

▪ **Basic Research**

**Effect of Perioperative Warming Interventions on the Prevention of Inadvertent Hypothermia among Patients Undergoing General Anesthesia**

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**Abstract**

**Background:** Inadvertent perioperative hypothermia poses a significant risk during and after surgery, adversely affecting patient outcomes. Nurses play a crucial role in preventing inadvertent perioperative hypothermia through effective warming interventions. **Aim:** This study aims to evaluate the effect of perioperative warming interventions on preventing inadvertent hypothermia among patients undergoing general anesthesia. **Design:** This study utilized a quasi-experimental research design. **Settings:** conducted at the Main University Hospital, Alexandria, Egypt, encompassing all the operating theaters, recovery rooms, and inpatient general surgical departments. **Subjects:** Involving two groups; **Group 1:** A convenience sample of 60 adults undergoing general anesthesia was selected and divided equally into either a study group (n = 30) or a control group (n = 30). **Group 2:** A convenience sample of 60 nurses working in operating theaters, recovery rooms, and inpatient general surgical department settings who were assigned into either an intervention (n =30) or a control group (n = 30). Data collection included a structured questionnaire to assess patients' knowledge, nurses' knowledge of perioperative hypothermia, and a checklist to evaluate the nurses' performance of warming interventions. Additionally, demographic and clinical data were collected. **Results:** No significant differences were found between groups regarding socio-demographic characteristics, body mass index, diagnoses, previous hospitalizations, and previous surgeries. However, a significant improvement in knowledge and performance was observed in the intervention group, demonstrating the effectiveness of educational sessions on perioperative warming interventions. **Conclusion:** Implementing perioperative warming interventions significantly improves nurses' and patients' knowledge, reduces the risk of inadvertent perioperative hypothermia, which consequently enhances perioperative care and patient outcomes by mitigating the risks associated with hypothermia. **Recommendations:** Nursing strategies such as comprehensive preoperative assessment, patient education on hypothermia risks, and adherence to established warming protocols are essential in minimizing hypothermia-related complications and optimizing perioperative care.

**Keywords:** Inadvertent hypothermia, General anesthesia, Perioperative, Warming interventions.

## 1. Introduction

Despite technological advancements aimed at preserving normothermia and extensive research on the topic, healthcare workers still face significant challenges when it comes to regulating a patient's body temperature throughout the perioperative period. Inadvertent perioperative hypothermia (IPH), defined as a core body temperature falling below 36°C, is a prevalent and often overlooked complication in patients undergoing general anesthesia (Morris., 2024). This condition can arise from several factors, including the anesthetic agents' suppression of the body's thermoregulatory mechanisms, exposure to the inherently cold environment of the operating room, and the administration of unwarmed intravenous fluids and anesthetic gases (Sessler, 2022).

Even though it is a common occurrence, inadvertent hypothermia has significant risks and adverse consequences, which makes it a critical concern in perioperative care. Lower body temperatures result in lower immune function and reduced oxygen delivery to tissues, which increases the risk of surgical site infections. An increased risk of bleeding and transfusion requirements is due to the adverse effects of coagulation. Hypothermia extends the time it takes to recover from anesthesia, impedes wound healing, and is linked to increased rates of cardiac events, particularly in patients with preexisting cardiovascular conditions. Moreover, hypothermia has been linked to an increase in postoperative pain and discomfort, leading to an extension of hospital stays and an increase in healthcare costs (Safia, 2019).

Effective management strategies are necessary due to the significant risks associated with IPH. Various pre-operative warming interventions have been developed and implemented to prevent this condition. These interventions can be categorized into preoperative, intraoperative, and postoperative measures. Preoperative warming involves the use of warming techniques before anesthesia is administered. This can include forced-air warming blankets, which increase the patient's body temperature and build up a thermal reserve. Pre-warming for at least 30 minutes can help reduce the risk of intraoperative hypothermia. In addition, the utilization of pre-warmed intravenous fluids and blankets can aid in maintaining a normal temperature from the start of surgery (Simegn, Bayable, & Fetene, 2021).

Intraoperative warming is the key to maintaining normothermia, as it is when heat loss is more significant. The most commonly used intraoperative warming devices are forced-air heating systems. The patient is warmed consistently and controlled through the blowing of warm air into a blanket by these systems. Additionally, warming intravenous and irrigation fluids to body temperature can prevent the cooling effects of these substances when administered during surgery. Other intraoperative measures include the use of warming mattresses, heated humidifiers for anesthetic gases, and maintaining a higher ambient temperature in the operating room, although the latter can be uncomfortable for the surgical team (Alcan et al., 2023).

Postoperative warming is important to prevent the drop in body temperature that can occur during the recovery phase. The continuation of the use of forced-air heating systems in the postoperative care unit assists in stabilizing the patient's core temperature while they recover from anesthesia. Early postoperative warming can help patients avoid shivering, which is both uncomfortable and causes an increase in metabolic demand and oxygen consumption (Yılmaz & Khorshid, 2023).

Numerous studies have backed up the efficacy of preoperative warming interventions. For instance, a systematic review and meta-analysis by (Sessler 2016) found that active warming techniques significantly reduce the incidence of hypothermia and its associated

complications. Despite the obvious benefits, preoperative warming interventions are not without challenges. The widespread adoption of these measures can be hindered by cost considerations, staff training, and patient comfort. However, the potential to improve patient outcomes and reduce healthcare costs associated with the complications of hypothermia makes these interventions highly valuable (Sahin and Dikmen, 2023).

Effective management through perioperative warming interventions, including preoperative, intraoperative, and postoperative measures, is essential to maintain normothermia and enhance patient safety. As healthcare providers strive to improve surgical outcomes and patient care, it is imperative to incorporate comprehensive warming protocols into perioperative management (Oden et al., 2024).

Maintaining normothermia and mitigating any potential complications caused by hypothermia is crucial for nurses. Nurses can protect patient safety and promote optimal surgical experiences by prioritizing preventive measures and implementing evidence-based strategies to tackle the challenges posed by perioperative hypothermia. Raising the level of knowledge of nurses will be a significant factor in preventing potential hypothermia (Woretaw et al., 2023).

### **1.1. Significance of the study:**

Nurses play a significant role in preventing and managing IPH as they are at the forefront of perioperative care. It is crucial that nurses are educated on the physiological mechanisms, risks, and effective management strategies for IPH. Nurses can be empowered with the knowledge and skills to implement evidence-based warming interventions, monitor patient temperatures diligently, and communicate effectively with other healthcare professionals. Moreover, patient education about IPH is equally crucial. Explaining the risks and benefits of warming interventions can help nurses motivate patients to participate in maintaining normothermia, leading to a sense of agency and shared responsibility for their well-being. Achieving optimal surgical outcomes and minimizing the adverse consequences of IPF can only be achieved through a collaborative approach between nurses and patients that is grounded in knowledge and communication (Oden et al., 2024).

## **2. The Aim of the Study:**

This study aimed to evaluate the effect of perioperative warming interventions on preventing inadvertent hypothermia among patients undergoing general anesthesia.

### **Through:**

1. Assessing the nurses' level of knowledge regarding perioperative hypothermia
2. Assessing the nurses' performance regarding perioperative hypothermia.
3. Assessing the patients' level of knowledge regarding perioperative hypothermia.
4. Assessing patients' outcomes in relation to the occurrence of perioperative hypothermia.

**2.1. Research Hypotheses:** To fulfill the aims of the study, the following research hypotheses were formulated:

**H<sub>1</sub>:** Patients who received the perioperative warming interventions do not exhibit inadvertent hypothermia compared with those who receive the routine nursing interventions.

**H<sub>2</sub>:** Nurses who received the perioperative warming educational sessions do not exhibit improvement in their performance compared with those who did not receive them.

**H<sub>3</sub>:** Nurses who received the perioperative warming educational sessions do not exhibit

improvement in their knowledge compared with those who did not receive them.

**H4:** Patients who received the perioperative warming educational sessions do not exhibit improvement in their knowledge compared with those who did not receive them.

### **3. Subject and Methods:**

#### **3.1. Research Design.**

A quasi-experimental study conducted pre- and post-test assessments in both the intervention and control groups.

#### **3.2. Settings**

The study took place across all operating theaters, recovery rooms, and inpatient general surgical departments at the Main University Hospital in Alexandria Governorate, Egypt. The selection of these settings was based on the availability of nurses and patients who were willing to participate, facilitating the achievement of the study's objectives.

#### **3.3. Subjects**

To achieve the study's aim of evaluating the effect of perioperative warming interventions on preventing inadvertent hypothermia in patients undergoing general anesthesia, the study was conducted on both perioperative patients and surgical nurses. Patients' knowledge, as well as nurses' knowledge and performance regarding perioperative warming interventions for preventing inadvertent hypothermia, were assessed. By systematically assessing both patients' and nurses' knowledge and performance regarding perioperative warming interventions, the study aims to contribute valuable insights into enhancing practices for preventing inadvertent hypothermia. The use of tailored assessment tools and structured methodologies ensures a comprehensive evaluation of educational effectiveness and potential impacts on patient outcomes in surgical settings.

