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Original Article

Heating pad vs. infusion warmer to prevent hypothermia in intraoperative patients: which one is more effective?

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A B S T R A C T

Background: The use of heating pads and infusion warmers on intraoperative patients has been proven to prevent hypothermia. However, the differences in the effectiveness of the two methods have not been studied.

Purpose: This study aims to compare the effectiveness of a heating pad and infusion warmer in preventing hypothermia (decreased body temperature and the incidence of shivering) in intraoperative patients.

Methods: This research was a quasi-experimental design by a Posttest-Only Design with Nonequivalent Groups. The populations in this study were surgical patients with regional anesthesia, with a total sample of 64 respondents (32 respondents in the heating pad group and 32 respondents in the infusion warmer group) selected randomly. The incidence of hypothermia was perceived from two indicators: a decrease in body temperature and the prevalence of shivering, which was observed and recorded during the intraoperative period. The data were analyzed by discrimination tests (mean discrimination test and proportion discrimination test) to determine the difference in the effectiveness of the two groups.

Results: The average decrease in body temperature during the intraoperative period (0-40 minutes of operation) in the group given the infusion warmer was greater than the group given the heating pad ($p<0.001$). The group given the infusion warmer was 8.750 times more likely to experience shivering than the group given the heating pad ($p<0.001$; OR=8.750).

Conclusion: Using a heating pad is better in preventing hypothermia in intraoperative patients than using an infusion warmer.

INTRODUCTION

The prevalence of intraoperative hypothermia around the world varies between 44.3%-78.6%.[1–3] While in Indonesia, the prevalence of hypothermia in postoperative patients also varies, yet several studies have found a rate above 80%.[4,5] Studies also found that around 5%-65% of cases of hypothermia are experienced by patients undergoing general anesthesia and about 30%-57% experienced by patients undergoing subarachnoid block regional anesthesia.[6]

Hypothermia can cause discomfort to the patient during surgery and also can cause metabolic rate to increase up to 40%, pain in the surgical wound due to shiver, interfere with the interpretation of the monitoring result of oxygen saturation, blood pressure, pulse rate, and electrocardiogram so that it slows down the transfer of patients from the recovery room to the inpatient room. Prevention of hypothermia during surgery can be done by two methods, namely non-pharmacological and pharmacological.[7,8]

The pharmacological approach is prepared by administering opioids, α2-agonist, anticholinergic, central nervous system stimulants, corticosteroids that can prevent and treat shivering symptoms due to hypothermia.[9] The non-pharmacological approach is recognized as the rewarming

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technique, which consists of 3 parts, namely external passive, external activities, and internal active.[6]

The passive heating method can be conducted by providing a cotton cloth blanket that aims to reduce direct exposure to cold air and inhibit releasing body heat. The internal active heating method can be done by giving warm intravenous fluids, warm oxygen, peritoneal lavage, stomach, colon, and mediastinum using warm irrigation fluids. External active heating can be done by providing a warm blanket or electric blanket that produces a warm temperature, a heating pad or mattress, a heating lamp, a warm humidifier, and an increased room temperature.[6,10,11]

Research on the use of electric heating pads and intravenous fluids warmed with an Infusion warmer to prevent intraoperative hypothermia has been done previously. The results presented that both the use of an electric heating pad and the administration of warm intravenous fluids were equally effective in preventing hypothermia. Previous studies have found that using an electric heating pad is as effective as using forced-air warming in maintaining the stability of the patient's intraoperative body temperature.[12] In another study, it was revealed that the administration of warm fluid therapy and a heating blanket had an effect on increasing body temperature and preventing shivering in postoperative patients in the recovery room compared to the administration of fluids at room temperature.[13,14]

Based on the results of several previous studies, no studies directly distinguish the effectiveness of the usage of electric heating pads and infusion warmer on surgical patients. Therefore, it is necessary to research to analyze the usage effectiveness of an electric heating pad using an infusion warmer to prevent hypothermia in intraoperative. The purpose of this study was to compare the effectiveness of heating pads and infusion warmers in preventing hypothermia with indicators of decreased body temperature and the prevalence of shivering in intraoperative patients.

METHOD

Study Design

This research was a quasi-experimental research by Posttest-Only Design with Nonequivalent Groups.[15]

Settings and Respondents

The study was conducted at the Sanjiwani Hospital Gianyar, Bali, Indonesia, in March-May 2021. The population in this study were all patients who undertook surgery at the Central Surgical Installation of the Sanjiwani Hospital Gianyar, Bali. The sample in this study amounted to 64 respondents who were randomly divided into the heating pad group (32 respondents) and the infusion warmer group (32 respondents),[16,17] with the inclusion criteria of patients undergoing urological surgery, obstetrics and gynecology surgery, general surgery and orthopedic surgery, aged 17-60 years old, ideal body weight, regional anesthesia type (subarachnoid block) and maximum operating time of 2 hours. Patients who experienced hypothermia (body temperature <35.5°C) or hyperthermia (body temperature >37.5°C) preoperatively were excluded from the study.

