

Research Article

Knowledge and Practices of Surgical Nurses on Inadvertent Perioperative Hypothermia

Aynur Koyuncu¹, Songül Güngör², Ayla Yava¹¹Department of Nursing, Hasan Kalyoncu University, Faculty of Health Sciences, Gaziantep, Turkey²Department of Nursing, Osmaniye Korkut Ata University, Faculty of Health Sciences, Osmaniye, Turkey

ORCID iDs of the authors: A.K. 0000-0003-3486-458X, S.G. 0000-0003-2814-5378, A.Y. 0000-0003-3468-6779

Cite this article as: Koyuncu, A., Güngör, S., & Yava, A. (2023). Knowledge and practices of surgical nurses on inadvertent perioperative hypothermia. *Florence Nightingale Journal of Nursing*, 31(1), 18-25.

Abstract

AIM: This study aimed to determine surgical nurses' knowledge of the risk factors and complications of inadvertent perioperative hypothermia and the practices preferred to prevent inadvertent perioperative hypothermia and to provide normothermia.**METHODS:** This descriptive study was conducted on 122 volunteer nurses working in the surgical clinics of a state and a private hospital between August 1 and September 15, 2019. The data collection form included questions to determine the characteristics of nurses and the risk factors, complications, and preventive practices of inadvertent perioperative hypothermia. The data forms were distributed by visiting the nurses one by one and were retrieved after an appropriate time. For statistical analyses, Statistical Package for the Social Sciences 22.0 software was used.**RESULTS:** The most known risk factors for IPH were "excessive blood loss" (75.4%), "anemia" (73.0%), and "inadequate covering of the patient/not enough clothing" (72.9%). The most known complications of inadvertent perioperative hypothermia were "increased oxygen consumption and need" (65.6%), "hypoxemia" (61.5%), and "hypoxia" (49.4%). The most preferred method to provide normothermia in the perioperative period was "covering the patient with a blanket" (80.3%).**CONCLUSION:** In this study, nurses did not have enough information about the risk factors and complications of Inadvertent perioperative hypothermia. In addition, it was determined that most of the nurses did not use the methods in the guidelines to prevent inadvertent perioperative hypothermia.**Keywords:** Body temperature, inadvertent perioperative hypothermia, knowledge, surgical nurses, warming

Introduction

The human body loses heat due to radiation, physical contact, convection caused by airflow, evaporation due to respiration, and perspiration (Kurz, 2008; Rauch et al., 2021). In addition to the above factors, in patients undergoing surgical intervention, local and general anesthetic drugs also cause loss of body temperature and hypothermia by various mechanisms (Turkish Society of Anesthesiology and Reanimation Guideline, 2013). Cold operating room environment, table, and other devices also deepen intraoperative hypothermia primarily through radiant heat loss (Kurz, 2008). Under normal conditions, the human body has its mechanisms to maintain or generate heat. However, general or local anesthesia causes vasodilation and disrupts homeostatic mechanisms (McSwain et al., 2015; Rauch et al., 2021). For the reasons outlined above, the surgical patient carries a high risk of perioperative inadvertent perioperative hypothermia (IPH) in the perioperative period (McSwain et al., 2015).

Inadvertent perioperative hypothermia is defined as a decrease in the core body temperature below 36°C from the preoperative period (1 hour before anesthesia) to the postoperative (the first 24 hours after anesthesia) period (Link, 2020; Turkish

Society of Anesthesiology and Reanimation Guideline, 2013; Polderman, 2009). It has been reported that the incidence of IPH in surgical patients varies between 50% and 90% (Burns et al., 2009; Knaepel, 2012). Inadvertent perioperative hypothermia causes an uncontrolled and unexpected decrease in the body's metabolic rate. This may lead to changes and delays in drug metabolism, shivering, increase in metabolic requirements, decrease in tissue oxygen perfusion, delay in wound healing, increase in surgical site infection, increased need for blood transfusion, and some cardiac events (Scott & Backland, 2006; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). In addition, it has been reported that as the body temperature decreases in patients with IPH, complications, mortality rates, the length of hospital stay, and healthcare costs increase, while patient satisfaction decreases (Karalapillai et al., 2009; Link, 2020; Turkish Society of Anesthesiology and Reanimation Guideline, 2013).

In the guideline for recognizing and preventing IPH, revised in 2019 by the American Association of Perioperative Registered Nurses (American Association of Perioperative Registered Nurses, 2020), the importance of understanding the risk factors, complications, and preventive interventions for IPH was emphasized by the surgical nurses. In the same guide, it is

stated that surgical nurses who have sufficient knowledge about IPH play a key role in preventing IPH and its negative consequences (American Association of Perioperative Registered Nurses, 2020). Surgical nurses are also responsible for identifying patients at risk for IPH from the preoperative period, planning appropriate interventions recommended in the guidelines to reduce body temperature losses, and providing normothermia with appropriate warming methods (American Association of Perioperative Registered Nurses, 2020; National Institute for Health and Care Excellence Guideline, 2016).

