

Guideline implementation and raising awareness for unintended perioperative hypothermia: Single-group “before and after” study

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ABSTRACT

BACKGROUND: Unintended Perioperative Hypothermia (UPH) is defined as a core body temperature less than 36°C. The Turkish Society of Anesthesiology and Reanimation [Türk Anesteziyoloji ve Reanimasyon Derneği (TARD)] published a “Guideline for the Prevention of the Unintended Perioperative Hypothermia” in 2013. This study aims to decrease the incidence of unintended UPH in our hospital using a protocol, which is prepared according to the recommendations in the Guideline for the prevention of unintended perioperative hypothermia.

METHODS: A prospective quality improvement study was conducted with the protocol, which was prepared to decrease the incidence of unintended perioperative hypothermia in patients undergoing surgery. We measured and compared the perioperative hypothermia incidence before the implementation (November 24th, 2015 – January 15th, 2016) and after the implementation (April 6th, 2016 – July 21st, 2017).

RESULTS: The incidence of unintended perioperative hypothermia was 35% and 23.8% in the pre-implementation and postimplementation sections, respectively, and the difference was statistically significant ($p=0.002$).

CONCLUSION: The incidence of unintended perioperative hypothermia can be significantly decreased with the evidence-based implementations.

Keywords: Patient safety; unintended perioperative hypothermia; warming.

INTRODUCTION

Unintended Perioperative Hypothermia (UPH) is defined as a core body temperature less than 36°C (96.8°F) starting from the first hour before anesthesia until the end of the first 24 hours after anesthesia.^[1] The reported incidence of hypothermia in the perioperative period is between 25% and 80%.^[2] Today, as a result of UPH, the effects of the hypnotic anesthetic agents and neuromuscular blockers are prolonged, the need for blood transfusion increases depending on the increased blood loss, cardiac complications may develop, the postanesthetic recovery delays, the incidence of postoperative nausea and vomiting increases, the risk of surgical wound

infection increases, the duration of the hospitalization prolongs, and finally the cost increases.^[3]

Regarding the prevention of UPH, several guidelines were introduced in the past by different institutes like National Institute for Health and Care Excellence (NICE, UK), Canadian Association of General Surgeons, and Association of the Scientific Medical Societies in Germany [Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften, (AMWF)] in different countries.^[4-6] In our country, the Turkish Society of Anesthesiology and Reanimation (TARD) also published the “Guideline for the Prevention of the Unintended Perioperative Hypothermia” in 2013.^[7]

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The TARD guideline has two major chapters titled “Definitions” and “Guideline for the Prevention and Treatment of UPH.” The first chapter “Definitions” contains the subtitles like the “Definition of the UPH”, “The Role of Anesthesia in the Development of Hypothermia”, “Stages, and Complications of UPH”, “Monitorization”, “Techniques used in the Prevention of Hypothermia”, and “Time to Start Warming up Patients”. “The recommendations to decrease the difference between the core and peripheral temperatures” and “Maintaining the core body temperature between 36°C (96.8°F) and 37°C (98.6°F)” are listed in the second main chapter.^[7]

In our clinic, we planned a study for the prevention of the UPH. The primary objective of our study was to investigate the change in the incidence of UPH by implementing a protocol that is prepared according to the recommendations in the “TARD Guideline for the prevention of UPH”. The secondary aims of the study were to find out the correlated risk factors and adverse effects of UPH if there were any.

MATERIALS AND METHODS

This single-center, prospective study was conducted in line with the Helsinki Declaration in the central operating rooms area of the Gülhane Military Medical Academy between November 1st, 2015 and July 31st, 2016. Our study was approved by the Ethics Committee for Clinical Research at Gülhane Military Medical Academy (2015 KAEK/33- The Efficacy of a protocol prepared according to the TARD Guideline for Unintended Perioperative Hypothermia: Implementation Study).