#### **3.4. Research Sampling**

Sample size calculation was performed using the Epi Info 7 software; a sample size of sixty patients and sixty nurses was determined. Nurses who directly cared for perioperative patients were recruited using convenient sampling. The study included nurses who volunteered to participate. Inclusion criteria were working in the operating theaters, recovery rooms, and inpatient general surgical departments, having at least six months of operating room experience, not having previously or currently participated in training related to prevention of IPH, and agreeing to participate. Participants nurses were assigned using a random number table to either the intervention or control group ( $n = 30$  in each). To avoid cross-contamination, data was collected from the control group first, followed by the intervention group.

Additionally, 60 adults' patients admitted to specified units from June to December 2023 were included, randomly assigned to either the intervention or control group ( $n = 30$  in each). Patients in the study group received perioperative warming interventions, including preoperative warming (using forced-air warming blankets for 30 minutes before anesthesia induction), intraoperative warming (utilizing forced-air warming blankets and warmed intravenous fluids), and postoperative warming in the recovery room as required. The control group of patients received standard perioperative care without perioperative warming interventions.

**Participants patients included in this study according to the following inclusion criteria:**

1. Age between 20 and 60 years.
2. Patients who were admitted to the hospital for a surgical operation and undergoing general anesthesia.

3. Patients scheduled for elective surgery under general anesthesia lasting less than 120 minutes.
4. Patients with a body temperature within the normal range ( $\geq 36^{\circ}\text{C}$ ) at admission to the surgical unit.
5. Patients who can communicate verbally are alert and capable of following instructions.

**Exclusion criteria:**

1. Patients with central nervous system impairment, thyroid disorders, or currently receiving insulin treatment.

**3.5. Tools of the study:**

The researchers developed three instruments for the study based on guidelines from the **Association of Perioperative Registered Nurses (ARON)**. AORN's vision is to provide evidence-based practices to establish a standard of excellence in every stage of perioperative nursing care to ensure the attainment of optimal patient care and the National Institute for Health and Care Excellence (**NICE**). (AORN, 2020; NICE, 2017) and other literature (**Koyuncu et al., 2023; Woretaw et al., 2023; Şenol & Yıldız, 2020; Jallow and Bayraktar, 2022; Oden et al., 2024**)

**Tool, I** assessed patients' knowledge about inadvertent hypothermia among those undergoing general anesthesia, comprising demographic and clinical data, along with a structured questionnaire to **assess knowledge regarding inadvertent hypothermia**. **Tool II** focused on nurses' knowledge of inadvertent hypothermia in patients undergoing general anesthesia, encompassing demographic information and a structured questionnaire to assess their knowledge. **Tool III** consisted of a structured interview schedule related to the Perioperative Warming Interventions Performance Checklist, which included guidelines for the care of surgical patients aimed at preventing hypothermia, organized into three parts.

**Tool I: Inadvertent perioperative hypothermia patients' knowledge structured interview schedule**

It included two parts as follows:

- **Part I: Patients' socio-demographic characteristics and clinical data.** This part assessed data related to patients' age, gender, marital status, education level, occupation, residence, weight, height, chief complaint, diagnosis, previous hospitalizations, previous surgeries, and body temperature.
- **Part II: Patients' knowledge regarding inadvertent hypothermia.** This part was used to assess patients' understanding of hypothermia, including its definition, risk factors, signs and symptoms, necessary preparations to prevent hypothermia, complications, and recovery post-surgery.

**Scoring system:**

- Each correct answer in part II received a score of one, and incorrect or missing answers received a score of zero.
- Scores were categorized as poor ( $<50\%$ ), moderate ( $50<70\%$ ), or good ( $\geq 70\%$ ).

**Tool II: Inadvertent perioperative hypothermia nurses' knowledge Structured Questionnaire**

It included two parts as follows:

- **Part I: Nurses' socio-demographic characteristics.** This part assessed data related to nurses' age, gender, and years of experience.

- **Part II: Perioperative Hypothermia knowledge** - divided into four parts:
  - **A: Preoperative hypothermia prevention.** Which assessed the risk, management of perioperative hypothermia, and selection of warming methods based on the surgical procedure before surgery.
  - **B: Intraoperative hypothermia prevention.** Which included knowledge about temperature management during surgery.
  - **C: Postoperative hypothermia prevention.** Which included knowledge regarding the management of hypothermia after surgery.
  - **D: Perioperative hypothermia prevention practices.** Which assessed knowledge regarding the current practices related to hypothermia prevention.

#### **Scoring system:**

- Each correct answer in Part II received a score of one, and incorrect or missing answers received a score of zero.
- Scores were categorized as poor (<60%), moderate (60-75%), or good ( $\geq 75\%$ ).

#### **Tool III: Nurses' Perioperative Warming Interventions Performance Checklist.**

The Perioperative Warming Interventions Performance Checklist was developed by the researchers based on guidelines from the Association of Perioperative Registered Nurses (AORN, 2016) and the National Institute for Health and Care Excellence (NICE, 2017) and used to evaluate nurses' performance of perioperative warming interventions. It provides a structured approach to evaluating adherence to guidelines for preventing inadvertent hypothermia in surgical patients. It was used to assess nurses' performance in maintaining patient temperature stability throughout the perioperative period. This tool facilitates quality improvement initiatives aimed at enhancing patient outcomes and reducing complications associated with perioperative hypothermia. It evaluates nurses' performance in the three phases: Preoperative Phase, Intraoperative Phase and Postoperative Phase.

#### **Scoring System:**

- Nurses' performance was evaluated using a 3-point Likert scale (0=Never, 1=Sometimes, 2=Always). Scores were converted to percentages and categorized as poor (<60%), fair (60%-<75%), or good ( $\geq 75\%$ ).

#### **Intervention and Procedures:**

1. **Preoperative Phase:**
  - Inform patients to stay warm before surgery to minimize postoperative complications.
  - Advise patients to bring additional clothing, like a dressing gown, due to potentially cooler hospital environments.
  - Encourage patients to notify hospital staff if they feel cold during their hospitalization.
  - Pay special attention to patients who have difficulty communicating their comfort needs.
2. **Health Professional Training:**
  - Ensure professionals using temperature recording or warming devices are well-trained in their use.
  - Maintain devices according to manufacturer and supplier manuals.
3. **Risk Assessment and Active Warming:**

- Assess surgical patients for the risk of inadvertent perioperative hypothermia.
  - Initiate active warming if the patient's temperature is less than 36.0°C for 30 minutes preoperatively.
  - Continue active warming throughout the intraoperative phase.
4. **Intraoperative Phase:**
- Measure and document the patient's temperature before anesthesia induction and every 30 minutes until surgery ends.
  - Ensure patients are covered to conserve heat, exposing them only during surgical preparation.
  - Use fluid warming devices to warm IV fluids and blood products to 37°C.
5. **Postoperative Phase:**
- Monitor and document the patient's temperature upon arrival at the recovery room and every 15 minutes thereafter.
  - Transfer patients to the ward unless the temperature is less than 36.0°C; in such cases, use active warming until they are warm.
  - Record the patient's temperature routinely every 4 hours in the ward; use active warming if the temperature drops below 36.0°C.

### 3.6. Ethical Consideration

This study obtained written approval from the ethical committee of the Faculty of Nursing at Alexandria University, Egypt, on October 13, 2021. Official permission was also obtained from the Dean of the Faculty of Nursing, Alexandria University, as well as the administrative authorities of the Alexandria main University hospital. Prior to participation, oral informed consent was obtained from the study subjects after a clear explanation of the research objectives. Detailed information regarding the purpose and benefits of the study was provided to the study subjects, and they had the freedom to participate voluntarily. The study strictly adhered to standard ethical principles, ensuring the maintenance of strict confidentiality and anonymity for all participants during data collection. No risks were posed to the participants.

### 3.7. Pilot study

To test the clarity, feasibility, and applicability of the study tools, a pilot study was conducted on 10% of patients (six patients) undergoing general anesthesia, as well as 10% of nurses who participated in the study (six nurses) they were excluded from the actual study subjects. Based on the feedback received from the pilot study, modifications were made to the tools, and the final versions were considered suitable for use.

### 3.8. Validity and reliability of the tools

To ensure the validity of the tools, five experts in medical-surgical Nursing were consulted, and their feedback was used to refine the study tools. The reliability of the developed tools was assessed using Cronbach's Alpha Test, and the reliability coefficients for Tool I, Tool II, and Tool III were found to be  $r=0.754$ ,  $r=0.795$  and  $r=0.943$ , respectively, which was accepted as reliable.

### 3.9. Data collection

Individual patients' interviews using the structured tool were conducted with each patient to collect data for the study objective for 30-45 minutes. Nurses were interviewed for 30-45 minutes after explaining the study's purpose.