Surgical nurses have responsibilities to prevent IPH and maintain normothermia. However, it is not known whether surgical nurses know the risk factors and complications of IPH and to what extent they apply the recommendations in the guidelines. In addition, despite increasing evidence and guideline recommendations on warming methods, IPH remains a major problem affecting surgical patients (Akers et al., 2019; Burns et al., 2009; Link, 2020; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). Despite the high incidence of IPH, its serious complications, and negative consequences affecting morbidity and mortality, the number of studies investigating nurses' knowledge about IPH and their practices to protect patients from IPH is limited. In these studies, it was stated that most of the nurses did not evaluate the body temperature of the patients before anesthesia (Tamer & Karadağ, 2020), they frequently neglected to record their body temperature (Ireland et al., 2006), and the definitions of hypothermia and normothermia showed significant differences between nurses (Evans & Kenkre, 2006; Ireland et al., 2006). In addition, nurses' awareness of IPH was not sufficient (Hegarty et al., 2009), and it has been shown that nurses do not know enough about the methods of preventing heat loss and warming patients (Evans & Kenkre, 2006; Hegarty et al., 2009; Ireland et al., 2006; Tamer & Karadağ, 2020).

Considering the incidence of IPH in surgical patients, its complications, and its effects on mortality, the importance of determining the knowledge and practices of surgical nurses on IPH and eliminating their deficiencies in this regard emerges. More research is needed to determine the level of knowledge of surgical nurses about the risk factors and complications of IPH and nurses' practices for prevention (Akers et al., 2019; Evans & Kenkre, 2006; Hegarty et al., 2009; Ireland et al., 2006; Tamer & Karadağ, 2020). It has been evaluated that studies examining nurses' knowledge about the risk factors and complications of IPH and their practices for the prevention of IPH may be useful in raising awareness of nurses about IPH, as well as developing in-service training programs and application algorithms.

This study aimed to determine the knowledge of surgical nurses about the risk factors and complications of IPH and their implementations for preventing IPH and providing normothermia in the perioperative period.

Research Questions

1. What is the knowledge of surgical nurses about the risk factors of inadvertent perioperative hypothermia?
2. What is the knowledge of surgical nurses about the complications of inadvertent perioperative hypothermia?

Method

Study Design

This study was carried out in descriptive type.

Sample

This descriptive study was conducted on 122 surgical nurses working in the surgical clinics and operating rooms of a state and a private hospital in Osmaniye, who met the sampling criteria and volunteered to participate in the research, between August 1 and September 15, 2019.

The universe of the study consisted of 176 nurses working in all surgical clinics and operating rooms of the two hospitals for at least 1 year. A total of 54 nurses, 21 of whom refused to participate in the study and 33 of whom were working night shifts at the time of data collection and could not be reached because they were on leave, were excluded from the study, and 122 (69.3%) nurses participated in the study voluntarily.

Data Collection Forms

Nurses' characteristics form. This form includes the characteristics of nurses such as age, gender, educational status, duration of nursing experience, and duration of experience in the last surgical department, education on IPH, and how competent the nurses perceive themselves about IPH and their training needs in this regard.

Inadvertent perioperative hypothermia questionnaire form. The form was composed of statements to determine nurses' knowledge of the risk factors and complications of IPH and their practices to prevent IPH. The statements on "IPH Risk Factors" and "Nurses' Practices to Maintain Normothermia and Prevent IPH" were created by researchers using relevant guidelines (American Association of Perioperative Registered Nurses, 2020; National Institute for Health and Care Excellence, 2016; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). There are many risk factors and complications that are not included in this study but are defined in the guidelines for IPH. For determining the risk factors and complications in the guidelines to be included in the study, attention was paid to the fact that these factors were obtained from strong scientific evidence.

A 33-item questionnaire was prepared—13 for IPH risk factors, 13 for complications, and 7 for practices for maintaining normothermia and preventing IPH. In the form, nurses were asked to mark the items they thought were "correct" from the statements under the headings of "IPH Risk Factors" and "IPH Complications." Nurses were also asked to mark their practices from the statements in the section under the heading "Practices for Protecting Normothermia and Preventing IPH."

Content Validity of the Inadvertent Perioperative Hypothermia Questionnaire Form

A content validity index (CVI) study was conducted to determine the validity of the form in terms of measuring the purpose of the research and the features expected to be determined. Davis technique was used for the CVI study (Davis, 1992). Under the Davis technique, the opinions of four nursing faculty evaluators were sought. Faculty members were asked to evaluate

the 34 statements in IPH questionnaire form, in terms of item structure, the level of measuring the investigated features, and suitability for the research (1: not suitable, 2: somewhat appropriate, 3: quite appropriate, and 4: completely appropriate). The rate of agreement between raters (CVI value) was determined to be 1.0, and it was decided that the content validity of the form was sufficient.