Patients, who were older than 18 years, scheduled for elective surgery by the departments of general surgery, urology, orthopedics, and thoracic surgery with an expected duration of surgery longer than 30 minutes, had ASA scores of I, II, and III; and accepted to participate with a verbal and written informed patient consent form, were included in our study. Patients, who had preoperative or postoperative obstacles for the body temperature measurement from the tympanic membrane, high fever related to the central nervous system, thermoregulation anomalies, active hypothyroidism/hyperthyroidism, infectious fever, a body temperature equal or higher than 38.5°C (101.3°F) in the last seven days, a body temperature less than 36°C (96.8°F) in the waiting room before anesthesia and patients pre-scheduled to active cooling or warming procedures as a part of the planned surgical treatment, were excluded from this study.

To measure the incidence of UPH, which was the primary evaluation parameter, the body temperatures of patients, were measured from the tympanic membrane with an electronic thermometer of the same brand (Genius 2 Infrared Tympanic Electronic Thermometer/Covidien, Mansfield, United States of America). This device has a sensitivity of $\pm 0.1^\circ\text{C}$.^[8] Before starting this study, the devices were calibrated according to the user manual published by the manu-

facturer to minimize the measurement errors. The body temperatures of the patients were measured from the tympanic membranes bilaterally and several times following their referral to the post-anesthesia care unit and recorded. We chose the higher value from the measurements done in both ears to decrease the errors due to the interobserver variability.

Our study consisted of three sequential periods (Fig. 1). In the first period, the condition before the protocol was evaluated. In this period, which we called the pre-implementation section, the data of 349 patients, who underwent perioperative thermal care and follow-up with the existing methods between 24.11.2015 and 15.01.2016, were recorded. Patients, who underwent surgery in the departments of general surgery, urology, orthopedics and traumatology, and thoracic surgery, were included in this study without randomization in order of arrival. During this period, the anesthesia clinic staff was not informed about the study details to obtain objective data related to the incidence of UPH.

The second period of this study is the protocol development and implementation strategy period, which was carried out between 16.01.2016 and 15.02.2016. In this period:

1. Microsoft PowerPoint presentations related to the prevention of UPH were prepared.
2. Presentations related to the content of the TARD guideline were briefed to all occupational groups working in the anesthesia clinic (anesthesia technicians, nurses, physicians).
3. On-site applied training was given to demonstrate the proper use of different types of thermometers, equipment used for active and passive warming in the pre-anesthesia waiting room, operating rooms and postanesthesia care unit (PACU).
4. A clinical checklist manual “Prevention of the Unintended Perioperative Hypothermia Manual” based on the TARD guideline was prepared (Fig. 2). Copies of this manual were distributed to the pre-anesthesia waiting room, operating rooms, and postoperative-anesthesia care unit.

In the third period between 06.04.2016 and 21.07.2016, which we called the postimplementation section, the data of

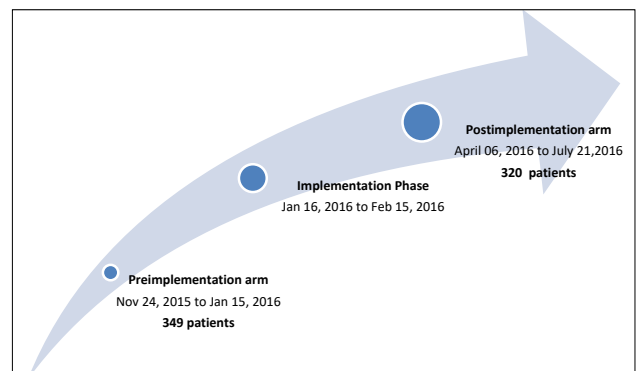


Figure 1. Study timeline.