## Phases of the study

### Phase I: Assessment (pre-intervention phase)

In phase I of the study, researchers established a therapeutic relationship, explained the study's purpose, and conducted an initial assessment using study tools.

- Pre-intervention assessment included baseline evaluation of nurses' knowledge and current practices.
- Pre-education assessment: included an initial evaluation of patients' baseline knowledge before any educational interventions. Subsequent assessments were conducted immediately after the educational sessions to evaluate their effectiveness, nurses' knowledge progress and assess patient understanding.

### Phase II: Planning

#### Educational Materials:

The educational materials were tailored to each group (patients and nurses). It included information on:

- Importance of maintaining body temperature during surgery.
- Different perioperative warming techniques (e.g., warming blankets, fluid warming devices).
- Signs and risks of inadvertent hypothermia.
- Practical steps for nurses and patients in implementing warming interventions.

#### Perioperative warming interventions

The Perioperative Warming Interventions guidelines were then developed based on patient assessments, needs, goals, priorities, and guidelines from AORN and NICE. The content was organized into three phases: pre-operative, intra-operative, and post-operative using feasible learning sequence, and teaching strategies included interactive lectures, discussions, demonstrations, and re-demonstrations.

#### Pre-warming interventions, which was conducted to the study group at the Pre-operative Phase and included:

- Pre-warming patients for 10 minutes using a forced-air warmer set at 47°C.
- Measuring body temperature with a tympanic membrane thermometer.
- Assessing shivering and thermal comfort in the pre-anesthesia area and the post-anesthesia care unit.

#### Session One: Preoperative Care

- Advising patients to stay warm and bring additional clothing.
- Encouraging communication with hospital staff about feeling cold.
- Training health professionals on temperature recording and warming devices.
- Assessing patients for the risk of hypothermia and initiating active warming if the patient's temperature is less than 36.0°C. Active warming continues throughout the intraoperative phase.

#### Session Two: Intraoperative Phase

- Monitoring and documenting temperatures before anesthesia and every 30 minutes during surgery.
- Ensuring patient coverage to conserve heat.
- Using fluid warming devices and maintaining irrigation fluids at appropriate temperatures using thermostat-controlled cabinets set to 38°C to 40°C.

#### Session Three: Postoperative Phase

- Monitoring patients' temperatures every 15 minutes in the recovery room and every 30 minutes in the surgical ward.



- Actively warming hypothermic patients and providing adequate bedding materials.

### Phase III: Implementation Phase

- Individualized nursing warming interventions educational sessions were implemented in three sessions lasting 30-60 minutes, depending on nurses' tolerance and response after explaining the purpose of the study through interactive discussions. The interventions included pre-warming, temperature monitoring, and patient education on staying warm. These sessions focused on three core interventions: pre-warming techniques, continuous temperature monitoring throughout the perioperative period, and educating patients on methods to maintain warmth.
- Patients' educational sessions were integrated seamlessly into the perioperative care pathway for each patient. Guidelines were communicated verbally to ensure clarity and were complemented by a written booklet that patients could refer to for reinforcement. To confirm comprehension, patients were encouraged to repeat the guidelines until the investigator was confident in their understanding. This approach emphasizes patient engagement and empowerment in their own care, promoting active participation in perioperative warming practices. By combining verbal instruction with written resources, the sessions catered to diverse learning styles and reinforced key concepts effectively.
- Throughout the implementation phase, ongoing assessment and feedback mechanisms were employed to monitor adherence to warming protocols and to address any questions or concerns from patients. This iterative process aimed to optimize the effectiveness of the educational sessions and enhance patient outcomes through improved perioperative warming practices.

### Phase IV: Evaluation Phase

- The impact of warming interventions was evaluated 2-3 hours after implementation using Tool II.
- The impact of nurses' knowledge and performance was evaluated using Tools II and III following the educational sessions.
- Patients' knowledge was evaluated using Tool I.

### 3.10. Data, statistical analysis, and processing:

After data collection, the data was coded, verified, and analyzed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 23.0, IBM Corporation, Armonk, New York). Statistical analyses included means, standard deviations, t-tests for independent samples, chi-square (Monte Carlo), and significance tests (2-tailed). A significant level of 0.05 was used to judge the results.

## 4. Results

**Table (1):** Frequency distribution of the patients' socio-demographic characteristics. Table 1 **compares** the demographic characteristics of the control group (n=30) and the study group (n=30). The table indicates that the mean patients' age was slightly higher in the study group ( $40.70 \pm 5.57$ ) compared to the control group ( $39.40 \pm 8.0$ ). A higher percentage of females (63.3%) was found in the study group compared to the control group (46.7%), although the difference was not statistically significant. Most participants in both groups were married, with a slightly higher percentage in the study group (90.0%) compared to the control group (83.3%). The higher percentage of patients in both groups were secondary, highly educated, and housewives.

A slightly higher percentage of participants from the control group (70.0%) resided in urban areas compared to the study group (53.3%), but the difference was not statistically significant. No significant differences were found between the two groups regarding their socio-demographic characteristics, indicating that the groups were well-matched and comparable for the study.

**Table 2:** Frequency distribution of the **patients' clinical data**. Table 2 shows a detailed **comparison** of clinical data between the control and study groups across various parameters. The table reveals no significant differences between the groups in terms of the body mass index (BMI) distribution, diagnoses, previous hospitalizations, and previous surgeries.

**Table (3):** Frequency distribution of the nurses' socio-demographic characteristics. Table (3) presents the nurses' socio-demographic characteristics that participated in the current study both the control and study groups, comprising age, gender distribution, and years of experience. The mean ages of 35.4 years in the control group and 36.1 years in the study group, with no significant difference ( $p=0.75$ ). The highest percentage of nurses in both the control and study group (66.7% and 70%) were females, yielding a non-significant difference ( $p=0.79$ ). Similarly, years of experience averaged (10.3 and 10.7) years in the control and study group, showing no statistically significant difference ( $p=0.78$ ). These findings indicate that participants' selection process effectively balanced demographic variables between groups, ensuring they are comparable and minimizing potential confounding effects in evaluating the study intervention's outcomes.

**Table (4): The relation between the perioperative warming interventions educational sessions and the patients' knowledge.** This table presents the mean total scores and mean percentage scores for both the study and control groups. After the patients' educational sessions, the study group exhibited a substantial increase in knowledge, as evidenced by a higher mean total score ( $5.33 \pm 1.99$ ) and mean percent score ( $66.67\% \pm 24.86\%$ ) compared to the control group. The statistical analysis indicates that the difference in mean total scores and mean percentage scores between the control and study groups is statistically significant ( $p<0.001$ ).

**Table (5): The relation between the perioperative warming interventions educational sessions and the nurses' knowledge.** The table shows the effect of perioperative hypothermia educational sessions among the nurses in both control and study groups. Significant improvements in nurses' knowledge levels were observed in the study group across all categories: Preoperative, intraoperative, postoperative, and overall score. These significant improvements in the nurses' study group highlight the effectiveness of the educational sessions in enhancing knowledge related to perioperative hypothermia, while the nurses control group showed negligible changes.

**Table (6): The relation between the perioperative warming interventions educational sessions and the nurses' performance.** The table indicates that the mean scores for all **dimensions** of nurses' performance significantly improved study group after conducting the educational sessions ( $p<0.001$ ), indicating enhancement in the nurses' performance of perioperative warming interventions. In contrast, the control group showed no significant improvements. These results suggest that the educational sessions were highly effective in improving perioperative warming practices in the study group.

**Table (7):** The relation **between** the perioperative warming interventions and the occurrence of the studied patients' inadvertent hypothermia. Body temperature

measurements before and during surgery were similar between the two groups (study and control), with no significant differences noted. However, a notable distinction was observed in postoperative body temperatures. Specifically, 83.3% of the control group experienced hypothermia postoperatively, whereas the study group maintained normal body temperatures in all cases. This difference was highly significant ( $p < 0.001$ ), suggesting that the warming interventions effectively prevented postoperative hypothermia in the study group. This finding underscores the potential benefit of perioperative warming interventions in maintaining normal body temperature postoperatively.