The pre-application of the form was carried out with 10 nurses working in the surgical clinics of a private hospital different from the hospitals where the research was conducted, meeting the sampling criteria and voluntarily participating in the pre-application. As a result of the pre-application, the form was not changed since the participants stated that no part was understood about the questions in the form. The data of the nurses who had attended the pre-application of the form were not included in the study.

Data Collection

The surgical clinics and operating rooms of the hospitals were visited by the researchers, and the nurses were informed one by one about the purpose and method of the study. Nurses who volunteered to participate in the study signed the voluntary consent form. Data forms of the research were then distributed to the volunteer nurses. After the forms were distributed, the researchers approximately 30–60 minutes later visited the nurses one by one and retrieved the completed data collection forms.

Statistical Analysis

Data were evaluated by using Statistical Package for Social Sciences, Version 22.0 (IBM SPSS Corp., Armonk, NY, USA). For statistical analysis, mean \pm standard deviation for continuous numerical variables, number (*n*) and percent (%) values for categorical variables were calculated. The statistical significance of the percentage differences between the groups (nurses' characteristics groups) was analyzed with the Pearson chi-square test, and a *p*-value $<.05$ was considered statistically significant.

Ethical Considerations

The university's Osmaniye Korkut Ata University, Scientific Research and Ethics Committee approval (date: July 12, 2019, and number 2019/9/1), written permission of the hospitals where the research conducted, and written informed consent of the volunteer nurses were obtained before starting the study. Written permission for the pre-application was obtained from the nursing management of the private hospital. The study was conducted with respect to the principles of the Declaration of Helsinki.

Results

The mean age of the nurses participating in the study was 35.20 ± 8.32 years; most of them (90.2%) were female and had a bachelor's degree (72.3%). The mean professional experience of the nurses was 12.84 ± 8.95 years, the mean experience in the surgical department was 5.86 ± 6.80 years, and 22.1% of the nurses were working in the operating room and 20.5% in the surgical intensive care unit (Table 1).

The number of the nurses who answered the question "Did you attend any IPH training before or after graduation?" as "no" was 101 (83.2%) and those who answered the question "Do you find

your knowledge and practices sufficient to prevent IPH?" as "yes" was 21 (17.2%). Eighty-four nurses (68.9%) stated that they would like to participate in the training to be given on IPH (these results are not shown in a table).

The rates of IPH risk factors known by the nurses are shown in Table 2. The most known risk factors by the nurses were "excessive blood loss" (75.4%), "anemia" (73.0%), "inadequate covering of the patient/not enough clothing" (72.9%), "cold operating room/ambient temperature" (71.3%), "high amount of fluid loss" (68.0%), and "long duration of surgery–anesthesia time" (61.5%). The least known risk factors were "large incision area" (24.9%), "types of surgical procedure" (18.9%), and "presence of type II diabetes mellitus" (18.0%) (Table 2).

The rates of the complications of IPH known by the nurses are shown in Table 3. According to Table 3, the most known IPH complications by the nurses were "increased oxygen consumption and need" (65.6%), "hypoxemia-decreased amount of oxygen in the blood" (61.5%), and "hypoxia-decreased amount of oxygen in tissues" (60.6%). The items "impairment and delay in wound healing" (27.9%), "impairment of drug metabolism" (26.2%), "increase in surgical site infection" (23.8%), and

Table 1.
Nurses' Descriptive Characteristics (N=122)

Characteristics	n	%
Age (minimum: 21, maximum: 59; mean \pm SD= 35.20 ± 8.32) years		
Gender		
Female	110	90.2
Male	12	9.8
Educational status		
Health vocational high school	12	9.8
Associate degree	15	12.3
Baccalaureate	88	72.3
Master degree + PhD in Nursing	7	5.7
Experience in nursing (minimum:1, maximum:32; mean \pm SD: 12.84 ± 8.95) years		
Experience in Department of Surgery (minimum:1, maximum: 30; mean \pm SD: 5.86 ± 6.80) years		
Departments		
Operating room	27	22.1
Surgical intensive care	25	20.5
Gynecology	22	18.0
General surgery	11	9.0
Orthopedic surgery	9	7.4
Urology	9	7.4
Neurosurgery	8	6.6
Ear–nose–throat–eye services	6	4.9
Plastic surgery	5	4.1

Note: SD = standard deviation.

Table 2.
Risk Factors of IPH Known by the Nurses (N= 122)

IPH Risk Factors	n	%
Excessive blood loss (>30 mL/kg)	92	75.4
Anemia	90	73.0
Inadequate covering of the patient/not enough clothing	89	72.9
Cold operating room/ambient temperature (<21°C)	87	71.3
High amount of fluid loss	83	68.0
Long duration of surgery–anesthesia time (>2 hours)	75	61.5
Age (<1 month and >65 years)	60	49.6
Presence of cardiovascular disease	45	36.9
Unheated intravenous serum infusions (>500 mL and <36°C)	44	36.0
Unheated blood transfusion	42	34.0
Large incision area	30	24.6
Type of surgical procedure ^a	23	18.9
Type II diabetes mellitus presence	22	18.0

Note: IPH = inadvertent perioperative hypothermia.

