

# The Effects of Heated Humidified Gases on Body Temperature and Shivering in Patients under General Anesthesia

Younkyung Lee<sup>1</sup> and Hyunli Kim\*

<sup>1</sup>Doctoral student

\*Ph. D., Professor of Department of Nursing, Chung-nam National University

Corresponding Author: \*hkim@cnu.ac.kr

<sup>1</sup>yeelulee@naver.com

## Abstract

**Purpose:** This study was performed to determine the effects of heated humidified anesthetic gases, via a heated and humidified circuit (HHC), on body temperature and shivering. **Methods:** A quasi-experimental design with pretest and posttest measures was used. Data was collected from 71 patients who underwent musculoskeletal surgery for clavicle or upper arm fractures under general anesthesia from June 4 to September 31, 2009. The experimental group consisted of 34 patients who received heated and humidified gas through a HHC, which was set at 40 °C, and continued to be warm during the period from the endotracheal tube intubation to extubation. The control group was made up of 37 patients who were provided with gas through a standard breathing circuit system with no added heat and humidity. The collected data was analyzed by chi-square test and t-test. **Results:** The esophageal temperature was significantly higher in the experimental group at 20, 30 and 40 minutes after intubation compared with those of the control group. However, there were no differences in the tympanic membrane temperature and in the level of shivering between the two groups. **Conclusion:** The finding partially supports evidence for applying HHC in patients undergoing surgery under general anesthesia to prevent hypothermia. However, further studies are required to measure the effects of HHC on body temperature and shivering over time considering different results among researches.

**Keywords:** heat, humidification, body temperature, shivering

## 1. Introduction

In spite of large fluctuations in the environmental temperature, a healthy human being maintains a nearly constant internal temperature of 37 °C to 38 °C at rest [7]. However, the temperature of patients while undergoing surgery falls for various reasons. Hypothermia is defined as the case in which a patient's core temperature, during surgery, is below 36 °C [26]. The temperature of patients undergoing surgery under general anesthesia decreases, with the temperature often dropping by somewhere between 0.2 °C to 2.5 °C, and 30% to 90% of them experiencing hypothermia with a body temperature of less than 35.5 °C [20], while up to 60% of postoperative patients experience hypothermia according to other studies [7]. On the other hand, hypothermia during general anesthesia shows a significant protective effect against ischemia and hypoxia [3], such as in the case of neurosurgery or cardiopulmonary bypass that is likely to induce tissue ischemia: hypothermic anesthesia may also be applied to protect the brain.

However, intraoperative hypothermia normally can cause varieties of serious complications on the human body such as ventricular tachycardia, hypertension, peripheral

vasoconstriction, and morbid cardiac events by increasing catecholamine in the blood [10, 17, 24]. Moreover, it is proven that intraoperative hypothermia impairs immune function and coagulation, causes acid-base imbalance, and increases the incidence of wound infection [15, 26, 29]. In addition, Barone, Pablo, & Barone (2004) reported that hypothermia prolonged recovery room stays. Furthermore, shivering is an unpleasant experience for the patients and can be remembered for several years afterwards, even though it is not a threat to life [23]. Shivering is a reaction of the compensatory mechanism for hypothermia to produce heat, commonly appearing at the recovery stage after surgery. This involuntary activity consists of the repetition of contraction and relaxation of the skeletal muscles 10-20 times per second, and it could induce an acid-base imbalance through the overproduction of lactic acid in anaerobic metabolism [25]. In addition, shivering increases the oxygen demand up to 400% to 500% and causes contraction of the skin blood vessels and hair muscles, which cause patients' severe discomfort [26]. On top of that, it was reported that postoperative shivering may raise wound pain by pulling on the operated area [6] and may increase intracranial pressure or intraocular pressure [18].

Currently, as an alternative to prevent side effects, hypothermia and shivering, after anesthesia, there have been several methods, including the warming of IV fluid or blood instead of injecting cold fluid [19], supplying heated and humidified anesthetic gas rather than cold and dry gas [9], and applying warm blankets and forced air warmers during surgery to keep the patient's body temperature up.