Experimental Procedure

The instrument used in the heating pad group is the RoHS brand model/type Tk-HP2412, which uses electrical sensor technology to prevent overheating. Respondents use this tool during surgical procedures on the back and shoulders. The temperature setting at level 2 is in the range of 37°C-39°C (Figure 1A). On the other hand, in the infusion warmer group, the intervention was carried out by administering 500cc of ringer lactate fluid intravenously during the surgical procedure. The liquid is warmed with an Infusion Warmer at 37°C (Figure 1B).

The Variable, Instrument, and Measurement

The variable observed in this study was the prevalence of hypothermia, which was perceived from two indicators; body temperature and the occurrence of shivering. Respondents' body temperature was measured using a digital thermometer at the beginning of the operation or 0 minutes and during the operating period (10 minutes, 20 minutes, 30, and 40 minutes). The occurrence of shivering was also observed during the surgical period and recorded on the data collecting sheet.

Data Analysis

Two discrimination tests of dual means and proportions were employed to determine the difference between the two intervention groups in this study. Data with numerical scale were tested using the Independent t-test, while the categorical data were tested using the chi-square.

Ethical Consideration

This research has received research ethics permit from the Research Ethics Committee of Institut Teknologi dan Kesehatan (ITEKES) Bali registration number 04.0105/KEPITEKES-BALI/II/2021.

RESULTS

Respondents in both groups in the study were female, with an average age range of 35.3 years in the heating pad group and 38.1 years in the Infusion Warmer group. The type of surgery in both groups was dominated by obstetric surgery with a length of surgery between 45-115 minutes (Table 1).

Figure 1. Heating Pads and Infusion Warming Devices

The average body temperature of patients in the Infusion Warmer group appeared to tend to decrease with time of surgery, that was 36.0 0C at the beginning of the surgery, decreased to 35.5 0C at 10 minutes of surgery time, then decreased to 34.9 0C, 34.4 0C, and 33.9 0C at 20 minutes, 30 minutes, and 40 minutes of surgery time. On the other hand, the Heating Pad group tended to be more stable. The analysis results indicated a significant difference in body temperature decrease between the Heating Pad group and the Infusion Warmer group during the operating period (Figure 2).

The results of the analysis of the prevalence of shivering demonstrated that the percentage of shivering was more experienced in the Infusion Warmer group than in the Heating pad group, namely 64.2% vs. 36.4%). The analysis results displayed a significant difference in the proportion of shivering between the heating pad group and the infusion warmer group (p<0.0001). Administrating an infusion warmer to surgery patients was 8,750 times more likely to experience shivering than those using a heating pad (Table 2).

Table 1. Characteristics of Respondents

Characteristics	Heating Pad (n=32)	Infusion Warmer (n=32)
Sex		
Male	13 (40.6%)	11 (34.4%)
Female	19 (59.4%)	21 (65.6%)
Age, Years (*Mean*±SD; (*Min-Max*))	35.3±13.1 (18-60)	38.1±12.6 (19-60)
Surgery Duration, Minutes (*Mean*±SD; (*Min-Max*))	83.90±20.11 (45-115)	73.28±20.42 (45-115)
Surgery Types		
Urology	6 (18.8%)	7 (21.9%)
Obgyn	15 (46.9%)	18 (56.3%)
Orthopedics	4 (12.5%)	3 (9.4%)
General surgery	7 (21.9%)	4 (12.5%)

Table 2. Differences in The Prevalence of Shivering in The Heating Pad and Infusion Warmer Groups

Group	Shivering occurrence		p-value	OR
	No	Yes		
Heating pad (n=32)	14 (63.6%)	8 (36.4%)	0.0001	8.750
Infusion Warmer (n=32)	7 (16.7%)	35 (64.2%)		
Total	21 (32.8%)	43 (67.2%)		

DISCUSSION

Hypothermia in patients undergoing surgery occurs due to a combination of anesthesia and the surgery itself. The interaction of the two can cause regulating body temperature to be disturbed and cause a decrease in core body temperature.[18,19] Whereas shivering is a compensatory response of the body to increase heat production in a hypothermic state.[20]

This study found that using a heating pad (as an external warmer) during surgery can significantly prevent hypothermia compared to using an infusion warmer (as an internal warmer) with the indicators of body temperature and the prevalence of shivering. The higher average decrease in