“PREVENTION OF UNINTENDED PERIOPERATIVE HYPOTHERMIA” MANUAL*	
PROCEDURE	EQUIPMENT / METHOD / ACTION
PRE-OPERATIVE HOLDING AREA	
Body core temperature should be measured.	Tympanic thermometer
For patients with a body temperature equal to or higher than 36°C: passive insulation	Blanket, stockings, beret...
Patients with a body temperature less than 36°C: actively warmed	Forced air warming devices
<i>The patient should not be referred to the operating room if the body temperature is not equal to or higher than 36°C.</i>	
OPERATING ROOM	
Body temperature should be monitored at the lower end of the esophagus	Bedside monitor, esophagus temperature probe
Ambient temperature above 21°C	Climate control center (Tel. No: 2875)
<i>Only if active warming is started after the patients were covered with surgical drapes. The room temperature can be reduced to lower degrees, which is more suitable for the surgical team to work.</i>	
If IV liquid, blood-blood derivative more than 1000mL will be administered, temperature should be increased to 37°C.	Fluid warming device, operation table cover warmers; (aqueous or electrical systems), forced air warming devices
<i>High-risk patients should be actively warmed, even though the intervention will last less than 30 minutes.</i>	
Temperature should be adjusted to the maximum level when using hot air blowing systems.	Forced air warming devices
<i>Active warming should be stopped when the body temperature rises to or above 37°C.</i>	
Patient irrigation fluids should be warmed to 38-40°C.	Warmed irrigation fluids and serum
Mechanical ventilation	Anest. circuit HME filter , Low-flow anesthesia
POSTANESTHESIA CARE UNIT	
Body temperature should be measured as soon as the patient arrives at the recovery unit.	Tympanic thermometer
Measurements should be either continuous or repeated at 15-minute intervals.	Tympanic thermometer, Bedside monitor heat probe
"Passive insulation" should be implemented, if the patient's body temperature is equal to or higher than 36°C in the recovery unit.	Blanket, stockings, beret...
In patients with a body temperature less than 36°C active warming should be implemented.	IV fluid warmers, Forced air warming devices
<i>Patients with a body temperature equal to or higher than 36°C should be sent to the ward covered at least with one blanket.</i>	
<i>Patients should not be transferred to the ward until the body temperature rises above 36°C.</i>	
* The Turkish Anaesthesiology and Reanimation Society Guidelines for the prevention of inadvertent perioperative hypothermia. Turk J Anaesthesiol Reanim 2013 Oct;41(5):188-90.	

Figure 2. “Prevention of Unintended Perioperative Hypothermia” Manual.

320 surgical patients were recorded to assess the efficacy of the implementation. During this period, patients, who were scheduled for surgery in the departments of general surgery, urology, orthopedics and traumatology, and thoracic surgery were included in this study without randomization in order of arrival. Data related to the age, gender, body mass index (BMI) of patients, and the name of the surgical department, type of surgery (endoscopic/non-endoscopic), anesthesia technique (only general anesthesia/general anesthesia and others/no general anesthesia component), ASA physical status, amount of the infused intraoperative intravenous fluids, blood or blood derivatives, duration of surgery, PACU complications (shivering, pain, nausea-vomiting, hypoxemia, hypertension, tachycardia, bradycardia) and duration of hospitalization in PACU were obtained from the anesthesia record forms.

The primary objective of this study was to compare the UPH incidence between the pre-implementation and postimplementation sections. Classification of all participating patients in two groups as hypothermic patients and normothermic patients; comparison of the postoperative PACU complications between these two groups, and evaluation of the possible relationship between hypothermia and intraoperative variables were the secondary objectives.

Definitions

“UPH” was defined as the core body temperature measured below 36°C (96.8°F) in patients who were just referred to the PACU. A measured core body temperature between 36°C (96.8°F) and 37°C (98.6°F) was defined as “normothermia”. The time between the admission to the operating room and admission to PACU was accepted as the “duration of

the surgery". In the PACU, a VAS score greater than 3 was considered as "pain", fasciculations in one region of the face, neck or body was defined as "shivering", the presence of one of nausea, gagging or vomiting was defined as "nausea-vomiting", oxygen saturation less than 95% as "hypoxemia", a heart rate higher than 100 beats/min as "tachycardia", a heart rate less than 60 beats/min as "bradycardia" and systolic blood pressure higher than 140 mmHg as "hypertension". In the PACU, the measurements were recorded every 10 minutes and two sequential measurements indicating the above-mentioned complications were defined as "complication present." The duration between the arrival to the PACU and discharge from the PACU was defined as "PACU length of stay".