Among the methods of heated humidification, that of inhaled anesthetic gas was to add heat and humidity during general anesthesia. According to Kim, Woo, Kim and Cho (1991), it was reported that heated (37 °C) and humidified gas was effective in preventing hypothermia for long-term surgeries such as hepatectomy, radical hysterectomy, and Mile's operation. The body temperature was significantly different between 90 minutes after intubation and 180 minutes.

However, methods of heated humidification have less effective on body temperature compared to methods of increasing skin temperature, such as using a warming pad or a warm touch system, because it is clear that 90% of metabolic heat is lost through the skin surface and only 10% is lost through breathing. In addition, it was reported that there was no effective way to maintain body temperature and reduce the time of staying in the recovery room in the case of short-term surgery by heated humidification methods [8]. Therefore, the method of heated humidified gas has been used as a secondary method to maintain the patients' temperature in the case of major surgery, while it has been used alone in minor operations of more than 1 hour. It has been applied in cases where other warming methods are difficult to use, including due to the patient's physical position. Although, HHC is used in many cases of surgery, Republic of Korea studies to figure out the effect of heated and humidified gas on the patient's body temperature are limited to Yoon (1989), Kim (1991), and Kim *et al.*, (2002); most of the studies are overseas ones.

Maintaining intraoperative normothermia is thus likely to decrease infectious complications and shorten hospitalization in patients undergoing colorectal surgery [15]. Moreover, a wound infection can prolong hospitalization by 5 to 20 days and substantially increase medical costs [2, 11]. Accordingly, we applied HHC, one of the warming methods to patients to minimize postoperative complications due to hypothermia and to promote health by testing the effect of HHC on patients' body temperatures and shivering.

The purpose of this study is to determine the effect of HHC on patients, undergoing general anesthesia from operations for a fracture of the upper arm or clavicle, and to determine the effect on body temperature and shivering during the operation and recovery

stage, including surgery. Therefore, we looked for evidence for efficient nursing intervention for maintaining the patients' body temperatures.

Specifically, first, the esophageal temperatures between the experimental group and control group during the surgery were to be compared. Second, the tympanic temperatures between two groups after the surgery were compared. Third, the degrees of shivering between two groups after the surgery were compared.

The hypotheses of this study are as follows:

### **Hypothesis 1**

The esophageal temperatures of the experimental group (heated humidification of inhaled gases) would be higher than that of the control group during surgery.

### **Hypothesis 2**

The tympanic membrane temperatures of the experimental group would be higher than that of the control group during the recovery stage after surgery.

### **Hypothesis 3**

The degrees of shivering would be lower in the experimental group than the control group during the recovery stage after surgery.

## **2. Methods**

### **2.1. Study Design**

A quasi-experimental study was designed with pretest and posttest measures.

### **2.2. Study Sample**

Data for this study was collected from 71 patients who underwent surgery under general anesthesia because of a simple fracture of the upper arm or clavicle at Eulji University Hospital in Daejeon, Republic of Korea, from June 4, 2009 to September 30, 2009. Even though the initial number of participants was 93, those who experienced a body temperature below 35 °C during the surgery were excluded for this study, as a warming method other than HHC was applied for them, including the use of warm touch. In addition, the case of earlier termination was excluded as well. The final number of participants was 71 for the analysis in this study.

Data collection was limited to patients with simple fractures of the upper arm or clavicle to minimize their temperature change under surgery; musculoskeletal surgery for upper arm or clavicle approximately takes approximately one hour for the surgical procedure, and does not commonly require the administering of massive irrigation, IV fluids or blood transfusions. In addition, the incision of the operative manipulation does not greatly affect the body temperature unlike expo-laparotomy or expo-thoracotomy.

The criteria for the data collection are as follows

- a) Only applicants who understood the purpose of this study and agree to participate voluntarily were included.
- b) Only applicants who were between 18 years old and under the age of 65 were included.
- c) The tympanic membrane temperatures of applicants were arranged in the normal range of measurements (36.0-37.5 °C) before surgery.