^aMajor surgeries which have open, large incision areas, such as open colorectal surgeries and gynecologic surgeries.

“myocardial ischemia and infarction” (13.9%) were the least known complications by the nurses. Participants did not mark “metabolic acidosis” (0%) as a complication at all (Table 3).

The answers given by the nurses to the question “Please mark the practices you have done to prevent IPH and provide normothermia in the perioperative process” are shown in Table 4. The most common three ranks were “covering with a blanket”

Table 3.
IPH Complications Known by the Nurses (N= 122)

IPH Complications	n	%
Increased oxygen consumption and need	80	65.6
Hypoxemia (decrease in oxygen amount in the blood)	75	61.5
Hypoxia (decrease in oxygen amount in tissues)	74	60.6
Delay in recovery from anesthesia	61	50.0
Increased bleeding due to surgery	43	35.2
Increased need for blood transfusion	43	35.2
Tachycardia	39	32.0
Arrhythmia (especially ventricular tachycardia)	36	29.5
Impairment and delay in wound healing	34	27.9
Impairment of drug metabolism	32	26.2
Increase in surgical site infection	29	23.8
Myocardial ischemia and infarction	17	13.9
Metabolic acidosis	0	0

Note: IPH = inadvertent perioperative hypothermia.

Table 4.
Nurses’ Implementations for Preventing IPH and Providing Normothermia (n= 122)

Implementations	n ^a	% ^a
Covering the patient with a blanket	98	80.3
Increasing the ambient temperature	97	79.5
Getting the patient to put on their clothes	79	64.8
Warming the patient with hot air blowers	60	49.1
Measuring body temperature every 15 minutes	59	48.3
Using a hot thermophore (except the wound area)	53	43.4
Warming blood and infusion fluids before infusing them	45	36.9

Percentage values were calculated according to the number of participants (N= 122).

Note: IPH = inadvertent perioperative hypothermia.

^aSince the participants could give more than one answer, the number and percentage values were multiplied.

(80.3%), “to increase the ambient temperature” (79.5%), and “getting the patient to put on their clothes” (64.8%). The least preferred implementation was “warming blood and infusion fluids before infuse” (36.9%) (Table 4).

Discussion

Inadvertent perioperative hypothermia maintains its importance as an issue that has negative effects on the morbidity and mortality of surgical patients all over the world. Surgical nurses, who are responsible for the care in the perioperative process, have an important role in the prevention and care of IPH (Ciğerci et al., 2020). The results of this study to determine the knowledge of the risk factors and complications of IPH and the practices of nurses working in surgical clinics to provide normothermia showed that the knowledge level of nurses was not at the expected level in general. Despite our expectation that the risk factors of IPH would be known by most of the nurses who participated in our study, surprisingly, the ratio of nurses who knew the risk factors was between 13.9% and 75.4%. These results were considered, as the nurses did not follow the literature on IPH and were not aware of the guidelines on IPH. In this respect, our study results are similar to the results of previous studies (Evans & Kenkre, 2006; Giuliano & Hendricks, 2017; Hegarty et al., 2009; Ireland et al., 2006; Tamer & Karadağ, 2020). The fact that most of the nurses (83.2%) were not trained in IPH in our study may also have contributed to this result. As a matter of fact, in the current study, the majority of the nurses (68.9%) think that they need training on IPH, which supports our evaluation.

In the current study, it was seen that more than 60% of the nurses evaluated intraoperative factors such as blood and fluid loss related to the surgical process, anemia, ambient (operating room) temperature, duration of surgery–anesthesia, and insufficient coverage of the patient as risk factors for IPH (Table 2). Anemia and blood and fluid losses cause insufficient circulating blood and fluid volume, inability to meet the oxygen and nutrients needed by the tissues, and a decrease in heat production (Akers et al., 2019; Billeter et al., 2014; Evans & Kenkre, 2006;

Hegarty et al., 2009). Cold operating room and operating table, inadequate surgical dressings, and inadequate postoperative clothing cause heat losses through convection and inability to maintain normothermia (Knaepel, 2012; Link, 2020; McSwain et al., 2015; Yang et al., 2015). Surgical procedures lead to a decrease in heat production in patients and concomitant heat loss. The longer the operation time, the longer the patient is exposed to anesthetic agents. This causes the patient's body and internal organs to be exposed to low ambient temperatures for a longer period of time. This increases the risk of developing IPH in patients (McSwain et al., 2015). In similar studies, these factors were evaluated by nurses as risk factors for IPH (Giuliano & Hendricks, 2017; Hegarty et al., 2009; Tamer & Karadağ, 2020). These results show that most of the nurses know these risk factors that contribute to the development of IPH.

