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Application and Intervention of Multi-modal Thermal Insulation Nursing for Patients Undergoing General Anesthesia in Perioperative Hypothermia

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Abstract

To explore the application and intervention effect of multi-modal thermal insulation nursing in perioperative hypothermia of patients under general anesthesia, 468 patients admitted to the Department of Anesthesiology of Deyang People's Hospital to be operated under general anesthesia from October 2023 to October 2024 were selected and divided into a control group and an observation group in accordance with the sequence of surgery, with each group consisting of 234 patients evenly; the control group implemented the traditional heat preservation nursing measures, while the observation group implemented the multi-mode heat preservation nursing measures, and compared the application effects of the 2 types of nursing interventions. As the results shown, the body temperature of patients in the observation group was significantly better than that of patients in the control group 30 minutes before anesthesia, 1 hour after the start of surgery, at the end of surgery and 30 minutes after admission to the anesthesia resuscitation room ($P < 0.05$); the incidence of perioperative hypothermia, postoperative chills 30 minutes after surgery, and postoperative agitation 30 minutes after surgery in patients in the observation group were significantly lower than those of patients in the control group ($P < 0.05$); the patients' satisfaction ratings of perioperative thermal insulation in the observation group were significantly higher than those of the control group ($P < 0.05$). Through the implementation of multi-mode thermal

insulation nursing measures, it suggests that this mode could effectively improve the perioperative temperature of general anesthesia patients, reduce the perioperative hypothermia-related complications of general anesthesia patients, and improve the degree of satisfaction of patients with the thermal insulation measures, which is worthy of popularization and application in the clinic in a larger scale.

Keywords: multi-modal care, thermal insulation nursing, perioperative hypothermia, general anesthesia patients

1. Introduction

Surgical hypothermia, also known as perioperative hypothermia, is a pathological condition in which a patient's core body temperature drops below 36°C during anesthesia and surgery and is also the most common complication of these 2 processes. Relevant statistics point out that the incidence of perioperative hypothermia among patients in mainland China is about 7%-90%. The occurrence of perioperative hypothermia increases the danger of adverse postoperative outcomes for the patient, and puts the patients at the risk of postoperative chills, coagulation disorders, wound infection, or delayed anesthetic resuscitation (Lai et al., 2019; Lee & Kim, 2021; Yang et al., 2024). The main reason for perioperative hypothermia is that after anesthesia induction, anesthesia drugs will directly inhibit the hypothalamic thermoregulatory center of the human body, resulting in the body's inability to effectively maintain the core body temperature, and at the same time, anesthesia drugs will also dilate the peripheral vasculature, reducing the metabolism of the body to decrease the production of heat, which results in the inability to maintain the core body temperature. Besides, the temperature of the operating room is maintained at 20-24 °C, and prolonged exposure of the patient to low temperature will accelerate the body heat dissipation (Rufiange et al., 2021). moreover, the surgical incision during the surgical process leads to the exposure of the body cavity to the environment, making the body's skin and fat thermal insulation barrier damaged, and causing the body heat geometrically multiplied to lose, coupled with the use of intraoperative cryogenic flushing fluids and transfusion, which further exacerbates the lowering of body temperature, making patients undergoing surgery susceptible to induced hypothermia (Sari et al., 2021; Sun et al.) Currently, the intervention of perioperative hypothermia for general anesthesia patients is mainly divided into active and passive heating measures, in which the active heating measures are mainly through external equipment or ways to actively supplement heat for the patient, and the common ways of warming-up are inflatable heating equipment (FAW), which mainly heats up the surface of the skin through the way of hot air convection, and it can significantly improve the core temperature of the patient. Followed by intravenous fluid warming or flushing fluid warming, which mainly avoids cold fluids from causing a drop in the patient's body temperature, and conductive heating systems, such as circulating water heating blankets and inflatable heating blankets, which provide heat mainly through contact conduction (Zhang et al., 2024). Passive warming measures achieve thermal insulation primarily by reducing heat loss, commonly by covering insulating materials such as cotton blankets, surgical blankets, or thermal blankets to minimize heat loss from the skin, and to a lesser extent, by regulating the temperature of the operating room to minimize heat loss from the patient (Simegn et al., 2021). However, perioperative hypothermia intervention, as a highly structured healthcare strategy, requires the use of multi-stage management and multi-disciplinary collaboration to achieve standardized management, as well as dynamic assessment and monitoring, and the use of composite thermal insulation to reduce the incidence of perioperative hypothermia, based on which, in this study, multimodal thermal insulation care will be used to achieve the implementation of perioperative hypothermia management in general anesthesia for patients, in order to observe its specific intervention effect.