Statistical Analysis

The sample size analysis carried out before this study for the determination of the required number of patients for the inclusion in this study showed that 600 patients should be enrolled to achieve a difference with a power of 0.8 at a significance level of 0.05 for a 10% improvement in the unintended UPH incidence after the implementation.

Regarding the descriptive statistics, mean and standard deviation were used for the continuous variables and frequency and percentage for the categorical variables. The distribution of the categorical variables in the groups was analyzed with Pearson's Chi-Square test. The normal distribution was checked using the Kolmogorov-Smirnov test. The distribution of the variables that do not match parametric assumptions (age, BMI, and PACU length of stay) was investigated with the Mann-Whitney U test in both groups.

The variables of the participating patients, who had undergone surgery in different clinics, were first investigated with the univariate logistic regression analysis if a correlation with UPH was considered. If the p-value belonging to the Wald statistics, which was obtained as a result of the univariate logistic regression, was less than 0.25 ($p < 0.25$), the variables were included in the multivariate logistic regression analysis. The age, BMI, amount of intraoperative fluids and duration of surgery; continuous independent variables were analyzed with the Box-Tidwell approach and they were included in the logistic regression analysis as a continuous variable. The multicollinearity test for the accuracy or validation (sufficiency) of the model was assessed with the multivariate linear regression and the effective observations Cook's distance, distant observations Leverage (observation distance) values and outlier observations were evaluated with the Pearson or deviation residues. All study data were analyzed with the IBM SPSS Statistics version 25 software package (IBM SPSS Inc., Chicago, IL). The accepted limit of significance was $p < 0.05$.

RESULTS

In this study, 669 patients were included and 411 (61.4%)

of these patients were males and 258 (38.6%) females. The mean age and BMI values were 47.54 ± 18.82 (18–82) years, 26.65 ± 5.01 kg/m², respectively.

The distribution and comparison of the pre- and postimplementation sections according to the demographic characteristics are shown in Table 1. There was no statistically significant difference between the groups.

The distribution and comparison of the core body temperature on arrival to the PACU, which was the primary evaluation parameter, in the pre- and postimplementation sections are summarized in Table 2. The incidence and percentage of patients with a core body temperature less than 36°C (96.8°F) at PACU admission were significantly higher in the pre-implementation section ($n=122$; 35%) compared to the postimplementation section ($n=76$; 23.8%) ($p=0.002$).

All participants were divided into two groups as hypothermic and normothermic patients. The distribution and comparison of the PACU complications between these groups are summarized in Table 3. The incidence of complications as shivering, pain, hypoxemia, hypertension and tachycardia was significantly higher in the hypothermia group ($p < 0.05$). The PACU length of stay was also significantly longer in the hypothermia group (60.98 ± 39.07 min.) compared to the normothermia group (48.75 ± 27.42 min.) ($p < 0.05$).

Considering all participants, the mean volume of the intravenously administered fluids, the mean duration of surgery and the percentage of the intraoperative blood and blood derivative transfusion were 1316.89 ± 898.11 (min: 500–max: 9500) milliliters, 139.22 ± 80.45 minutes and 1.79%, respectively. These parameters were included in the logistic regression analysis related to hypothermia as a candidate variable.

The independent variables as ASA implemented anesthesia technique and intraoperative blood and blood derivative transfusion with a p-value greater than 0.25 ($p > 0.25$), which belongs to the Wald statistics obtained from the univariate logistic regression analysis, were not included in the multivariate logistic regression analysis carried out for the examination of the candidate variables related to hypothermia. The model fit was significant according to the Model Chi-Square ($\chi^2(9)=45.462$, $p < 0.001$), Hosmer-Lemeshow goodness of fit test ($\chi^2(8)=11.811$, $p=0.160$), percentile rank (70.1%), and Nagelkerke ($R^2=0.098$) statistics. Seven candidate variables included in the model were investigated using the likelihood ratio test with the backward LR elimination method. The continuous independent variables as age, BMI, amount of intraoperative fluids, and duration of surgery were analyzed with the Box-Tidwell approach and they were included in the logistic regression analysis as a continuous variable. We determined that the clinical variables age, gender, BMI and the

