researchers have stated that keeping irrigation fluids at room temperature or warming them is necessary but not sufficient alone for maintaining body temperature, and other active and passive warming methods should also be used for preventing hypothermia (Pan et al., 2015; Tekgul et al., 2015).

#### ***The Relationship Between the Nurses' Scores of Knowledge and Application for Preventing the Hypothermia During the Surgery***

In the present study, it was determined that as the nurses' scores of knowledge for preventing hypothermia during the surgery increases, their application scores also increases. This result suggests that nurses who have gained knowledge about hypothermia perform more applications to prevent hypothermia during the surgery and that there is an awareness among nurses in this regard.

**Limitations of the Study:** The research is limited to nurses who work in the surgical units of a university hospital and provide care for adult patients.

**Conclusions:** The research showed that the nurses do not know enough about patients at high risk of hypothermia, know and apply passive methods for preventing IH more than active ones, but cannot adapt adequately to the guideline recommendations. In addition, the research revealed that as the nurses' knowledge about preventing IH increases, their related applications also increase. As a result of this research, it can be recommended that training programs covering the identification of patients at high risk of hypothermia in the perioperative period and active and passive methods for preventing hypothermia be planned for nurses, and these training programs be included in the undergraduate curriculum, in-service training, and certificate programs. In addition, it may



be recommended that new studies be planned to investigate the reasons for nurses' inability to abide by guidelines.

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