It has been reported that patients over 65 years old and newborn and premature babies are in the risk group for IPH (Akers et al., 2019; American Association of Perioperative Registered Nurses, 2020; Knaepel, 2012; Link, 2020; National Institute for Health and Care Excellence Guideline, 2016; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). More than half of the nurses in this study did not evaluate age as a risk factor for IPH. More than half of the nurses (58.1%) were working in surgical clinics for 1–4 years, and the mean working experience was approximately 6 years. In addition, considering the departments where the nurses work, it is seen that they work with different patient populations who underwent different surgical interventions (Table 1: see the subhead "Departments"). This may have caused some of the nurses to not be able to observe newborns and elderly patients adequately in terms of IPH and not gain enough experience. Another reason may be that the nurses did not know that the physiological mechanisms of newborns and geriatric patients were insufficient in balancing and regulating body temperature. In similar studies (Giuliano & Hendricks, 2017; Hegarty et al., 2009), unlike our study, most of the nurses evaluated newborns, patients over 70 years old, and pediatric patients as high risk for IPH. It is considered that the difference between the studies may be due to the different research designs and data collection tools. Indeed, in a similar study, nurses' ($n=324$) mean experience as a perioperative nurse is twice as much as our study (17.75 years), and more than 90% of them were working in the intraoperative field (Giuliano & Hendricks, 2017). Hegarty et al. (2009) stated that the majority of the nurses who participated in their study were working in the anesthesia and operating room departments (Hegarty et al., 2009). In the current study, only 22.1% of the nurses were working in the operating room. These results suggested that the nurses working in the operating room had the opportunity to experience the effects of age on IPH more because they observed patients in different age groups more frequently than the nurses working in other surgical areas. In the perioperative process, not only operating room nurses but also those working in all surgical clinics have important duties and responsibilities for recognizing IPH and identifying and preventing risky patients (American Association of Perioperative Registered Nurses, 2020; Burns et al., 2009; National Institute for Health and Care Excellence Guideline 2016). For this reason, we believe that it would be beneficial to provide the necessary training support to increase the awareness of all surgical nurses about IPH as well as operating room nurses.

Concomitant cardiovascular diseases in surgical patients cause hypoperfusion, insufficient oxygenation of the tissues, metabolic dysfunction, and, as a result, the development of IPH and deepening of hypothermia (Billeter et al., 2014; Kurz, 2008; McSwain et al., 2015). Only 36.9% of the nurses participating in this study evaluated this as a risk factor for IPH. This factor was not questioned in other studies (Giuliano & Hendricks, 2017; Hegarty et al., 2009; Tamer & Karadağ, 2020). Nurses should be aware that patients with cardiovascular disease are in the high-risk group for IPH. Adding this subject to nursing education will be beneficial in increasing the awareness of nurses on this issue.

Patients with diabetes are in the risk group in terms of both IPH and complications of IPH (Akers et al., 2019; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). Nervous system damage in type 2 diabetes patients with polyneuropathy causes the thermoregulation mechanism to not work effectively during surgical procedures and causes IPH (Kitamura et al., 2000). In addition, hypothermia causes a decrease in insulin sensitivity and the amount of insulin released from the pancreas, an increase in insulin requirement, and ultimately hyperglycemia (Billeter et al., 2014; Ousey et al., 2017). The majority of the nurses who participated in our study could not mark that diabetic patients are in the risk group for IPH. This result indicated that most of the participants could not evaluate the risk factors of IPH in patients with diabetes who underwent surgery; this made us think that they did not know or were not aware of the effect of hypothermia on insulin and glucose metabolism. Since the diabetes factor was not investigated in similar studies (Giuliano & Hendricks, 2017; Tamer & Karadağ, 2020), the studies' results could not be discussed together. In order to reach a conclusion on this issue, it was evaluated that more research is needed to investigate the effects of diabetes, which is a public health problem, on IPH. In addition, it was thought that recommendations for the prevention of IPH in diabetes patients should be included in guidelines and algorithms.

In this study, when the level of knowledge about the complications of IPH was asked, it was observed that more than 50% of the nurses correctly marked the complications such as increased oxygen demand and prolonged recovery time from anesthesia (Table 3). During the surgical process, blood loss, effects of anesthetic agents, and vasoconstriction decrease oxygen distribution to the body, thus increasing oxygen demand (McSwain et al., 2015; Poveda et al., 2009). It can be said that nurses reached this conclusion by observing the increase in the oxygen requirements of the patients in the postoperative period.

In hypothermic patients, decreased serum potassium values and increased sympathetic activity cause cardiac problems such as tachycardia, ventricular dysrhythmia, and hypertension (Rajagopalan et al., 2008). In this study, it was evaluated that the majority of nurses did not know about cardiac complications of IPH such as tachycardia and arrhythmia. In Giuliano and Hendricks's (2017) study, cardiac events were identified as risk factors for IPH by more than half (61.7%) of the participants (Giuliano & Hendricks, 2017). It was thought that this difference between studies was because the participants in the other study had more perioperative nursing experience. Providing information about cardiovascular complications of

IPH in in-service training is important for the early detection of IPH complications.