**Table 1: Frequency Distribution of the Patients' Socio-demographic Characteristics**

Patients' socio-demographic characteristics	Patients Control (n=30)		Patients Study (n=30)		$\chi^2$	<sup>MC</sup> p
	No.	%	No.	%		
Age in years						
- 30 <40 years	14	46.7%	13	43.3%	0.601	0.438
- 40 <50 years	16	53.3%	17	56.7%		
- Mean $\pm$ SD	<b>39.40<math>\pm</math>8.0</b>		<b>40.70<math>\pm</math>5.57</b>		<b>t =0.727</b>	<b>0.470</b>
Gender						
- Male	14	46.7%	11	36.7%	1.684	0.194
- Female	16	53.3%	19	63.3%		
Marital status						
- Married	25	83.3%	27	90.0%	0.577	0.706
- Divorced	5	16.7%	3	10.0%		
Level of education						
- Basic education	5	16.7%	3	10.0%	1.888	0.451
- Secondary education	9	30.0%	14	46.7%		
- University education	16	53.3%	13	43.3%		
Occupation before retirement						
- Manual	8	26.7%	7	23.3%	1.137	0.851
- Professional	8	26.7%	7	23.3%		
- Housewife	13	43.3%	13	43.3%		
- Not work	1	3.3%	3	10.0%		
Area of residence						
- Urban	21	70.0%	16	53.3%	1.763	0.184
- Rural	9	30.0%	14	46.7%		
$\chi^2$ : Chi square test    MC: Monte Carlo    t: Student t-test						

**Table 2: Frequency Distribution of the Patients' Clinical Data**

Patients' clinical data	Patients Control (n=30)		Patients Study (n=30)		$\chi^2$	MC p
	No.	%	No.	%		
BMI					2.684	0.280
Normal	6	20.0%	2	6.7%		
Overweight	21	70.0%	26	86.7%		
Obese	3	10.0%	2	6.7%		
Mean $\pm$ SD	26.64 $\pm$ 2.82		27.40 $\pm$ 2.53		t =1.091	0.280
Diagnosis						
Cholecystectomy	4	13.3%	6	20.0%	6.423	0.178
Cancer colon	12	40.0%	4	13.3%		
Appendectomy	8	26.7%	8	26.7%		
Umbilical hernia	3	10.0%	5	16.7%		
Abdomen exploration	3	10.0%	7	23.3%		
Previous hospitalization						
No	14	46.7%	18	60.0%	1.071	0.301
Yes	16	53.3%	12	40.0%		
Previous surgery						
No	23	76.7%	24	80.0%	0.098	0.754
Yes	7	23.3%	6	20.0%		
If yes what is the operation name						
Appendectomy	3	10.0%	2	6.7%	0.351	1.000
Removal renal stone	4	13.3%	4	13.3%		
No previous operation	23	76.7%	24	80.0%		
Baseline Temperature ( $^{\circ}$ C)	Control (n=30)		Study (n=30)		$\chi^2$	MC p
Mean $\pm$ SD	36.4 $\pm$ 0.4		36.5 $\pm$ 0.5		1.031	0.451

$\chi^2$ : Chi square test      MC: Monte Carlo      t: Student t-test

**Table (3): Frequency Distribution of the Nurses' Socio-demographic Characteristics**

Nurses' Socio-demographic Characteristics	Nurses Control (n=30)		Nurses Study (n=30)		$\chi^2$	MC p	
	No.	%	No.	%			
Age (Mean $\pm$ SD)	35.4 $\pm$ 7.8		36.1 $\pm$ 8.1		0.10	0.75	
Gender	• Male	10	33.3	9	30	0.07	0.79
	• Female	20	66.7	21	70		
Years of Experience (Mean $\pm$ SD)	10.3 $\pm$ 5.2		10.7 $\pm$ 5.5		0.08	0.78	

**Table (4): The Relation between the Perioperative Warming Interventions Educational Sessions and the Patients' Knowledge.**

Patients' knowledge	Patients Control (n=30)				Patients Study (n=30)				Test of sig.	
	Before		After		Before		After		Before	After
	No.	%	No.	%	No.	%	No.	%		
<b>Overall knowledge score</b>										
Poor	17	56.7%	22	73.3%	19	63.3%	8	26.7%	$\chi^2=0.443$ MC p=0.931	$\chi^2=24.529^*$ MC p<0.001*
Fair	9	30.0%	6	20.0%	7	23.3%	2	6.7%		
Good	4	13.3%	2	6.7%	4	13.3%	20	66.7%		
Total score	2.97 $\pm$ 1.92		2.03 $\pm$ 1.94		2.77 $\pm$ 1.91		5.33 $\pm$ 1.99		t=0.405 p=0.687	t=4.768* p<0.001*
Mean percent score	37.08 $\pm$ 24.01		25.42 $\pm$ 24.23		34.58 $\pm$ 23.83		66.67 $\pm$ 24.86			
p <sub>0</sub>	0.174				<0.001*					

$\chi^2$ : Chi square test for comparing the two group

MC: Monte Carlo

t: Student t-test for comparing the two groups.

P<sub>0</sub>: p value for Paired t test compares outcomes before and after in each group.

\* Statistically significant p-value at  $\leq 0.05$

**Table (5): The Relation between the Perioperative Warming Interventions Educational Sessions and the Nurses' Knowledge.**

Nurses' knowledge	Nurses Control (n=30)				Nurses Study (n=30)				Test of sig.	
	Before		After		Before		After		Before	After
	No.	%	No.	%	No.	%	No.	%		
<b>Preoperative hypothermia prevention</b>										
Poor	12	40.0%	11	36.7%	7	23.3%			$\chi^2=2.506$ MCp=0.305	$\chi^2=22.010^*$ MCp<0.001*
Fair	8	26.7%	8	26.7%	13	43.3%	2	6.7%		
Good	10	33.3%	11	36.7%	10	33.3%	28	93.3%		
Total score	2.87±1.61		2.93±1.64		3.13±1.46		4.57±0.63		t=0.672	t=5.100*
Mean percent score	57.33±32.26		58.67±32.77		62.67±29.12		91.33±12.52		p=0.504	p<0.001*
<b>p<sub>0</sub></b>	0.804				<0.001*					
<b>Intraoperative hypothermia prevention</b>										
Poor	19	63.3%	17	56.7%	19	63.3%	5	16.7%	$\chi^2=0.296$ MCp=1.000	$\chi^2=10.899^*$ MCp=0.004*
Fair	3	10.0%	4	13.3%	4	13.3%	11	36.7%		
Good	8	26.7%	9	30.0%	7	23.3%	14	46.7%		
Total score	2.73±1.87		2.60±2.30		2.43±2.18		4.00±2.07		t=0.572	t=7.187*
Mean percent score	45.56±31.24		43.33±38.31		40.56±36.27		66.67±34.46		p=0.570	p<0.001*
<b>p<sub>0</sub></b>	0.601				0.031*					
<b>Postoperative hypothermia prevention</b>										
Poor	17	56.7%	18	60.0%	23	76.7%	4	13.3%	$\chi^2=4.025$ MCp=0.151	$\chi^2=14.290^*$ MCp<0.001*
Fair	3	10.0%	2	6.7%			4	13.3%		
Good	10	33.3%	10	33.3%	7	23.3%	22	73.3%		
Total score	2.50±2.01		2.20±2.17		2.03±1.50		4.07±1.26		t=1.916	t=4.074*
Mean percent score	50.00±40.26		44.00±43.44		40.60±30.00		81.33±25.15		p=0.060	p<0.001*
<b>p<sub>0</sub></b>	0.568				<0.001*					
<b>Perioperative hypothermia on practices</b>										
Poor	4	13.3%	2	6.7%	4	13.3%			$\chi^2=0.0$ MCp=1.00	$\chi^2=53.417^*$ MCp<0.001*
Fair	26	86.7%	28	93.3%	26	86.7%	5	16.7%		
Good							25	83.3%		
Total score	19.30±1.66		7.73±4.49		19.10±1.42		12.63±2.19		t=0.500	t=5.376*
Mean percent score	53.61±4.62		48.33±28.04		53.06±3.95		78.96±13.68		p=0.619	p<0.001*
<b>p<sub>0</sub></b>	0.270				<0.001*					
<b>Overall knowledge</b>										
Poor	12	40.0%	16	53.3%	19	63.3%			$\chi^2=3.443$ MCp=0.205	$\chi^2=24.845^*$ MCp<0.001*
Fair	8	26.7%	5	16.7%	4	13.3%	9	30.0%		
Good	10	33.3%	9	30.0%	7	23.3%	21	70.0%		
Total score	8.67±4.95		19.73±1.55		7.07±4.35		28.43±2.36		t=1.329	t=16.875*
Mean percent score	54.17±30.94		54.81±4.31		44.17±27.22		78.98±6.55		p=0.189	<0.001*
<b>p<sub>0</sub></b>	0.377				<0.001*					

$\chi^2$ : Chi square test for comparing the two groups -MC: Monte Carlo - t: Student t-test for comparing the two groups

P<sub>0</sub>: p value for Paired t test for comparing the measurements before and after within each group.