- d) The ASA (American Society Anesthesiologist Class) of the applicants belonged to class I or II.
- e) Only applicants who do not receive blood transfusion during surgery were included.

The sample size of this study was based on G Power 3 Analysis. In addition, the significance level was set to 0.05, the effect size to 0.8, and a power of 0.8 were set. According to the statistics program, the minimum number of participants to satisfy these conditions was required to be 26 in each group. As this study was not a randomized arrangement, the data from 34 subjects in the experimental group and 37 subjects in the control group were collected for this study.

### 2.3. Measurement

**2.3.1. Tympanic Membrane Temperature:** In this study, an infrared tympanic thermometer (Thermoscan BROUN, IRT 3020, Germany) was used. The investigator measured applicants' tympanic membrane temperature initially when applicants arrived at the operation room to identify their body temperature arranged normal range and to assess homogeneity between the two groups. The tympanic membrane temperature was measured every 10 minutes during the participant's stay at the recovery room for 60 minutes after the operation. The mean value of the temperature measurement was recorded after checking it twice. A disposable cab was used and exchanged with a new one for each patient-

**2.3.2. Esophageal Temperature:** Right after the intubation, the esophageal temperature probe was inserted orally and located in the middle of the esophagus (approximately 24 cm below the larynx). The other side of the probe was connected to the temperature monitoring device (HP Virida, M1167A, USA) to observe the core body temperature. The investigator recorded the core temperature every 10 minutes based on the study that body temperature changes significantly every 10 minutes to 15 minutes [27]. The esophageal temperature was collected from the intubation of tracheal tube to extubation; the temperatures of during the 90 minutes after the intubation were investigated in this study. A re-usable probe was used. After each use, it was rinsed and sterilized by E. O. gas.

**2.3.3. Shivering:** The shivering scale by Collins was used; it has 5 points (from 0 to 4 points), and the higher the point score, the more severe the shivering. In this study, one investigator assessed the patient's shivering score, from the patient's arrival to the recovery room to the leaving time. If a patient was detected shivering, the investigator injected 25mg pethidine via IV, after the anesthesia doctor's consultation. Every 10 minutes after injection, the investigator assessed the shivering and recorded it.

### 2.4. Procedure

**2.4.1. The Allocation of Subjects to the Control and Experimental Group:** This study protocol was approved by the institutional review board of Eulji University Hospital (09-19). The investigator visited the patients before operation day and explained the purpose of this study, the additional cost and the pros and cons of HHC application. Through these individual interviews, the experimental group consisted of patients who agreed to both consents (voluntary written consent for this study and for the use of HHC). On the other hand, patients who did not agree with the use of HHC and only agreed to participate in this study were arranged to be in the control group. The arrangement of the experimental or control group

was followed by the operation schedule. In the case of the experimental group, HHC was equipped to the ventilator before induction; however, the general circuit was set up for the control group.

#### **2.4.2. Procedure of the Study:**

- ① From the induction of general anesthesia to extubation, including the measurement of the initial tympanic membrane temperature, the research procedure was performed directly by the investigator. Another trained investigator performed observation and measurement during the patient's stay in the recovery room.
- ② Individual written consent forms were collected before operation day by an investigator. In addition, questionnaires on age, height, weight, BMI, and history of disease were filled out by participants.
- ③ When patients arrived at the operating room, the investigator helped the patient to move to the surgical bed and measured the patient's EKG, BP, pulse, and tympanic temperature in the supine position.
- ④ The temperature probe was inserted on 1/3 points of the esophagus right after intubation, and the temperature was recorded every 10 minutes.
- ⑤ The tympanic temperature was measured every 10 minutes during the 60 minute patient's stay in the recovery room. In addition, the shivering was closely observed and measured. When shivering by a patient was observed, the investigator recorded the shivering score (as developed by Collins) and performed the same treatment for each shivering patient (pethidine 25 mg IV). The researcher reassessed the shivering every 10 minutes after the treatment and recorded it until disappeared.