Anaerobic metabolism develops and lactic acid accumulates, as IPH causes tissue hypoxia and shivering and increased oxygen consumption. Metabolic acidosis is observed as a result of lactic acid accumulation (Billeter et al., 2014; Link, 2020; McSwain et al., 2015). In this study, none of the participants evaluated metabolic acidosis as a complication of IPH. This may be because the nurses did not encounter a patient with metabolic acidosis caused by IPH in the clinic. In addition, because metabolic acidosis is a complication mostly associated with shock or trauma, participants may not have associated it with IPH. Similar to the findings of the study, Ireland et al. (2006) found that nurses rarely defined metabolic acidosis (9%) caused by IPH (Ireland et al., 2006).

Even mild hypothermia postoperatively reduces both renal and hepatic blood flow and metabolism. This situation changes the pharmacokinetics of drugs (Hart et al., 2011; McSwain et al., 2015). Inadvertent perioperative hypothermia impairs the functions of enzymes that metabolize drugs (Akers et al., 2019; McSwain et al., 2015). As a result, excretion and plasma clearance of drugs are reduced, and the duration of action of drugs is prolonged (Hart et al., 2011). Disruption of drug metabolism may prolong or prevent the recovery time of patients from anesthesia, especially by prolonging the duration of action of anesthetic drugs (McSwain et al., 2015). The patient remains under the influence of anesthetic drugs longer. This means a prolongation of the postoperative awakening time and a longer stay in the postoperative recovery unit (Knaepel, 2012; McSwain et al., 2015). The findings of this study showed that more than 73% of nurses were unaware of this important complication. It is important for nurses to know this effect of IPH and to follow the effects of drugs administered to hypothermic patients. Therefore, training on IPH will contribute to the safety of surgical patients.

Inadvertent perioperative hypothermia causes a decrease in collagen level, delayed wound healing, and surgical site infections (McSwain et al., 2015; Öner et al., 2021). In the current study, we concluded that more than 70% of the nurses did not know that IPH causes delayed wound healing and surgical site infections. In a similar study, most of the nurses (65.4%) evaluated surgical site infection as a complication of IPH (Giuliano & Hendricks, 2017). It is thought that providing education on the clinical consequences of perioperative hypothermia will contribute to the reduction of surgical site infections, which are among the common problems in the postoperative period.

There is insufficient evidence about which heating methods are used in the management of IPH, when, and for how long (American Association of Perioperative Registered Nurses, 2020; Link, 2020; National Institute for Health and Care Excellence Guideline, 2016; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). Preserving the patient's body temperature, also known as passive heating methods in the literature, are applications for reducing heat loss. These practices include dressing patients in their clothes, putting on socks, and covering blankets (American Association of Perioperative Registered Nurses, 2020; National Institute

for Health and Care Excellence Guideline, 2016). It is recommended that patients with a body temperature of 36°C or higher, whose surgical procedure is completed, should be covered with at least one blanket during transfer to the recovery unit (American Association of Perioperative Registered Nurses, 2020; Madrid, et al., 2016; National Institute for Health and Care Excellence Guideline, 2016). In a previous study, nurses evaluated the application of heated blankets to patients as the most effective way to provide normothermia (Giuliano & Hendricks, 2017). In the current study, nurses stated that they used blanket covering (80.3%) and dressing the patient's clothes (64.4%) as passive heating methods. Although most of the nurses participating in the study stated that they used some methods to warm the patients, it was evaluated that all of the nurses should use active warming methods.

There is evidence that patients who develop IPH should be warmed up for at least 20 minutes. To prevent IPH, it is recommended that patients be warmed actively 20–30 minutes before the operation, and if the surgical operation time is longer than 60 minutes, they should be warmed for 30 minutes during the intraoperative period (American Association of Perioperative Registered Nurses, 2020; National Institute for Health and Care Excellence Guideline, 2016; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). In a meta-analysis study conducted by Ousey et al (2017), it was shown that the use of active warming methods in the perioperative process reduced surgical site infection due to IPH (Ousey et al., 2017). In our study, it was determined that less than half of the nurses used heated air-blowing devices and hot thermophores. In the guidelines, it is recommended to use active warming methods for inappropriate patients for the prevention and reduction of IPH (American Association of Perioperative Registered Nurses, 2020; National Institute for Health and Care Excellence Guideline, 2016; Turkish Society of Anesthesiology and Reanimation Guideline, 2013). The fact that the nurses in this study did not use heated air-blowing devices may have been a factor in the fact that they were not aware of the recommendations of the guide, as well as the absence of these devices in the service they worked.

In a systematic review by Campbell et al (2015), administration of heated intravenous fluids increased the body temperature by half a degree, and it has been reported that it also reduces the risk of shivering when compared to intravenous fluids at room temperature (Campbell et al., 2015). In this study, it was determined that most of the nurses applied blood and infusion fluids without warming them. In a previous study, unlike this study, it was determined that the third of the first four methods used by nurses to provide normothermia in the perioperative process was to warm and then infuse intravenous fluids into the patient (Giuliano & Hendricks 2017). It can be said that the nurses in this study did not know the methods of heating blood and infusion fluids or were not aware of the negative effects of these fluids given without heating.