\* Statistically significant p-value at ≤0.05

**Table (6): The Relation between the Perioperative Warming Interventions educational Sessions and the Nurses' Performance**

Nurses' Performance	Nurses Control (n=30)				Nurses Study (n=30)				Test of sig.	
	Before		After		Before		After		Before	After
	No.	%	No.	%	No.	%	No.	%		
<b>Preoperative care</b>										
Poor	10	33.3%	10	33.3%	16	53.3%			$\chi^2=2.443$ p=0.11	$\chi^2=73.115^*$ MC p<0.001 *
Fair	20	66.7%	20	66.7%	14	46.7%				
Good							30	100.0%		
<b>Total score</b>	5.67±0.48		5.90±0.76		5.47±0.51		10.07±0.69		t=1.569 p=0.122	t=22.229* p<0.001*
<b>Mean percent score</b>	47.22±4.0		49.17±6.32		45.56±4.23		83.89±5.76			
<b>p<sub>0</sub></b>	0.070				<0.001*					
<b>Intraoperative care</b>										
Poor	24	80.0%	16	53.3%	25	83.3%			$\chi^2=0.111$ p=0.739	$\chi^2=45.885^*$ MC p<0.001 *
Fair	6	20.0%	10	33.3%	5	16.7%				
Good			4	13.3%			30	100.0%		
<b>Total score</b>	3.07±1.01		4.43±0.73		2.63±0.93		6.33±0.48		t=1.726 p=0.090	t=11.939* p<0.001*
<b>Mean percent score</b>	38.33±12.69		55.42±9.10		32.92±11.60		79.17±5.99			
<b>p<sub>0</sub></b>	0.101				<0.001*					
<b>Postoperative care</b>										
Poor	14	46.7%	16	53.3%	20	66.7%			$\chi^2=2.443$ p=0.118	$\chi^2=43.200^*$ MC p<0.001 *
Fair	16	53.3%	14	46.7%	10	33.3%	6	20.0%		
Good							24	80.0%		
<b>Total score</b>	4.87±1.31		4.67±1.30		4.50±1.20		8.0±0.64		t=1.134 p=0.262	t=12.623* p<0.001*
<b>Mean percent score</b>	48.67±13.06		46.67±12.95		45.0±11.96		80.0±6.43			
<b>p<sub>0</sub></b>	0.599				<0.001*					
<b>Overall Performance Checklist</b>										
Poor	18	60.0%	19	63.3%	16	53.3%			$\chi^2=0.270$ p=0.602	$\chi^2=48.267^*$ MC p<0.001 *
Fair	12	40.0%	11	36.7%	14	46.7%	4	13.3%		
Good							26	86.7%		
<b>Total score</b>	14.23±2.81		15.0±2.38		15.23±3.36		24.40±1.40		t=1.250 p=0.216	t=18.642* p<0.001*
<b>Mean percent score</b>	47.44±9.37		50.0±7.93		50.78±11.20		81.33±4.68			
<b>p<sub>0</sub></b>	0.918				<0.001*					

 $\chi^2$ : Chi square test

MC: Monte Carlo

t: Student t-test

**Table (7): The relation between the Perioperative Warming Interventions and the Occurrence of the Studied Patients' Inadvertent Hypothermia.**

Patients' body temperature	Patients Control (n=30)		Patients Study (n=30)		$\chi^2$	MC <sub>p</sub>
	No.	%	No.	%		
<b>Preoperative</b>						
Normal	30	100.0%	30	100.0%		
Hypothermia						
Hyperthermia						
<b>Intra-operative</b>						
Normal	5	16.7%	2	6.7%		
Hypothermia	25	83.3%	28	93.3%	1.456	0.424
Hyperthermia						
<b>Postoperative</b>						
Normal	5	16.7%	30	100.0%		
Hypothermia	25	83.3%			42.857*	<0.001*
Hyperthermia						

 $\chi^2$ : Chi square test

MC: Monte Carlo

## 5. Discussion

Perioperative hypothermia is a frequent challenge in surgical environments and presents substantial risks for patients undergoing procedures with general anesthesia. Given that the body's natural temperature regulation mechanisms are impaired during surgery, it is vital to maintain normothermia to achieve optimal patient outcomes (Hart 2021).

Hypothermia not only disturbs cellular metabolism and hormonal balance but also raises the likelihood of adverse events, including surgical site infections, delayed wound healing, and cardiovascular complications. To reduce these risks, effective perioperative warming strategies are crucial, beginning well before anesthesia induction. Both active and passive warming methods are essential for preventing and managing perioperative hypothermia, thus protecting patient safety and improving surgical outcomes (Jallow & Bayraktar, 2022).

Concerning sociodemographic characteristics of the studied patients; Socio-demographic characteristics may influence the risk of perioperative hypothermia. A comparison of these characteristics between the control and study groups showed that the populations were well-matched and comparable, which validates the subsequent comparisons. Importantly, no significant differences were observed, suggesting a balanced distribution across various demographic factors. This balance ensures that any differences in clinical outcomes can be attributed to the interventions rather than variations in demographics.

The slightly higher mean age of the patients in the study may indicate a greater vulnerability to perioperative hypothermia, attributable to age-related physiological changes like a reduced metabolic rate and compromised thermoregulation. Additionally, the greater proportion of females in the study group may be linked to hormonal factors that affect thermoregulation, potentially elevating the risk of perioperative hypothermia during anesthesia and surgical procedures (Sagiroglu et al., 2020).

The predominance of individuals with secondary education or higher in both groups may suggest a better understanding of perioperative hypothermia risk factors and preventive measures, potentially leading to more proactive management strategies. Moreover, the prevalence of housewives in both groups could imply differences in lifestyle factors or daily

activities that might influence preoperative preparation and postoperative recovery, including temperature management. Finally, the difference in urban residence percentages between the groups might be related to access to healthcare resources or environmental factors that could affect perioperative temperature regulation and contribute to differences in hypothermia risk.

These findings are congruent with those of Ruetzler & Kurz (2018), who recognized age as a significant risk factor for the development of postoperative hypothermia. However, they differ from the results reported by Vural, Çelik, Deveci, & Yasak (2018), which indicated that neither age nor gender influenced preoperative inadvertent hypothermia. Furthermore, a study conducted by Kim & Yoon (2014) found no relationship between gender and intraoperative hypothermia during abdominal surgeries performed under general anesthesia.

In relation to clinical data, general anesthesia carries inherent risks to thermoregulation, primarily due to the suppression of shivering and the redistribution of body heat. As a result, patients undergoing general anesthesia are especially susceptible to perioperative hypothermia. Additional factors, such as the type of anesthesia used, the duration of anesthesia, and the patient's comorbidities, can further heighten this risk. To combat anesthesia-induced heat loss and prevent hypothermia in surgical patients, perioperative warming interventions are critical. These include preoperative warming, active intraoperative warming, and careful monitoring of body temperature postoperatively (Sagiroglu et al., 2020).

Regarding the clinical data of the studied patients, there were no significant differences in BMI distribution, diagnoses, previous hospitalizations, or prior surgeries between the study and control groups. However, a critical distinction was found in postoperative body temperatures. A notable proportion of patients in the control group experienced hypothermia, while all patients in the study group maintained normal body temperatures. This significant difference highlights the potential advantages of perioperative warming interventions in preserving normothermia during the postoperative period.

Several factors may explain the observed differences in postoperative body temperatures between the study and control groups. Anesthesia-induced vasodilation, along with exposure to cold operating room environments, presents significant challenges in maintaining normothermia during surgery. However, the implementation of perioperative warming interventions—such as preoperative warming, active intraoperative warming, and postoperative warming measures (including forced-air warming systems, warmed intravenous fluids, and heated blankets)—has proven effective in preventing heat loss and enhancing thermal comfort. These interventions effectively counteracted the physiological responses induced by anesthesia and surgical exposure, thereby helping to maintain patients' body temperatures within the normal range (Ruetzler & Kurz, 2018).

While patients with a high BMI ( $\geq 25$  kg/m<sup>2</sup>) are thought to have better insulation due to increased subcutaneous fat, which should lead to reduced heat loss and improved core temperature protection, the findings of the current study reveal that these patients still experienced hypothermia. This is consistent with the results of Sari, Aksoy, and But (2021), who found a higher incidence of hypothermia among overweight patients (BMI  $\geq 25$  kg/m<sup>2</sup>) and those with comorbidities. In contrast, the findings differ from those of Kim and Yoon (2014), who identified low preoperative body temperature and low weight as risk factors for intraoperative hypothermia within the first two hours following anesthesia. Consequently, they recommended the use of forced air warming devices for prewarming and intraoperative heating, as well as covering patients with warm blankets during transport.

Knowledge regarding inadvertent hypothermia of patients undergoing general anesthesia is essential for preventing complications and promoting optimal recovery outcomes.



Effective patient education has been recognized as a crucial strategy for enhancing knowledge and understanding of disease prevention. To improve a patient's physical and psychosocial well-being, personalized educational materials tailored to individual patients, along with verbal guidance from healthcare providers, play a vital role in enhancing patient care through shared decision-making and increased satisfaction (Bhattad & Pacifico, 2022).