#### **2.4.3. Procedures for Providing Experimental Treatment:**

- ① The heated humidified gas was supplied for experimental treatment and the Heated Circuit System (ACE Medical Co, Korea) was used in this study. Prior to the experimental application of temperature, the controllers were calibrated. Each circuit was pre-heated and pre-humidified 5 minutes before beginning the surgery by pouring 20 ml of sterile water into the device and setting the temperature controller to 40 °C. The temperature was set according to a study which found that the temperature setting of the heated humidified circuit should be restricted to less than 43 °C because of the risk of esophageal burn [28].
- ② In case where heating and humidification was not to be accomplished, the disposable regular circuit was used in control group.
- ③ All drugs used for the induction of anesthesia were applied to patients by consultation with anesthesiologists before conducting this study. Thiopental sodium 4-5 mg/kg and Vecuronium 0.08-0.12 mg/kg were intravenously injected and endotracheal intubation was performed after intravenous injection. In addition, all patients were treated equally by the anesthesia machine, the Avance (Datex-Ohmeda) ventilator, and maintained with the same ratio of anesthetic gas of 2 liters of oxygen per minute, 2 liters of nitrous oxide per minute and Isoflurane as a inhalator. The ventilator was controlled under the same conditions for all patients with a tidal volume of 10-15 ml/kg, and with a respiratory frequency of 10-12 times/min.

- ④ With respect to the temperature of the operation room, the researcher operated an air conditioner and set it at 21 °C when skin preparation was done and finished with a surgical drape. Temperature and humidification were measured until one hour elapsed.
- ⑤ Normal saline which was used for irrigating a surgical site before suture was not warmed (it was at room temperature).

### 2.5. Data Analysis

The WIN SPSS 16.0 program was used to analyze the collected data. The  $\chi^2$ -test and t-test were applied to prove the homogeneity of the general characteristics and the type of performed surgery between the two groups. The T-test was used to analyze the temperature change and difference of the degree of shivering depending on the experimental treatment.

## 3. Results

### 3.1. The Homogeneity of the Demographic Characteristics and Clinical Characteristics (Table 1)

There was no difference in the demographic characteristics such as gender, age, and category of the surgery, between the two groups.

Seventy-one participants completed this test, among them 34 people who were in the experimental group (24 male (70.6%) and 10 female (29.4%)), and those in the control group, which consisted of 37 people (25 male (26.7%) and 12 female (32.4%)). The average age of the participants was 40.01 (Table 1). There were no statistically significant differences between the two groups regarding clinical characteristics, such as height, weight, BMI, the tympanic membrane temperature of pre-operation, the temperature and humidity of the operating room, the temperature and humidity of the recovery room, the total surgery time, the total anesthesia time, the amount of intravenous fluids, and the amount of irrigation ( $p < 0.05$ ).

**Table 1. Homogeneity of Demographic and Clinical Characteristic between the Experimental Group and the Control Group (N=71)**

Characteristics		Experimental group (n = 37) n (%) or M D	Control group (n = 34) n (%) or M D	t or $\chi^2$	p
Age (yr)		39.21 (11.72)	40.76 (12.42)	0.38	.563
Gender	Male	24 (70.6)	25 (67.6)	0.08	.783
	Female	10 (29.4)	12 (32.4)		
Operation	ORIF (clavicle)	8 (23.5)	7 (18.9)	2.66	.447
	ORIF (upper extremity)	17 (50.0)	16 (43.2)		
	Implant removal (clavicle)	5 (14.7)	4 (10.8)		
	Implant removal (upper extremity)	4 (11.8)	10 (27.0)		
Height (m)		1.7 (0.08)	1.7 (0.08)	0.21	0.652