Table 1. Distribution of the pre- and postimplementation arms according to the perioperative characteristics

	Pre-implementation (n=349)	Post-implementation (n=320)	p
ASA physical status, (n, %)			
ASA 1	n=196, 56.1%	n=182, 56.9%	$\chi^2=2.642^*$, p=0.267
ASA 2	n=136, 39.0%	n=130, 40.6%	
ASA 3	n=17, 4.9%	n=8, 2.5%	
Gender, (n, %)			
Male	n=214, 61.3%	n=197, 61.6%	$\chi^2=0.004^*$, p=0.948
Female	n=135, 38.7%	n=123, 38.4%	
Age (year), (mean±SD)	48.13±18.45	46.89±19.22	z=-0.806**, p=0.420
Body mass index (kg/m ²), (n, %)	26.78±5.26	26.51±4.72	z=-0.398**, p=0.691
Surgical specialities (n, %)			
General surgery	n=170, 48.7%	n=153, 47.8%	$\chi^2=3.637^*$, p=0.303
Urology	n=80, 22.9%	n=62, 19.4%	
Orthopaedics and trauma	n=79, 22.6%	n=76, 23.8%	
Thoracic surgery	n=20, 5.7%	n=29, 9.1%	
Type of procedure, (n, %)			
Endoscopic	n=121, 34.7%	n=115, 35.9%	$\chi^2=0.117^*$, p=0.732
Not endoscopic	n=228, 65.3%	n=205, 64.1%	
Type of anesthesia, (n, %)			
General anesthesia only	n=237, 67.9%	n=228, 71.3%	$\chi^2=1.292^*$, p=0.524
No general anesthesia component	n=108, 30.9%	n=87, 27.2%	
General anesthesia and others	n=4, 1.1%	n=5, 1.6%	

ASA: American Society of Anesthesiologists; SD: Standard deviation. *Pearson chi-square test statistic value; **Mann-Whitney U test statistical value.

Table 2. Distribution and comparison of the core body temperature on arrival to the PACU in the pre- and postimplementation arms

	Pre-implementation (n=349)	Post-implementation (n=320)	p
Body Temperature on Arrival to the PACU, (n, %)			
<36°C	n=122, 35.0%	n=76, 23.8%	$\chi^2=10.062^*$, p=0.002**
36°C and above	n=227, 65.0%	n=244, 76.3%	

*Pearson chi-square test statistic value; **Statistically significant at level of 0.05. PACU: Postanesthesia care unit.

related surgery department had a significant correlation with the dependent variable perioperative hypothermia (p<0.05). The results of the multivariate logistic model created with the candidate variables are given in Table 4.

The age was included in the model as a continuous variable and we found that the probability of perioperative hypothermia increased 9.8 times with a 10-year increase in the age (95% CI=0.972–0.991). In other words, the probability of perioperative hypothermia was directly proportional to the advanced age and this probability dropped with the decrease of the age.

Regarding the gender (another independent variable), the probability of the perioperative hypothermia was 0.6 times lower in females compared to males (95% CI=0.421–0.921).

BMI was included as a continuous variable in the model and it was found out that the probability of the perioperative hypothermia increased 1.04 times with the 1 point increase in BMI (95% CI=1.008–1.089), which means that high BMI values favor the presence of perioperative hypothermia, while a decrease in BMI value led to a decrease in the probability of perioperative hypothermia.

Table 3. Distribution and comparison of the PACU complications in hypothermic and normothermic patients