The current study revealed that the study group demonstrated a significant improvement in their knowledge, highlighting the comprehensive nature of the warming intervention, which included preoperative, intraoperative, and postoperative temperature management practices. This contributed to a notable increase in knowledge scores among patients in the study group. This finding is consistent with Kang and Park (2022), who noted that inadvertent hypothermia is a preventable complication that can have profound consequences for patients undergoing general anesthesia. Understanding the risk factors and implementing effective warming measures are critical for maintaining normothermia and improving patient outcomes. When patients are informed about the risks of hypothermia and the advantages of active warming interventions, they are more likely to engage in preventive measures and communicate any sensations of cold, leading to better patient outcomes.

The effect of perioperative hypothermia sessions on nurses' knowledge and performance is crucial for reducing the incidence of hypothermia among surgical patients. Perioperative hypothermia is acknowledged as a significant health risk for this population; however, its occurrence remains prevalent. Surgical nurses play a vital role during the perioperative phase, and their knowledge, perceptions, and practices concerning hypothermia prevention are believed to influence patient outcomes. Evaluating the understanding of surgical nurses regarding hypothermia prevention can shed light on the effectiveness of their practices and the strategies they employ. A lack of adequate knowledge and insufficient professional development in thermal care may lead to less effective prevention of perioperative hypothermia. Therefore, it is vital to implement effective strategies aimed at enhancing professional competence and knowledge, as well as fostering a nursing culture that prioritizes the importance of thermal care (You et al., 2024).

The demographic data from the surgical nurses who participated in the current study indicate that the majority were female, with an average age ranging from 35.4 to 36.1 years and a mean year of experience between 10.3 and 10.7 years. In contrast, Cakir and Cilingir (2018) reported that the nurses in their study were younger, primarily falling within the age group of 26 to 35 years, and most had graduate or postgraduate degrees, with varying years of experience from 0 to 15 years.

Furthermore, the comparison of perioperative hypothermia knowledge levels between the control and study groups before and after the intervention demonstrates significant improvements in the study group across all categories: preoperative, intraoperative, postoperative, and overall scores. This finding underscores the effectiveness of targeted educational interventions in enhancing knowledge about hypothermia prevention among surgical nurses.

Before the intervention, both the control and study groups likely had differing levels of knowledge regarding perioperative hypothermia, influenced by factors such as prior education, clinical experience, and exposure to hypothermia-related information. However, after the intervention, the study group exhibited significant improvements in their understanding of hypothermia risks and related practices, indicating the effectiveness of the intervention in providing essential information and fostering a more thorough comprehension of perioperative temperature management.

In contrast, the control group showed minimal changes in their knowledge levels, highlighting the absence of focused educational interventions or resources designed to enhance their understanding in this critical area. This disparity in outcomes emphasizes the importance of structured training programs and educational initiatives aimed at improving the knowledge and skills of surgical nurses in preventing perioperative hypothermia.

These results highlight the effectiveness of the intervention in providing healthcare providers with the essential knowledge and skills needed to optimize temperature management during surgical procedures. By prioritizing perioperative warming interventions, healthcare teams can effectively reduce the risk of hypothermia and enhance patient outcomes in the perioperative setting.

This conclusion aligns with findings from Horn et al. (2012), who examined the impact of heating measures on preventing inadvertent hypothermia. Their studies indicated that the incidence of hypothermia was significantly lower in patients who received active intraoperative heating. Furthermore, the AORN Guidelines for Perioperative Practice emphasize the importance of intraoperative heating in preventing inadvertent hypothermia, supporting the evidence that targeted warming interventions can be effective in this context (Card et al., 2014; AORN, 2017). Therefore, implementing structured heating protocols as part of standard practice can significantly contribute to patient safety and quality of care in the surgical environment.

Additionally, the current findings reveal a significant enhancement in both knowledge acquisition and practical application among participating nurses. The structured educational approach, covering pre-warming techniques, temperature monitoring, and patient education strategies, effectively equipped nurses with the necessary skills to implement these interventions accurately and confidently.

Additionally, the current findings demonstrate a significant improvement in both knowledge acquisition and practical application among the participating nurses. The structured educational approach, which encompassed pre-warming techniques, temperature monitoring, and patient education strategies, effectively equipped nurses with the necessary skills to implement these interventions accurately and confidently.

The educational sessions were carefully designed to actively engage nurses in perioperative warming practices through interactive learning methods and hands-on training. Such pedagogical approaches are known to enhance knowledge retention and facilitate the translation of theoretical understanding into practical application in clinical environments. As a result, nurses exhibited significant improvements in their ability to assess and manage patient temperatures effectively during the perioperative period.

Looking ahead, future research could investigate the long-term effects of such educational initiatives on sustained improvements in nursing practices and the overall quality of patient care (Sutherland-Fraser et al., 2016). This exploration could provide valuable insights into how ongoing education influences not only individual nurse performance but also broader healthcare delivery systems, ultimately contributing to enhanced patient safety and better health outcomes across various clinical settings.

On the other hand, the current results findings come in contrast with those by Koyuncu., Güngör., & Yava., (2023) who reported in their study Knowledge and practices of surgical nurses on inadvertent perioperative hypothermia that 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.

Additionally, the current findings contrast with those reported by Koyuncu, Güngör, and Yava (2023), who conducted a study on the knowledge and practices of surgical nurses regarding inadvertent perioperative hypothermia. Their research revealed that nurses lacked adequate information about the risk factors and complications associated with inadvertent perioperative hypothermia. Furthermore, it was observed that a considerable number of nurses did not employ the recommended methods outlined in the guidelines to prevent this phenomenon.

In line with this, Woretaw et al. (2023) reported in their study on the knowledge and practice of nurses regarding perioperative hypothermia prevention that nurses demonstrated inadequate knowledge and practice in this area. Their findings suggest that hospital managers need to develop and enhance training programs specifically tailored to improve nurses' understanding and application of hypothermia prevention strategies. Additionally, it is crucial to focus on increasing job satisfaction among nursing staff to foster a more conducive learning environment.

Similarly, Worku et al. (2022) found that nursing knowledge and practice related to hypothermia prevention in trauma patients were poor in their study. These findings collectively underscore the pressing need for targeted educational initiatives that not only address knowledge gaps but also aim to improve practical competencies in nursing practice. By prioritizing education and staff satisfaction, healthcare institutions can work towards minimizing the risks associated with hypothermia and ultimately enhance patient care outcomes.

Accordingly, Jallow and Bayraktar (2022) found that while nurses exhibited a prominent level of knowledge regarding the prevention of unintentional perioperative hypothermia, their practical application of this knowledge was notably low. Based on the findings of their study, the authors recommended the development of policies, and the implementation of guidelines specifically focused on preventing unintentional perioperative hypothermia. Furthermore, they emphasized the necessity for continuous education to enhance both nurses' knowledge and their practical skills in this critical area.

Additionally, Oden, Doruker, and Korkmaz (2024), in their study titled "Perioperative Health Care Professionals' Knowledge of Evidence-Based Inadvertent Perioperative Hypothermia Management," reported that the knowledge of healthcare professionals involved in the perioperative process regarding evidence-based practices for managing inadvertent perioperative hypothermia was found to be at a moderate level. The authors recommended enhancing the knowledge of these professionals by providing targeted education on the guidelines pertaining to inadvertent perioperative hypothermia management.

This recommendation aligns with the overarching need for continuous professional development and training within the healthcare sector, particularly in areas critical to patient safety. By ensuring that healthcare professionals are well-versed in the latest evidence-based practices, institutions can help prevent incidents of inadvertent perioperative hypothermia and improve overall patient outcomes in surgical settings.

Since the implementation of educational sessions focused on perioperative warming interventions has led to substantial improvements in nurses' knowledge and practices related to managing patient temperatures during surgical procedures, this highlights the significance of structured educational initiatives. Such studies contribute valuable insights into the efficacy of

these interventions in enhancing healthcare delivery and patient safety.

The effect on patients' body temperature is also a significant concern in the context of surgical procedures. The high prevalence of postoperative hypothermia in the control group highlights the inherent risks associated with anesthesia and surgical interventions, as these can disrupt thermoregulatory mechanisms and increase patients' susceptibility to heat loss. Factors such as prolonged exposure to cold operating room environments, inadequate insulation during surgery, and anesthesia-induced vasodilation can exacerbate the risk of hypothermia in surgical patients (Sessler, 2022). Addressing these factors is critical to maintaining normothermia and minimizing complications related to hypothermia during the perioperative period.

In a randomized controlled study, Kang and Park (2022) investigated the effect of the with the American Society of Peri Anesthesia Nurses (ASPAN) guideline on hypothermia in fifty-four patients who underwent surgery. They found that normothermia was maintained in the entire experimental group that adhered to the guidelines during the perioperative process, whereas most patients in the control group exhibited hypothermia upon entering the recovery room. The study indicated that complete implementation of the guideline during the perioperative process not only reduced shivering and thermal discomfort but also increased overall thermal comfort.

These findings align with recent studies demonstrating that perioperative warming, even for durations shorter than 30 minutes, can effectively mitigate hypothermia. Horn et al. (2012) reported that warming for as little as 10 minutes significantly reduces the incidence of hypothermia. However, it is noteworthy that while other studies emphasize intraoperative warming only, the benefits of pre-warming combined with continuous intraoperative warming remain a topic of debate.