Study Limitations

This study was conducted with surgical nurses working in two hospitals who agreed to participate in the study. Therefore, the research findings cannot be generalized. The research findings

are not based on observation, but the statements of the participants. The fact that there are few studies in the literature on this subject makes the research findings valuable.

Conclusion and Recommendations

The level of knowledge and practice competence of nurses is one of the factors affecting the success of preventing IPH and providing perioperative normothermia. In the current study, it was determined that the knowledge and practices of the nurses for the management of IPH were not sufficient and they did not know the risk factors and complications at the expected level. It was determined that a significant part of the nurses did not receive training on IPH, and they did not consider themselves competent in IPH management and wanted to receive training on it.

The knowledge level of nurses should be increased with in-service training programs to be organized on IPH. In addition, nurses should be informed about current guideline recommendations about IPH. Having sufficient knowledge about IPH by nurses can prevent or lessen IPH. Studies should be conducted to measure the effect of nurses' knowledge level on the success of management of IPH and the incidence of IPH in surgical patients.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Osmaniye Korkut Ata University (Date: July 12, 2019, No: 2019/9/1).

Informed Consent: Written permission of the hospitals where the research was conducted and written informed consent of the volunteer nurses were obtained before the start of the study. Written permission for the pre-application was obtained from the nursing management of the private hospital.

Peer-review: Externally peer-reviewed.

Author Contributions: Design – A.K., S.G., A.Y.; Supervision – A.K., A.Y., S.G.; Resources – A.K., S.G., A.Y.; Materials – A.K., S.G., A.Y.; Data Collection and/or Processing – S.G., A.K.; Analysis and/or Interpretation – A.Y., A.K., S.G.; Literature Search – A.K., S.G., A.Y.; Writing Manuscript – A.K., A.Y., S.G.; Critical Review – A.Y., A.K.

Declaration of Interests: We declare that there is no conflict of interest between the authors in this study.

Funding: The authors declared that this study has received no financial support.

References

Akers, J. L., Dupnick, A. C., Hillman, E. L., Bauer, A. G., Kinker, L. M., & Hagedorn Wonder, A. (2019). Inadvertent perioperative hypothermia risks and postoperative complications: A Retrospective Study. *AORN Journal*, 109(6), 741–747. [\[CrossRef\]](#)

American Association of Perioperative Registered Nurses (AORN) Guideline for Prevention of Hypothermia (2020). *Guidelines for perioperative practice* (pp. 327–356). Association of Operating Room Nurses.

Billeter, A. T., Hohmann, S. F., Druen, D., Cannon, R., & Polk, H. C. Jr. (2014). Unintentional perioperative hypothermia is associated with severe complications and high mortality in elective operations. *Surgery*, 156(5), 1245–1252. [\[CrossRef\]](#)

Burns, S. M., Wojnakowski, M., Piotrowski, K., & Caraffa, G. (2009). Unintentional hypothermia: Implications for perianesthesia nurses. *Journal of Perianesthesia Nursing*, 24(3), 167–73; quiz 174. [\[CrossRef\]](#)

Campbell, G., Alderson, P., Smith, A. F., & Warrtig, S. (2015). Warming of intravenous and irrigation fluids for preventing inadvertent perioperative hypothermia. *Cochrane Database of Systematic Reviews*, 13(4), CD009891. [\[CrossRef\]](#)

Ciğerci, Y., Yavuz van Giersbergen, M., Ayva, E., & Kılıç, İ. (2020). Comparison of body temperature, normothermia, and extubation times of patients heated with forced-air warming method based on whether patients underwent on-pump or off-pump coronary artery bypass graft. *Florence Nightingale Journal of Nursing*, 28(1), 33–40. [\[CrossRef\]](#)

Davis, L. L. (1992). Instrument review: Getting the most from a panel of experts. *Applied Nursing Research*, 5(4), 194–197. [\[CrossRef\]](#)

Evans, J., & Kenkre, J. (2006). Current practice and knowledge of nurses regarding patient temperature measurement. *Journal of Medical Engineering and Technology*, 30(4), 218–223. [\[CrossRef\]](#)

Giuliano, K. K., & Hendricks, J. (2017). Inadvertent perioperative hypothermia: Current nursing knowledge. *AORN Journal*, 105(5), 453–463. [\[CrossRef\]](#)

Hart, S. R., Bordes, B., Hart, J., Corsino, D., & Harmon, D. (2011). Unintended perioperative hypothermia. *Ochsner Journal*, 11(3), 259–270.