Weight (kg)	65.4 (10.94)	66.2 (9.92)	0.19	0.667
BMI (kg/m <sup>2</sup> )	23.07 (2.73)	23.03 (2.35)	1.70	0.196
Operation time (min)	94.12 (52.23)	88.11 (35.42)	2.08	0.154
Anesthetic time (min)	146.08 (39.20)	155.74 (62.85)	3.64	0.061
IV amount (ml)	900.00 (556.91)	756.22 (418.15)	1.56	0.216
Irrigation fluid (ml)	1920.59 (887.55)	2089.19 (1488.43)	3.15	0.080
Temperature arrival at OR (°C)	37.17 (0.35)	37.07 (0.43)	0.37	0.545
*OR temperature (°C)	22.93 (1.60)	23.95 (1.94)	0.52	0.473
*OR humidity (%)	50.06 (8.67)	44.57 (11.10)	1.13	0.291
†RR temperature (°C)	27.06 (2.78)	26.92 (0.95)	3.93	0.051
†RR humidity (%)	56.00 (7.75)	54.28 (11.10)	0.84	0.097

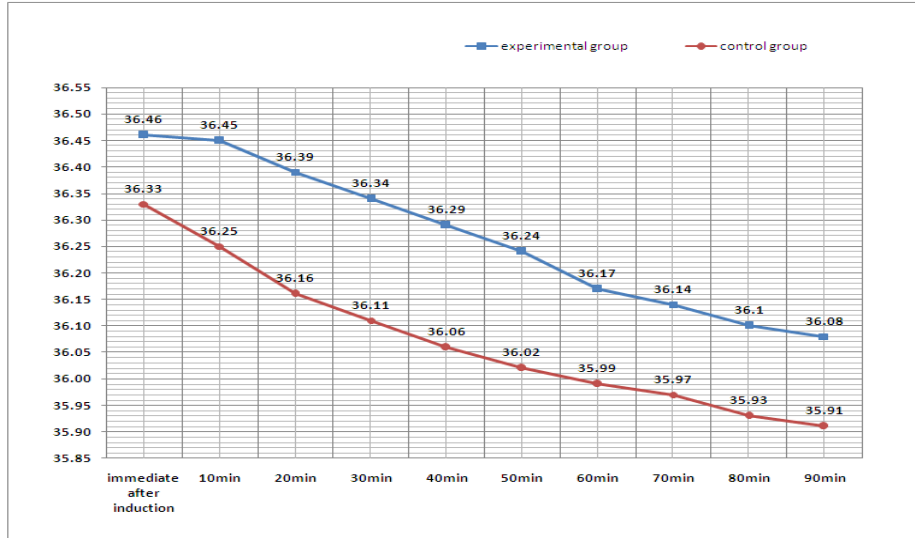
\*OR=Operation Room, †RR=Recovery Room, BMI=Body Mass Index

### 3.2. Verification of Hypothesis (Table 2)

**Table 2. The Comparison of Esophageal Temperature in the Operation Room and Tympanic Membrane Temperature and Shivering in the Recovery Room between the Experimental Group and Control Group (N=71)**