Further supporting this, Buraimoh et al. (2019) conducted a study examining the effects of forced-air warming blanket positioning on intraoperative core body temperature and concluded that the use of a forced-air warming blanket was associated with a lower incidence of intraoperative hypothermia. Similarly, Lau et al. (2018) performed a randomized controlled trial involving 200 participants to assess the impact of preoperative forced-air warming on intraoperative hypothermia, finding that applying forced-air warming for a minimum of 30 minutes before surgery significantly lowered incidence rates.

Moreover, research by Xiao et al. (2020) focused on the effects of warming patients 30 minutes prior to Video-assisted Thoracic (VAT) surgery, in conjunction with intraoperative methods to prevent hypothermia. Their findings revealed that the incidence of hypothermia was significantly lower in the pre-warming group compared to other groups, reinforcing the argument for implementing warming interventions across all phases of the perioperative process to improve core body temperature prior to anesthesia induction. Collectively, these studies underscore the importance of consistent warming interventions applied preoperatively, intraoperatively, and postoperatively to effectively reduce the incidence of hypothermia and enhance patient comfort during the surgical experience.

## **6. Limitation of the study**

A limitation of this study is the short follow-up period, which was restricted to the immediate postoperative phase. While the results indicate that perioperative warming interventions effectively maintained normothermia during surgery and reduced the incidence of hypothermia, future studies would benefit from incorporating extended follow-up periods to comprehensively assess the effectiveness and implications of perioperative warming protocols on patient health beyond the immediate recovery stage.

## 7. Conclusion

This study provides compelling evidence supporting the effectiveness of perioperative warming interventions in improving patient outcomes and healthcare practices among individuals undergoing general anesthesia. The study findings demonstrate that perioperative warming interventions significantly reduce the incidence of postoperative hypothermia, enhance patient knowledge regarding inadvertent hypothermia, and improve knowledge and practices related to perioperative hypothermia management. The implementation of perioperative warming interventions led to a substantial increase in knowledge scores, improved knowledge levels, and enhanced performance in perioperative warming practices among patients and healthcare providers.

## 8. Recommendations

**In light of the study's findings, the following recommendations are proposed:**

- 1. Implementation of standardized perioperative warming protocols:** Healthcare institutions should adopt standardized perioperative warming protocols based on evidence-based guidelines to ensure consistent and effective management of patient body temperature during the perioperative period. These protocols should encompass preoperative, intraoperative, and postoperative warming strategies tailored to individual patient needs and surgical procedures.
- 2. Multidisciplinary education and training:** Healthcare providers involved in perioperative care, including nurses, anesthesiologists, surgeons, and support staff, should receive comprehensive education and training on the importance of perioperative warming interventions and best practices for their implementation. This training should emphasize the identification and mitigation of risk factors for perioperative hypothermia, proper use of warming devices, and effective communication with patients regarding perioperative warming measures.
- 3. Patient education and empowerment:** Patients undergoing surgery should be educated about the risks of perioperative hypothermia and the importance of maintaining normothermia to optimize surgical outcomes and recovery. Healthcare providers should engage patients in shared decision-making regarding perioperative warming interventions, providing them with information and resources to actively participate in their perioperative care.
- 4. Integration of perioperative warming interventions into clinical pathways:** Perioperative warming interventions should be integrated into standardized clinical pathways and protocols for surgical patients across healthcare settings. This integration can help streamline perioperative care processes, improve adherence to evidence-based practices, and facilitate the systematic implementation of perioperative warming interventions as part of routine care delivery.
- 5. Ongoing quality improvement and monitoring:** Healthcare institutions should establish mechanisms for continuous quality improvement and monitoring of perioperative warming practices and outcomes. This includes regular audits of perioperative warming protocols, monitoring of patient body temperature during the perioperative period, and evaluation of healthcare provider adherence to best practices for perioperative warming interventions. Feedback mechanisms should be implemented to identify areas for improvement and implement corrective actions as needed.
- 6. Research and innovation:** Further research is needed to explore the long-term impact of perioperative warming interventions on patient outcomes, healthcare practices, and

healthcare resource utilization. Future studies should focus on evaluating the effectiveness of novel warming devices and techniques, assessing the cost-effectiveness of perioperative warming interventions, identifying strategies to enhance patient engagement and satisfaction with perioperative care and explore the long-term impact of perioperative warming interventions on patient outcomes and healthcare practices across diverse clinical settings. Collaboration between researchers, healthcare providers, and industry partners is essential to drive innovation and advancement in perioperative warming practices.

### **Ethics approval**

This study obtained written approval from the ethical committee of the Faculty of Nursing at Alexandria University on October 13, 2021.

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**Conflict of interest:** The researchers declare that there is no conflict of interest.

**Data and materials availability:** All data are available upon reasonable request from the corresponding author.

**Informed consent:** Oral informed consent was obtained from patients and nurses who participated in this study after explaining the aim of the study.

**Peer-review: Externally peer-reviewed.**

**Author contributions:** All the researchers shared in identifying the research title, review of literature, concepts, design, resources materials, materials and method, data collection and processing, data analysis and interpretation as well as writing the manuscript with critical review.

### **References:**

1. Alcan, A. O., Aygün, H., & Kurt, C. (2023). Resistive warming mattress, forced-air warming system, or a combination of the two in the prevention of intraoperative inadvertent hypothermia: A randomized trial. *Journal of Peri-anesthesia Nursing*. <https://doi.org/10.1016/j.jopan.2022.11.007>
2. AORN, (2020). Guidelines for prevention of hypothermia. Guidelines for perioperative practices. Denver, CO: AORN, 327-356. Available at: <https://www.aorn.org/guidelines>. Retrieved in February 2024.
3. Bhattad, P. B., & Pacifico, L. (2022). Empowering patients: promoting patient education and health literacy. *Cureus*, 14(7).
4. Buraimoh, M. A., Nash, A., Howard, B., Yousaf, I., Koh, E., Banagan, K., ... & Ludwig, S. C. (2019). Effect of forced air warming blanket position in elective lumbar spine surgery: Intraoperative body temperature and postoperative complications. (“[PDF] Effect of forced air warming blanket position in elective lumbar ...”) *Surgical Neurology International*, 10.
5. Cakir, G. & Cilingir, D. (2018). Maintaining normothermia to prevent surgical area infections during surgical interventions. *Anadolu Hemşirelik ve Sağlık Bilimleri Dergisi*, 21(2):137-43.
6. Card R, Sawyer M, Degan B, Harder K, Kemper J, Marshall M, et al. Institute for clinical systems improvement. (“Guideline-based quality indicators—a systematic comparison of German ...”) Perioperative protocol. 2014. (March 2024). Available