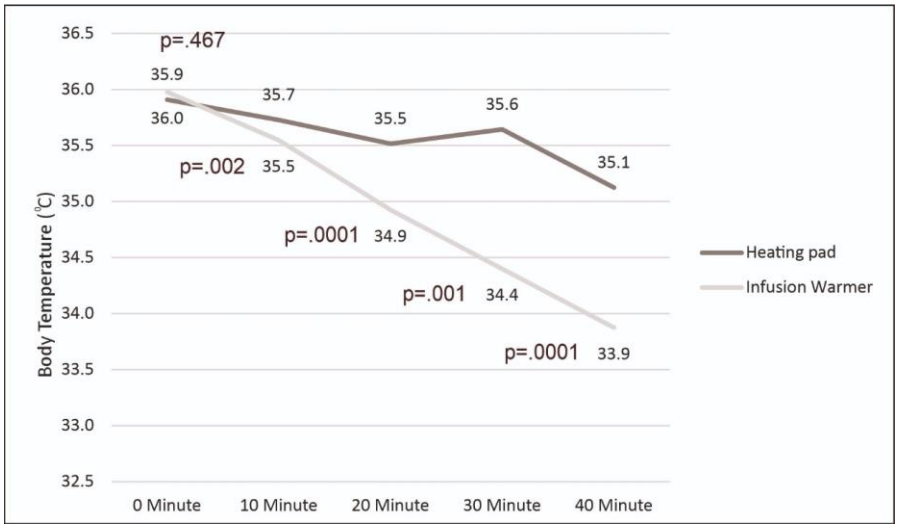

Figure 2. Differences in Body Temperature Decline During Surgery Between The Heating Pad Group and The Infusion Warmer Group

body temperature occurred using an infusion warmer of 2.1°C (from the beginning of the surgery to 40 minutes of surgery), while the decrease in average body temperature with the use of a heating pad was 0.8°C. The results of the analysis of the prevalence of shivering also exhibited that the prevalence of shivering was more experienced in the infusion warmer group than the heating pad group, which was 64.2% compared to 36.4%, p<0.0001.

Using a heating pad as an external heating method in this study was better than using an infusion warmer as an internal heating method in preventing loss of body heat during surgery. The results of this study were different from previous studies, which found that administering warm fluid therapy (internal heating method) was better in increasing the body temperature of post-spinal anesthesia patients than using blankets as external warmers.[13,21]

The heating pad device used in this study is an electric coil inserted into a waterproof pad and covered by cotton or flannel. The pad is connected to an electric wire which has a regulator unit to regulate the temperature. This heat pad is powered by 30 watts of electricity, equipped with a circuit breaker fuse and an automatic heat indicator light, making it safe and efficient. The temperature on the heat pad reaches 42°C. In comparison, the infusion warmer device used in this study is the one commonly used in hospitals. This device is used to warm intravenous fluids or blood during transfusion procedures to reduce the cold temperature of fluids or blood that enters the patient's body.

The external heating method can transfer warm temperatures to the core body temperature to affect the increase in peripheral temperature.[22] The warm temperature resulting from using a heating pad will be responded to through the stimulation of skin nerve points. This stimulus will be sent to the hypothalamus to maintain an average body temperature.[23] Electric heating pads have also been tested on hypothermic subjects with the result that there is a significant increase in total heat in respondents who experience hypothermia.[24] Other studies have also found the use of electric heating pads in patients undergoing Laparotomy surgery. The average temperature can be maintained at 35.5°C.[25]

Administering warm fluids through an infusion warmer can result in changes in temperature in the blood vessels that thermoreceptors can directly detect in the hypothalamus. The hypothalamus directly monitors the heat level in the blood flowing to the brain. The hypothalamus then stimulates the vasomotor center resulting in vasodilation of blood vessels which causes increased blood flow. The high speed of blood flow causes the surface of the body to become warm. Previous studies have also found that warm infusion can prevent hypothermia in surgical patients.[14,26]

The ineffectiveness of using an infusion warmer compared to a heating pad in the study may be caused by the insufficient device providing heat to the infusion fluid or because the number of infusion drops given to the patient is not constant (too fast or too slow), so that it affects the process of heating the infusion fluid. At the beginning of the completion of anesthesia and during surgery, the fluid needs of each respondent are different. In the first 5 minutes post-anesthesia, the patient is given a more rapid drip infusion to meet the blood vessels' fluid needs. The rapid drip causes much cold fluid to enter the respondent. Even though this device has been warmed up to 36-37°C, the heat generated cannot be maintained in the infusion fluid. The study results also explained that the effectiveness of the provided heating was inversely proportional to the increase in the drip rate; the faster the infusion fluid, the lower the heating of the fluid.[27]

CONCLUSIONS AND RECOMMENDATION

The use of heating pads in intraoperative patients is better in preventing hypothermia compared to infusion warmers. Standard operating procedures to prevent intraoperative hypothermia need to pay attention to the findings of this study.

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