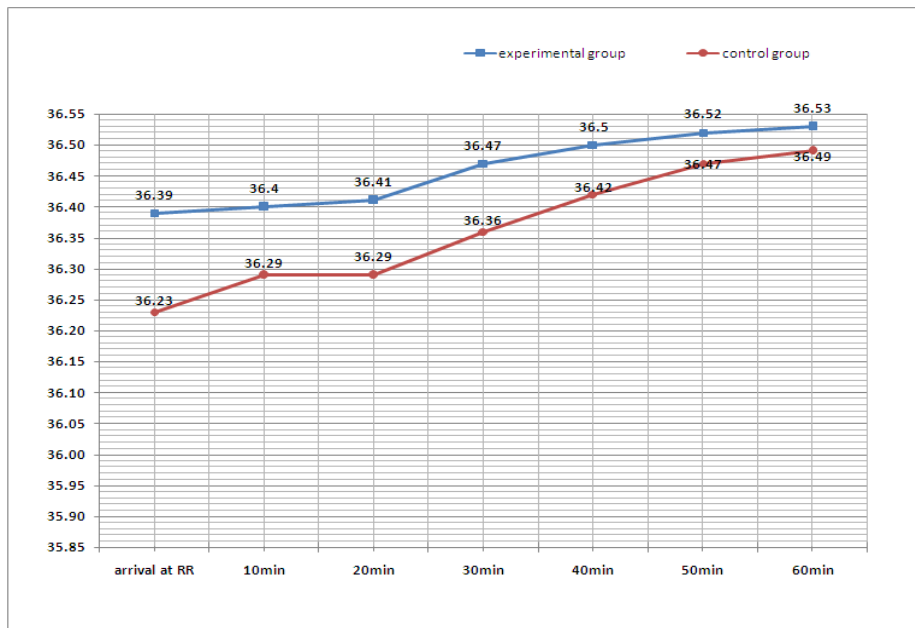
Time lapse (min)	Experimental group (n=34)	Control group (n=37)	F	p
	M (SD)	M (SD)		
Tympanic temperature after induction at *OR	36.46 (0.36)	36.33 (0.50)	-1.25	.216
10 min	36.45 (0.37)	36.25 (0.47)	-1.96	.504
20 min	36.39 (0.36)	36.16 (0.51)	-2.22	.030
30 min	36.34 (0.37)	36.11 (0.49)	-2.24	.029
40 min	36.29 (0.37)	36.06 (0.49)	-2.25	.027
50 min	36.24 (0.38)	36.02 (0.50)	-2.00	.050
60 min	36.17 (0.39)	35.99 (0.50)	-1.74	.086
70 min	36.14 (0.40)	35.97 (0.50)	-1.51	.137
80 min	36.10 (0.42)	35.93 (0.54)	-1.50	.140
90 min	36.08 (0.42)	35.91 (0.53)	-1.48	.146
Tympanic temperature after arrival at †RR	36.39 (0.46)	36.23 (0.57)	-1.31	0.196
10 min	36.40 (0.45)	36.29 (0.50)	-0.98	0.331
20 min	36.41 (0.47)	36.29 (0.47)	-1.07	0.290
30 min	36.47 (0.41)	36.36 (0.47)	-1.02	0.311
40 min	36.50 (0.39)	36.42 (0.47)	-0.84	0.402
50 min	36.52 (0.39)	36.47 (0.40)	-0.63	0.534
60 min	36.53 (0.38)	36.49 (0.43)	-0.45	0.657
Shivering after arrival at †RR	0.15 (0.70)	0.11 (0.52)	-0.27	0.790
10 min	0.21 (0.73)	0.14 (0.54)	-0.49	0.641
20 min	0.09 (0.29)	0.16 (0.55)	0.70	0.488
30 min	0.03 (0.17)	0.05 (0.23)	0.51	0.612
40 min	0 (0)	0.03 (0.16)	0.96	0.341
50 min	0 (0)	0.05 (0.33)	0.96	0.341
60 min	0 (0)	0		

**3.2.1. Verification of Hypothesis 1:** The esophageal temperature measurement for the first 90 minutes during the surgery were significantly higher in the experimental group than in the control group at 20 minutes ( $t = -2.22$ ,  $p = 0.030$ ), 30 minutes ( $t = -2.24$ ,  $p = 0.029$ ), and 40 minutes ( $t = -2.25$ ,  $p = 0.027$ ) after the intubation (Figure 1).