2. General Information

468 patients admitted to the Department of Anesthesiology of Deyang People's Hospital from October 2023 to April 2024 who were undergoing surgical treatment under general anesthesia were selected. Inclusion criteria: (1) those whose anesthesia mode was general anesthesia and whose ASA classification was grade I-II; (2) those who were well-informed and voluntarily agreed to participate in this study; (3) those whose age was ≥18 years old. Exclusion criteria: (1) those whose basal body temperature was ≥37.5℃ or <36℃ after the patients entered the operating room; (2) those with combined hyperthyroidism, hypothyroidism, or severe cardiovascular disease; (3) those whose collection of clinical data was incomplete for various reasons. The 468 patients included in the study were divided into the control group and the observation group according to the order of surgery. Among the patients in the control group (n=234), there were 136 males and 98 females, 87 abdominal surgeries, 79 thoracic surgeries, 43 limb surgeries, and 25 head surgeries; there were 20 cases with a BMI (kg/m^2) <18.5, 134 cases with a normal BMI (kg/m^2). BMI (kg/m^2) ≥23.9 in 80 cases, mean age (64.89±4.27) years, mean operation time (121.78±11.89) minutes, mean volume of infusion (1799.27±376.73) ml, mean volume of flushing (899.35±105.78) ml. Among the patients in the observation group (n=234), there were 126 male and 108 females, 90 abdominal surgeries, 72 thoracic surgeries, 48 limb surgeries, and 24 cranial surgeries; there were 22 patients with BMI (kg/m^2) <18.5, 129 patients with normal BMI (kg/m^2), and 83 patients with BMI (kg/m^2) ≥23.9; the average age was (65.33±3.89) years old, and the average operation time was (122.76 ±13.65) minutes, average infusion volume was (1804.22±386.65) ml, average flushing volume was (902.67±113.82) ml, and there was no significant difference in the comparison of the general data of patients in the 2 groups ($P>0.05$). In this study, an ear thermometer (Braun ear thermometer, model: IRT6525+LF20, manufactured by Kashu Company in Europe, implementation standard: National Machinery Injection 20192070043) was used to implement temperature measurement for the patients included in the study.

3. Methodology

3.1 Anesthesia Methods and Pre-anesthesia Preparation

general anesthesia was used in both groups, and after the patients entered the operating room, the temperature of the operating room was adjusted to 22 ℃, the humidity was controlled at 40%-60%, and the irrigation fluid and intravenous rehydration fluid were placed in the thermostat, so as to keep their temperature at 37 ℃.

3.2 Control Group

The control group implements the traditional thermal insulation nursing measures, the specific interventions are as follows: before surgical disinfection, according to the patient's surgical site laying sterile therapeutic towels; during the operation according to the patient's surgical exposed parts, using suitable surgical sheets, blankets or quilts to cover; after the operation, returning patients to the anesthesia resuscitation room, taking timely measurement of the patient's body temperature, and covering them with quilts or blankets to keep warm according to the patient's body temperature.

3.3 Observation Group

The observation group implemented multi-mode thermal insulation nursing measures, the specific interventions are: (1) preoperative warming measures: 30 minutes before the induction of anesthesia, the use of passive warming measures in the form of hot water bags or thermal blankets to implement thermal insulation for the patient, it is worth noting that the temperature of the hot water bag should be maintained at 43 ℃ or less in order to prevent scalding. (2) Intraoperative warming measures: after the patient is anesthetized, except for the surgical site or head, the whole body is covered with a surgical cover sheet, and an inflatable heating blanket is used to warm the patient until the end of the surgery, and the ear temperature needs to be monitored every 15-30 minutes during the surgery in order to dynamically adjust the warming measures, and the temperature of the inflatable heating blanket is adjusted to 45 ℃ when the ear temperature is <36.5 ℃, and adjusted to 40 ℃ when the ear temperature is between 36.5-37.5 ℃. When the ear temperature is >37.5℃, turn off the inflatable heating blanket. Before sterilizing, heat the disinfectant solution to avoid taking away too much body temperature from the patient when sterilizing, and when the amount of irrigation solution used by the patient is >500ml, it needs to be heated up to 38-40℃, and when the rate of blood transfusion is >500ml/h, it needs to be heated up to room temperature, but it is necessary to be wary of the blood deterioration. (3) Postoperative continuity of thermal insulation measures: after the patient's operation, dry the residual disinfectant and blood on the patient's skin in a timely manner, transfer the patient to the anesthesia recovery room, and continue to use the inflatable heating blankets to keep the patient warm, and give the patient a thermal insulation blanket until the patient's temperature is ≥36℃ before leaving the anesthesia recovery room, if necessary.

4. Observation Indicators and Statistical Methods

4.1 Record the body temperature of the 2 groups of patients 30 minutes before anesthesia, 1 hour after the start of surgery, at the end of surgery and 30 minutes after admission to the anesthesia resuscitation room, and compare the effect of the application of these 2 nursing interventions.

4.2 Record the occurrence of perioperative hypothermia, postoperative chills 30 minutes after surgery, and agitation 30 minutes after surgery in the 2 groups, and compare the effect of the application of the 2 nursing interventions.

4.3 Patient satisfaction: the department's self-designed patient satisfaction questionnaire was used to investigate the satisfaction of perioperative thermal insulation measures of the 2 groups of patients, the satisfaction score is full of 100 points, and the higher the score value, the better the patient's satisfaction with perioperative thermal insulation measures.