	Hypothermic patients (n=198)	Normothermic patients (n=471)	p
Shivering, (n, %)			
Yes	n=41, 20.7%	n=17, 3.6%	$\chi^2=51.466^*$, p=0.000***
No	n=157, 79.3%	n=454, 96.4%	
Pain (n,%)			
Yes	n=58, 29.3%	n=101, 21.4%	$\chi^2=4.740^*$, p=0.029***
No	n=140, 70.7%	n=370, 78.6%	
Nausea and vomiting, (n, %)			
Yes	n=13, 6.6%	n=44, 9.3%	$\chi^2=1.378^*$, p=0.240
No	n=185, 93.4%	n=427, 90.7%	
Hypoxaemia, (n, %)			
Yes	n=64, 32.3%	n=105, 22.3%	$\chi^2=7.428^*$, p=0.006***
No	n=134, 67.7%	n=366, 77.7%	
Hypertension, (n, %)			
Yes	n=53, 26.8%	n=88, 18.7%	$\chi^2=5.477^*$, p=0.019***
No	n=145, 73.2%	n=383, 81.3%	
Tachycardia, (n, %)			
Yes	n=27, 13.6%	n=34, 7.2%	$\chi^2=6.928^*$, p=0.008***
No	n=171, 86.4%	n=437, 92.8%	
Bradycardia, (n, %)			
Yes	n=12, 6.1%	n=29, 6.2%	$\chi^2=0.002^*$, p=0.962
No	n=186, 93.9%	n=442, 93.8%	
Length of stay in the PACU (min.), (mean±SD)	60.98±39.07	48.75±27.42	z=-4.232**, p=0.000***

*Pearson chi-square test statistic value; **Mann-Whitney U test statistical value; ***Statistically significant at level of 0.05. SD: Standard deviation. PACU: Postanesthesia care unit.

There was also a statistically significant difference between the related surgery department and the risk of perioperative hypothermia (p=0.042). The probability of perioperative hypothermia was 1.78 times higher in patients undergoing orthopedic surgery compared to patients undergoing general surgery (95% CI=0.913–3.504). It was 0.97 times lower in patients undergoing urologic surgery compared to patients undergoing general surgery (95% CI=0.485–1.951) and it was 1.27 times higher in patients undergoing thoracic surgery compared to patients undergoing general surgery (95% CI=0.619–2.628).

DISCUSSION

We found in our study that the UPH incidence in surgery patients declined from 35% to 23.8% thanks to the implementation strategy that was developed according to the evidence-based recommendations in the “TARD Prevention of UPH Guideline”. However, in the 1st Patient Safety Campaign,^[9] a core body temperature above 36°C (96.8°F) was targeted in 95% of patients, who were referred from the operation room. Even though this target was not achieved in

this study, the incidence of UPH declined from 35% to 23.8% (p<0.005).

Yi et al.,^[10] conducted a nationwide study in China and they reported an incidence rate of 44.3% for UPH. This study had a multicenter design, the core body temperature was measured every 15 minutes throughout the perioperative period, hypothermia was defined as a core body temperature less than 36°C (96.8°F) in any measurement, and a much wider spectrum of the surgical departments, including cardiovascular and peripheral vascular surgeries, was included.^[10]

The incidence of UPH was 66% in a study conducted by Karalapillai et al.^[11] In this study, the core body temperature was monitored after cardiac surgery in the intensive care unit for 24 hours. We did not include cardiac surgeries in our study and recorded only the core body temperature on arrival to the PACU. These factors may explain the conflicting results between these two studies.

Aksu et al.^[12] conducted a study in Turkey and reported an incidence of 45.7% for UPH. Like in our study, the incidence

Table 4. The results of the hypothermia-related candidate variables according to the logistic regression models

Independent variable	B	S.E.	Wald	p	95% CI for Odds Ratio (OR)		
					Below	OR Exp(B)	Above
Gender*							
(Reference male)	-.473	.200	5.620	.018	.421	.623	.921
Age	.019	.005	13.536	.000	.972	.982	.991
Body mass index	.046	.020	5.523	.019	1.008	1.048	1.089
Surgical specialities**							
(Reference general surgery)			8.205	.042			
Orthopaedics and trauma	.581	.343	2.869	.090	.913	1.788	3.504
Urology	-.028	.355	.006	.937	.485	.972	1.951
Thoracic surgery	.243	.369	.434	.510	.619	1.275	2.628
Type of Procedure***							
(Reference endoscopic)	-.400	.207	3.747	.053	.447	.670	1.005
Intraoperative IV Fluid	.000	.000	2.502	.114	1.000	1.000	1.000
Total surgery time	-.002	.001	2.117	.146	.996	.998	1.001

CI: Confidence Interval. *Gender: reference male; **Surgical specialities: reference general surgery; ***Type of Procedure: reference endoscopic.

of UPH was determined with the core body temperatures measured on arrival to the PACU, but hypothermia was defined as a core body temperature less than 35°C (95.0°F).