Hegarty, J., Walsh, E., Burton, A., Murphy, S., O'Gorman, F., & McPolin, G. (2009). Nurses' knowledge of inadvertent hypothermia. *AORN Journal*, 89(4), 701–704. [\[CrossRef\]](#)

Ireland, S., Murdoch, K., Ormrod, P., Saliba, E., Endacott, R., Fitzgerald, M., & Cameron, P. (2006). Nursing and medical staff knowledge regarding the monitoring and management of accidental or exposure hypothermia in adult major trauma patients. *International Journal of Nursing Practice*, 12(6), 308–318. [\[CrossRef\]](#)

Karalpillai, D., Story, D. A., Calzavacca, P., Licari, E., Liu, Y. L., & Hart, G. K. (2009). Inadvertent hypothermia and mortality in postoperative intensive care patients: Retrospective audit of 5050 patients. *Anaesthesia*, 64(9), 968–972. [\[CrossRef\]](#)

Kitamura, A., Hoshino, T., Kon, T., & Ogawa, R. (2000). Patients with diabetic neuropathy are at risk of a greater intraoperative reduction in core temperature. *Anesthesiology*, 92(5), 1311–1318. [\[CrossRef\]](#)

Knaepel, A. (2012). Inadvertent perioperative hypothermia: A literature review. *Journal of Perioperative Practice*, 22(3), 86–90. [\[CrossRef\]](#)

Kurz, A. (2008). Thermal care in the perioperative period. *Best Practice and Research. Clinical Anaesthesiology*, 22(1), 39–62. [\[CrossRef\]](#)

Link, T. (2020). Guidelines in practice: Hypothermia prevention. *AORN Journal*, 111(6), 653–666. [\[CrossRef\]](#)

Madrid, E., Urrutia, G., Roqué i Figuls, M., Pardo-Hernandez, H., Campos, J.M., Paniagua, P., Maestre, L., & Alonso-Coello, P. (2016). Active body surface warming systems for preventing complications caused by inadvertent perioperative hypothermia in adults. *Cochrane Database Syst Rev*, 21(4):CD009016.

McSwain, J. R., Yared, M., Doty, J. W., & Wilson, S. H. (2015). Perioperative hypothermia: Causes, consequences, and treatment. *World Journal of Anesthesiology*, 4(3), 58–65. [\[CrossRef\]](#)

National Institute for Health and Care Excellence (NICE) Guideline (2016). *Hypothermia: Prevention and management in adults having surgery*. National Institute for Health and Clinical Excellence. Retrieved from <https://www.nice.org.uk/guidance/cg65>

Öner Cengiz, H., Uçar, S., & Yılmaz, M. (2021). The role of perioperative hypothermia in the development of surgical site infection: A systematic review. *AORN Journal*, 113(3), 265–275. [\[CrossRef\]](#)

Ousey, K., Edward, K. L., Lui, S., Stephenson, J., Walker, K., Duff, J., & Leaper, D. (2017). Perioperative, local and systemic warming in surgical site infection: A systematic review and meta-analysis. *Journal of Wound Care*, 26(11), 614–624. [\[CrossRef\]](#)

Polderman, K. H. (2009). Mechanisms of action, physiological effects, and complications of hypothermia. *Critical Care Medicine*, 37(Suppl. 7), S186–S202. [\[CrossRef\]](#)

Poveda, VdB., Galvão, C. M., & Santos, C. Bd (2009). Factors associated to the development of hypothermia in the intraoperative period. *Revista Latino-Americana de Enfermagem*, 17(2), 228–233. [\[CrossRef\]](#)

Rajagopalan, S., Mascha E., Na, J., & Sessler, D.I. (2008). The effects of mild perioperative hypothermia on blood loss and transfusion requirement. *Anesthesiology*, 108(1):71–7.

Rauch, S., Miller, C., Bräuer, A., Wallner, B., Bock, M., & Paal, P. (2021). Perioperative hypothermia—A narrative review. *International Journal of Environmental Research and Public Health*, 18(16), 8749. [\[CrossRef\]](#)

Scott, E. M., & Buckland, R. (2006). A Systematic review of intraoperative warming to prevent postoperative complications. *AORN Journal*, 83(5), 1090–1104. [\[CrossRef\]](#)

Tamer, F., & Karadağ, M. (2020). Cerrahihemşirelerinin istenmeyen perioperatif hipotermi bakımına yönelik bilgi ve uygulamalarının belirlenmesi [determining the knowledge and interventions by surgical nurses for inadvertent perioperative hypothermia care]. *Türkiye Klinikleri - Journal of Nursing Science*, 12(1), 19–29. [\[CrossRef\]](#)

Turkish Society of Anesthesiology and Reanimation (TARD) Guideline (2013). Turkish Society of anaesthesiology and Reanimation practice guideline for prevention of unintentional perioperative hypothermia. *Turkish Journal of Anaesthesiology and Reanimation*, 41(5), 188–190. [\[CrossRef\]](#)

Yang, L., Huang, C. Y., Zhou, Z. B., Wen, Z. S., Zhang, G. R., Liu, K. X., & Huang, W. Q. (2015). Risk factors for hypothermia in patients under general anesthesia: Is there a drawback of laminar airflow operating rooms? A prospective cohort study. *International Journal of Surgery*, 21, 14–17. [\[CrossRef\]](#)