**Figure 1. Esophageal Temperature Comparison between Experimental Group and Control Group at Operation Room**

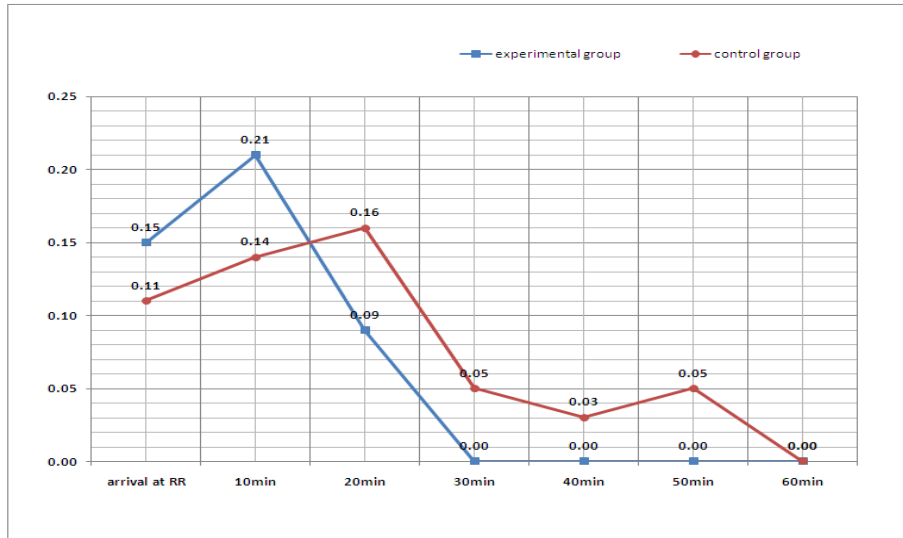
**3.2.2. Verification of Hypothesis 2:** The tympanic membrane temperature measured every 60 minutes in the recovery room after the surgery was not statistically significantly different between the two groups (Figure 2).



**Figure 2. Tympanic Membrane Temperature Comparison between Experimental Group and Control Group at Recovery Room**



**3.2.3. Verification of Hypothesis 3:** The degree of shivering between the two groups was not remarkably different for 60 minutes from their arrival to the operation room until discharge (Figure 3).



**Figure 3. The Comparison of Shivering at Recovery Room after Operation**

#### 4. Discussion

Patients undergoing surgery under general anesthesia are always in danger of hypothermia, and a temperature of less than 36.5 °C leads to an acid-base imbalance, wound infection by decreasing immune responses, and delayed recovery [15, 17, 26, 29]. In addition, shivering, a compensatory mechanism for hypothermia, is reported to cause considerable discomfort with various side effects to the patients [23].

Therefore, temperature management during general anesthesia is very important in preventing adverse side effects and to ensure patient comfort. Accordingly, we applied HHC, one of the warming methods, during the operation and tested the effect of HHC on the patients' body temperatures and shivering.

To identify Hypothesis 1, a t-test was done and the measured esophageal temperature was significantly higher in the experimental group than in the control group between effective times of 20 minutes and 40 minutes after the induction of general anesthesia. Other studies proved temperature differences at different effective times compared to the results of this study. A study by Kim *et al.*, (2002) verified that there was a difference in temperature at 50 min ( $p=0.047$ ) and 60 min ( $p=0.025$ ). In addition, there was a statistically significant difference between 90 minutes and 150 minutes ( $p<0.05$ ) according to the study of Kim *et al.* (1991).

The operating room temperature was set at over 21 °C in all three studies, and the esophageal temperature was checked. However, the temperature inhaled by patients was set at 40 °C in this study, 41 °C in the study of Kim *et al.*, (2002), and 37 °C in the study of Kim *et al.*, (1991). In addition, the selection of the operation in each study was different. To be specific, patients who fractured their upper arm or clavicle were collected for this study; however, laminectomy patients were collected for the study of Kim *et al.*, (2002), and exploratory laparotomy patients for Kim *et al.*, (1991). The difference in the operations may bring

different degrees of exposure, different incisions, and different irrigation times. Thus, these factors may affect the different results of each study.

Theoretically, the application of heated and humidified gases is a trial to minimize the heat loss due to vaporization in the second stage of anesthesia. It can not inhibit the movement of heat from the core to the distal regions within one hour after the induction of general anesthesia. Consequently, the application of heated and humidified gases is effective on body temperature on the surgery taking longer than one hour [21]; however, the finding of this study was different from the results of those studies. Therefore, it is suggested that these experiments be repeated many times.