Sagiroglu et al.^[13] conducted a study with 529 patients and reported an incidence of 63.3% for UPH. This high UPH incidence might be explained with inclusion of patients who had undergone only gynecological, obstetric, urological, and general surgeries.

In Turkey, Duman et al.^[14] conducted a study with 116 patients who had undergone orthopedic surgery and reported an incidence of 69.8% for UPH. In this study, the incidence was evaluated according to the core body temperatures measured in the first hour of surgery. This can be explanatory for the different results between our study and Duman's study.

As is seen in the literature, studies report different incidence rates for UPH in comparison to our study. This may be explained by the variability of methodologies, lack of a standard definition for the perioperative hypothermia, different cut-off points and measurement time for hypothermia, inclusion of different surgery types, and various kinds of equipment used in the prevention of UPH.

The time between the end of the implementation stage and recording of the postimplementation data is relatively short (50 days) in our study. The evaluation of the behavioral change before a sufficiently long time passes after the intervention may not be appropriate for the observation of the efficacy of the intervention. However, another study conducted one year later in our department provided valuable information.

In the study conducted by Eksert et al.^[15] with 629 patients, the incidence of UPH was 22.1%. We believe that this study provided objective evidence for the success and reliability of the implementation given that this study was conducted just one year later than our implementation and reported a similar incidence rate.

In the survey, which was conducted by Köksal et al.^[16] with anesthetists in Turkey and published before the introduction of the TARD guideline, the investigators had foreseen the necessity of standardization regarding the concepts related to perioperative hypothermia and the prevention of UPH and recommended to TARD to prepare a guideline. In 2017, after the introduction of the TARD guideline, İnal et al.^[17] surveyed with the anesthetists to evaluate their perioperative hypothermia management. They found that the TARD guideline was the most commonly referred guideline by the anesthetists for UPH.

In our study, the implementation was built on the evidence-based recommendations of the TARD guideline. A similar study was conducted in Germany. In this multicenter study, which had comprised the Northern Germany hospitals, compliance with the German S3 guideline was investigated. In this study, the details of the implementation had been listed item by item and then the authors had checked whether the anesthetists had followed these items or not. Although at the end of the study, the authors found that the anesthetists had only partially followed the recommendations in the guideline, hypothermia had not been observed in any of the included 431 patients.^[18] In our study, we did not itemize our implementations, but we used cotton blankets that

provided passive isolation and active warming methods like devices blowing heated air, electrical surgery table warming pad, intravenous fluid warmer, and HME filters in anesthesia circuit in both pre-implementation and postimplementation sections. We hung the prevention of the UPH checklist manual (Fig. 2) on easily visible walls in the working areas. However, we received feedback from the staff that the clinical guideline was too detailed. We decided to shorten the text with simpler and clearer expressions and made it available in the pre-anesthesia room, operation rooms, and PACU. We added extra lines to the anesthesia record forms and to the monitorization part for the core body temperature follow-up and core body temperature monitorization.

As a secondary outcome of our study, we found that, in the PACU, the rate of the complications as shivering, pain, hypoxemia, hypertension, and tachycardia was significantly higher in the hypothermia group compared to the normothermia group. These results were consistent with the current information in the literature.^[19]

We also evaluated correlated risk factors for UPH. In the TARD guideline, age over 70 was considered as a risk factor for the development of hypothermia.^[7] In our study, the age was accepted as a continuous variable and we found out that the possibility of the hypothermia incidence increased with the advanced age. Lau et al. conducted a study with 18,758 patients and showed that the UPH incidence was higher in patients over 65 years.^[20]

In the study conducted by Flores-Maldonado et al., no correlation between gender and UPH incidence was found in 130 patients.^[21] We determined that the probability of UPH was lower in females compared to males. We believe that this difference depended on that our study was conducted in a military hospital and the male: female ratio was 62%: 38% and the surgical interventions implemented in males are relatively more complicated.