- FromURL: [https://www.icsi.org/guidelines\\_more/catalog\\_guidelines\\_and\\_more/catalog\\_guidelines/catalog\\_patient\\_safetyreliability\\_guidelines/perioperative](https://www.icsi.org/guidelines_more/catalog_guidelines_and_more/catalog_guidelines/catalog_patient_safetyreliability_guidelines/perioperative).
7. Hart, C. (2021). Effect of perioperative hypothermia on recovery in young adults: A Systematic Review.
  8. Horn EP, Bein B, Böhm R, Steinfath M, Sahili N, Höcker J. The effect of short time periods of preoperative warming in the prevention of perioperative hypothermia. *Anaesthesia*. 2012; 67:612–617. Doi: 10.1111/j.1365-2044.2012.07073. X.
  9. Jallow, O., & Bayraktar, N. (2022). Nurses' knowledge and practices of unintentional perioperative hypothermia prevention: A cross-sectional study. *Therapeutic Hypothermia and Temperature Management*. <https://doi.org/10.1089/ther.2022.0030>
  10. Kang S, Park S. Effect of the ASPAN guidelines on perioperative hypothermia among patients with upper extremity surgery under general AANA.com/AANA Journal Online AANA Journal + August 2022 + Vol. 90 No. 4 287 anesthesia: A randomized controlled trial. *J Peri-anesthesia Nurs*. 2020;35(3):298-306. Doi: 10.1016/j.jopan.2019.11.004
  11. Kim, E. J., & Yoon, H. (2014). "Preoperative factors affecting the intraoperative core body temperature in abdominal surgery under general anesthesia: an observational cohort." ("Inadvertent hypothermia: a prevalent perioperative issue that remains ...") *Clinical Nurse Specialist*, 28(5), 268-276.
  12. 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. [nursingjournal.fnu.edu.tr](http://nursingjournal.fnu.edu.tr)
  13. Lau, A., Lowlaavar, N., Cooke, E. M., West, N., German, A., Morse, D. J., ... & Merchant, P. R. N. (2018). Effect of preoperative warming on intraoperative hypothermia: A randomized-controlled trial. *Canadian Journal of Anesthesia*. 65(9), 1029.
  14. Morris, C. A. (2024). Evidence-based guidelines for prevention of inadvertent hypothermia in total joint arthroplasty (Doctoral dissertation, Otterbein University).
  15. NICE, (2017). Inadvertent perioperative hypothermia overview. <http://pathways.nice.org.uk/pathways/inadvertent-perioperative-hypothermia>.
  16. Oden, T. N., Doruker, N. C., & Korkmaz, F. D. (2024). Perioperative health care professionals' knowledge of evidence-based inadvertent perioperative hypothermia *Management. Journal of Peri-anesthesia Nursing*.
  17. Ruetzler K, Kurz A. Consequences of perioperative hypothermia. *Handbook Clin Neurol* 2018; 157:687-97.
  18. Safia, I. H. (2019). Prevalence of perioperative hypothermia amongst patients undergoing anesthesia at the Kenyatta National Hospital theatres (Doctoral dissertation, University of Nairobi).
  19. Sagioglu, G., Ozturk, G. A., Baysal, A., & Turan, F. N. (2020). Inadvertent perioperative hypothermia and important risk factors during major abdominal surgeries. *J Coll Physicians Surg Pak*, 30(2), 123-128.
  20. Sahin Akboga, O., & Dikmen Aydin, Y. (2023). Barriers and solutions in implementing evidence-based recommendations to prevent intraoperative inadvertent hypothermia: A qualitative study. *Therapeutic Hypothermia and Temperature Management*.
  21. Sari, S., Aksoy, S. M., & But, A. (2021). The incidence of inadvertent perioperative hypothermia in patients undergoing general anesthesia and an examination of risk factors. *International Journal of Clinical Practice*, 75(6), e14103.
  22. Şenol, T. & Yıldız, T. (2020). Effects of a training programme on the knowledge of inadvertent perioperative hypothermia among surgical nurses. *Current Health Studies*. [bookchapter.org](http://bookchapter.org)
  23. Sessler DI. Perioperative Thermoregulation and Heat Balance. *Lancet*. 2016; 387(10038):2655-64. DOI: 10.1016/S0140-6736(15)00981-2.
  24. Simegn, G. D., Bayable, S. D., & Fetene, M. B. (2021). Prevention and management of perioperative hypothermia in adult elective surgical patients: A systematic review. *Annals of Medicine and Surgery*, 72, 103059.

25. Sutherland-Fraser, S., Davies, M., Gillespie, B. M., & Lockwood, B. (2016). *Perioperative Nursing-eBook-epub: An introduction*. Elsevier Health Sciences.
26. Vural, F., Çelik, B., Deveci, Z., & Yasak, K. (2018). Investigation of inadvertent hypothermia incidence and risk factors. *Turkish Journal of Surgery*, 34(4), 300.
27. Woretaw, A. W., Mekonnen, B. Y., Tsegaye, N., & Dellie, E. (2023). Knowledge and practice of nurses with respect to perioperative hypothermia prevention in the Northwest Amhara Regional State Referral Hospitals, Ethiopia: a cross .... *BMJ open*. [bmj.com](https://www.bmj.com)
28. Worku, E., Desu, B., Tilahun, L., Tegegne, A., Wondifraw, E. B., Zeleke, M., & Mohammed, T. (2022). Nurses' knowledge, practice, and associated factors towards hypothermia prevention among trauma patients visiting Woldiya and Dessie Comprehensive Specialized Hospitals, Northeast Ethiopia, 2022. *International Journal of Africa Nursing Sciences*, 17, 100472.
29. Xiao, Y., Zhang, R., Lv, N., Hou, C., Ren, C., & Xu, H. (2020). "Effects of a preoperative forced-air warming system for patients undergoing video-assisted thoracic surgery: A randomized controlled trial." ("Effects of a preoperative forced-air warming system for patients ...") *Medicine*, 99(48), e23424.
30. Yılmaz, H. & Khorshid, L. (2023). "The effects of active warming on core body temperature and thermal comfort in patients after transurethral resection of the prostate: A randomized clinical trial." ("The Effects of Active Warming on Core Body Temperature and Thermal ...") *Clinical Nursing Research*.
31. You, Y., Gong, Z., Zhang, Y., Qiu, L., & Tang, X. (2024). Observation of the effect of hypothermia therapy combined with optimized nursing on brain protection after cardiopulmonary resuscitation: A retrospective .... *Medicine*.



## الملخص العربي

### تأثير تدخلات التدفئة ما حول فترات الجراحة لمنع انخفاض درجة حرارة الجسم غير المتعمد لدى المرضى الخاضعين للتخدير العام

**مقدمه:** تشكل تدخلات التدفئة المناسبة أثناء فترات الجراحة أحد العوامل الحيوية في الحفاظ على درجة حرارة الجسم الطبيعية للمرضى الخاضعين للتخدير العام. لذا فإن منع انخفاض درجة حرارة الجسم غير المتعمد يُعتبر أمرًا ضروريًا لتفادي المضاعفات الصحية وتحسين النتائج السريرية، مما يعزز من سلامة المرضى وفعالية العمليات الجراحية.

**الهدف:** هدفت الدراسة الي تقييم تأثير تدخلات التدفئة المستخدمة أثناء فترات الجراحة على تقليل أخطار انخفاض درجة حرارة الجسم غير المتعمد لدى المرضى الذين يخضعون للتخدير العام للمحافظة على درجة حرارة الجسم المثلى، مما يسهم في تحسين النتائج السريرية وتعزيز سلامة المرضى أثناء وبعد العمليات الجراحية.

**التصميم:** استخدمت هذه الدراسة تصميم بحث شبه تجريبي. كما أجريت هذه الدراسة في المستشفى الجامعي الرئيسي، الإسكندرية، مصر، وشملت جميع غرف العمليات وغرف الإفاقة وأقسام الجراحة العامة للمرضى الداخليين. حيث شملت الدراسة مجموعتين؛ المجموعة 1 عينة ملائمة مكونة من 60 مريضاً بالغاً خضعوا للتخدير العام تم اختيارهم وتقسيمهم بالتساوي إلى مجموعة الدراسة (ن=30) ومجموعة ضابطة (ن=30). المجموعة 2: عينة ملائمة مكونة من 60 ممرضة يعملن في غرف العمليات وغرف الإفاقة وأقسام الجراحة العامة للمرضى الداخليين وتم تقسيمهن بالتساوي إما إلى مجموعة الدراسة (ن=30) أو مجموعة ضابطة (ن=30). وشمل جمع البيانات استبياناً منظماً لتقييم معرفة المرضى، ومعرفة الممرضات بخفض حرارة الجسم أثناء فترات، وقائمة مرجعية لتقييم أداء الممرضات لتدخلات التدفئة. بالإضافة إلى ذلك، تم جمع البيانات الديموغرافية والسريرية.

**النتائج:** أظهرت الدراسة عدم وجود فروق ذات دلالة إحصائية بين المجموعات فيما يتعلق بالخصائص الاجتماعية والديموغرافية، ومؤشر كتلة الجسم، والتشخيص، والدخول السابق إلى المستشفى، والعمليات الجراحية السابقة. ومع ذلك، أظهرت النتائج تحسناً كبيراً في المعرفة والأداء لدى مجموعة الدراسة، بالإضافة الي تحسناً في التحكم في درجة حرارة الجسم وبالتالي تقليل المضاعفات المرتبطة بانخفاض درجة الحرارة لدى المرضى الذين تم تعليمهم والذين تلقوا تدخلات التدفئة أثناء فترات الجراحة كما لوحظ تحسناً كبيراً في معرفة وتدخلات الممرضين الذين تلقوا الجلسات التعليمية مما يبرز فعالية الجلسات التعليمية فيما يتعلق بتدخلات التدفئة أثناء فترات الجراحة. تم التوصل إلى أن تنفيذ هذه التدخلات يسهم في تحسين معرفة الممرضين والمرضى، ويقلل من أخطار انخفاض درجة حرارة الجسم غير المتعمد، مما يعزز جودة الرعاية ونتائج المرضى.

**الخلاصة والتوصيات:** إن تنفيذ تدخلات التدفئة أثناء فترات الجراحة يحسن بشكل كبير من معرفة الممرضين والمرضى، ويقلل من خطر انخفاض درجة حرارة الجسم غير المتعمد خلال العملية، مما يعزز رعاية ما قبل وبعد الجراحة ونتائج المرضى من خلال تقليل المخاطر المرتبطة بانخفاض درجة حرارة الجسم.

**التوصيات:** تطوير استراتيجيات التمريض من حيث التقييم الشامل للمرضى قبل العملية، وتعليم المرضى حول أخطار انخفاض درجة حرارة الجسم، والالتزام بالبروتوكولات المعتمدة للتدفئة ضرورية في تقليل مضاعفات انخفاض درجة حرارة الجسم غير المتعمد وتحسين الرعاية المحيطة بالجراحة لتعزيز السلامة أثناء التخدير العام.