The tympanic temperature in the recovery room was not significantly different between the two groups. It is considered that the temperature threshold value has been recovered within 15 minutes, and it has been adjusted to 36.2 °C to allow for the occurrence of peripheral vasoconstriction in response [23].

Although the heated humidification of inhaled gases could not increase significantly the recovery stage in this study, Kim *et al.*, (2002) investigated that the tympanic temperature of the heated humidified group was significantly higher than the control group from the admission time to the recovery room to 60 minutes afterwards. In addition, other studies to investigate between the heated humidification of the inhaled gas and the patient's temperature with the application of general anesthesia reported that the average temperature of the experimental group was 0.5 °C higher than the control group, thus shortening the average time required to stay in the recovery room by 58 minutes [5].

Hypothesis 3, that "the grade of shivering would be lower in the experimental group than the control group during the recovery stage after surgery", was not proven. Unfortunately, a Republic of Korea based study on the effect of heated humidified gas on shivering has not yet been performed to our knowledge; however, Lee & Lee (2002) investigated the effect of a warming method on the body temperature by applying an electronic circulated water blanket. Lee & Lee (2002) applied this warming method at the intraoperation and preoperation stages to be compared with the control group. The results were a 25% occurrence of shivering in the preoperative warming group and a 55% occurrence of shivering in the control group. Additionally, there was no shivering in the intraoperative warming group.

These different results are reported because each study applied different warming methods – the electronic warming method of Lee & Lee (2002) and the heated humidified gas method of this study. However, Kim & Kim (2002) claimed that a significant difference between the warming group and the non-warming group until 30 minutes after the arrival to the recovery room, even though the warming methods applied were different. Therefore, a study of the relationship between the warming method and shivering is needed, or a study of the relationship between the use of heated humidified gas and shivering needs to be performed and reported.

The purpose of this study was to investigate the effect of heated humidified gas on body temperature and on the condition of the patients undergoing general anesthesia with the controlled condition of other factors to lose body temperature. Therefore, the target operation group was selected as those with a simple fracture patients of the upper arm or clavicle because it usually takes one hour for the surgery, and the surgery does not have many opportunities, such as massive irrigation, broad opening of the skin, and expo-laparotomy, to take body temperature.

As a result, the heated humidification of inhaled gas was helpful to maintain the intraoperative body temperature; however, there was no significant effect on maintaining the body temperature and preventing shivering between the experimental group and the control group in the recovery room.

Thus, the heated humidification gas had relatively little effect when it was applied by itself, but in combination with other warming methods it is expected to be highly effective in maintaining body temperature, even if the surgery does not cause much loss of heat.

Therefore, the heated humidification method is considered as one of the effective ways to improve the quality of medical care and to offer comfort to patients on the basis of this study. In addition, non-Korean studies support the use of heated humidification to decrease occurrence of pneumonia related to patients who need long-term mechanical ventilation [22]. We expect additional studies about effect to help prevent respiratory cross-infection by the installation of a bacteria filter to the ventilator would be conducted.

## 5. Conclusion

The temperature of the HHC group was significantly higher between 20 and 40 minutes after intubation, and had not dropped below 36 °C (hypothermia) by 90 minutes after intubation, while there were no significant differences in the tympanic membrane temperature and in the level of shivering in the recovery room between the two groups.

Based on the results of this study, the following steps are recommended. First, it is necessary to investigate the effects on body temperature in the case of an operation which takes much longer than the 90 minutes of this study. Second, it is necessary to explore the effects of preventing irritation of the endotracheal tube, including pulmonary complications and effects on temperature. Third, it is necessary to seek for an effective heating method to prevent postoperative shivering. Fourth, it is necessary to find out how effective is the use of bacterial filters included in heated gases and HHC in preventing cross-infection between patients. Finally, we should be aware of the importance of maintenance patients' body temperature, considering the adverse effect of hypothermia. In current clinics, the monitoring of body temperature of postoperative patients is neglected or omitted. However, care for keeping patients' temperatures in a normal range should be performed if we consider the adverse effects of hypothermia.

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