The relationship between BMI and perioperative hypothermia incidence is not fully elucidated yet. While Okue et al. showed that BMI did not affect the intraoperative body temperature,^[22] Vinslow et al.^[23] demonstrated that high BMI had a mild protective effect on UPH. We added BMI as a continuous variable to regression analysis and showed that high BMI values increased the probability of UPH. The conflicting results in the literature may indicate that BMI is not an independent risk factor for UPH incidence or cannot be considered as a protective factor and may provide significant results only together with parameters like the type and duration of surgery.

We compared UPH incidence in different surgery clinics and found significant results. However, we believe that the results related to the surgical clinics were specific to our center and cannot be generalized. If we had classified surgeries as minor, moderate, and major, as universally accepted, the obtained

findings might probably have been evaluated as generalizable results.

In our study, the first period was conducted in the autumn and winter months and the second period in the spring and summer months. Although we have some concerns about the effects of the seasonal differences on our results, we did not implement any adjustments. However, we recommend that patient sampling should be preferably done in the same season and seasonal temperatures in the UPH studies.

Our study was a quality improvement study in a good purpose in light of the published guidelines. We recommend the consideration of international standards defined for such studies like the SQUIRE project by the investigators, which we did not consider.^[24] The single-center, uncontrolled and semi-experimental design, the inclusion of only anesthesia staff and lack of separate itemization are the limitations of our study. UPH is not a perioperative problem concerning only the staff of the anesthesiology department. The staff of all related surgery departments should be informed about UPH and their awareness should be improved.

Conclusion

Unintended perioperative hypothermia is a common complication and its incidence is still far away from the targeted level. Our primary recommendation is the standardization of the core body temperature monitorization in the perioperative period and the incidence of UPH and indirectly related perioperative complications can be significantly decreased with the implementation of the evidence-based recommendations (Fig. 2) like the “Guideline for the Prevention of the Unintended Perioperative Hypothermia” published by TARD. Suitable protocols should be established for the prevention and management of UPH in the operating rooms, and efforts should be made to improve the awareness and encourage behavioral changes.

Ethics Committee Approval: This study was approved by the Ethics Committee for Clinical Research at Gülhane Military Medical Academy (2015/KA EK/33).

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ORIJİNAL ÇALIŞMA - ÖZET

İstenmeyen perioperatif hipotermi için farkındalık oluşturmak ve kılavuz implementasyonu: Tek gruplu “önce ve sonra” çalışması

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AMAÇ: İstenmeyen perioperatif hipotermi vücut sıcaklığının 36°C'nin altına düşmesi olarak tanımlanır. Türk Anesteziyoloji ve Reanimasyon Derneği (TARD) 2013 yılında “İstenmeyen Perioperatif Hipotermimin Önlenmesi Rehberini” yayınladı. Amacımız rehber önerilerini içeren bir protokol oluşturmak ve hastanemizde perioperatif hipotermi insidansını azaltmaktır.

GEREÇ VE YÖNTEM: Cerrahi geçiren hastalarda perioperatif hipotermi insidansını azaltmaya yönelik oluşturulan protokol ile ileriye yönelik bir kalite iyileştirme çalışması yaptık. Hastaların perioperatif hipotermi insidansını; implementasyondan önce (24 Kasım 2015–15 Ocak 2016) ve implementasyondan sonra (6 Nisan 2016–21 Temmuz 2017) ölçtük ve karşılaştırdık.

BULGULAR: İstenmeyen perioperatif hipotermi (<36°C) insidansı preimplementasyon kolunda %35, postimplementasyon kolunda %23.8 olarak bulundu ve bu farkın istatistik olarak anlamlı olduğu görüldü (p=0.002).

TARTIŞMA: Kanıt dayalı uygulamalar ile yapılan müdahaleler sonucunda istenmeyen perioperatif hipotermi insidansı belirgin olarak azaltılabilir.

Anahtar sözcükler: Hasta güvenliği; ısıtma; istenmeyen perioperatif hipotermi.

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