All data were statistically analyzed by using SPSS 26.0, and statistical significance was indicated when P<0.05. For general information, frequency, percentage, $\bar{x} \pm s$ were used for statistical description. The perioperative count data of patients were statistically analyzed by Chi-square test, and the data of patients' body temperature and patient satisfaction were statistically described by $\bar{x} \pm s$, and statistically analyzed by Independent-samples t-test and Repeated-measures ANOVA.

5. Results

5. 1 Comparing the Body Temperatures of the 2 Groups of Patients 30 Minutes Before anesthesia, 1 hour after the start of surgery, at the end of surgery and 30 minutes after admission to the anesthesia resuscitation room, it is found that the body temperatures of the patients in the observation group were significantly better than those of the patients in the control group (P < 0.05), as shown in Table 1 below.

Table 1. Comparison of Perioperative Body Temperature Between the 2 Groups of Patients ($\bar{x} \pm s$, °C)

Group	No. of Cases	30 minutes before anesthesia	1 hour after surgery	End of surgery	30 minutes after anesthesia recovery room
Observation group	234	36.61±0.68	36.32±0.37	36.58±0.67	36.31±0.86
Control group	234	36.22±0.72	35.88±0.68	35.55±0.49	35.83±0.74
t		6.024	8.694	18.982	6.472
P		0.000	0.000	0.000	0.000

5. 2 Comparing the occurrence of perioperative hypothermia, postoperative 30-minute chills, and postoperative 30-minute agitation in the 2 groups, the incidence of perioperative hypothermia complications in the patients of the observation group was significantly lower than that of the control group (P < 0.05), see Table 2.

Table 2. Comparison of the Incidence of Perioperative Hypothermia Complications Between the 2 Groups of Patients (n, %)

Group	No. of Cases	Hypothermia	Postoperative chills after 30 minutes	Postoperative agitation after 30 minutes
Control group	234	55 (23.50%)	21 (8.97%)	24 (10.26%)
Observation group	234	20 (8.55%)	10 (4.27%)	11 (4.70%)
χ^2		19.450	4.180	5.219
P		0.000	0.041	0.022

5.3 Comparing the satisfaction of perioperative thermal insulation measures between the two groups, the satisfaction scores of patients in the observation group were significantly higher than those of the control group ($P < 0.05$), see Table 3.

Table 3. Comparison of the Satisfaction Scores of Perioperative Thermal Insulation Measures in the 2 Groups ($\bar{x} \pm s$, points)

Group	No. of Cases	Satisfaction scores of patients
Control group	234	84.78±3.75
Observation group	234	95.89±4.28
t		29.866
P		0.000

6. Discussion

6.1 Multi-modal Heat Preservation Nursing Measures Could Effectively Improve the Perioperative Body Temperature of General Anesthesia Patients

The body's core body temperature is controlled by the body's defense system, and under normal circumstances the body's hypothalamic thermoregulatory center is maintained through neural-humoral regulation to maintain the body's temperature at about 37°C. When the body's core body temperature changes beyond the threshold, the thermoregulatory center will be regulated through vasoconstriction or dilatation, sweating, chills, etc. (Ashoobi et al., 2023). After a patient undergoes general anesthesia, peripheral vasodilatation causes heat from the body's core areas such as viscera and other systems to be redistributed to peripheral tissues, resulting in a rapid drop in the body's core body temperature by 1-1.5°C. The hypothermia of the operating room environment and exposure of the surgical field results in the continued loss of heat through radiation, convection, and evaporation, so that the surgical patient's core body temperature continues to slowly decline at a rate of 0.5°C/h during surgery, and the application of unheated fluids or blood products further accelerates heat loss (Emmert et al., 2018; Simegn et al., 2021; Tu & Zhang, 2025). Studies have shown that perioperative hypothermia can be effectively ameliorated by combining active and passive warming measures (Shaw et al., 2017), whereas another study showed that perioperative hypothermia was significantly reduced by implementing perioperative temperature interventions throughout the entire perioperative period (Shin et al., 2024; Shirozu et al., 2023). This is also confirmed by the fact that in this study, we effectively reduced the incidence of perioperative hypothermia in general anesthesia patients by combining passive and active insulation measures. We applied passive insulation measures to general anesthesia patients during the anesthesia waiting period, which to a certain extent was also effective in avoiding the drop in patients' preoperative body temperature caused by the low temperature of the operating room, and the combination of active insulation measures with passive insulation measures used in the intraoperative period, as well as the dynamic temperature monitoring help nursing staff to better realize the dynamic control of patient's body temperature during general anesthesia, realize the standardization and scientific management of patient's body temperature, and avoid hypothermia and thus affect the patient's surgical outcome otherwise. After arriving at the anesthesia resuscitation room, nursing staff did not give up the implementation of heat preservation plan for patients due to the withdrawal of anesthesia drugs and the recovery of patients' body temperature, and consistently adopted active-and-passive combined heat preservation to realize the effective management of patients' body temperature, therefore, the perioperative body temperature of the patients in the observation group was significantly higher than that of the control group, which could be explained.

6.2 Multi-modal Thermal Insulation Nursing Measures Could Effectively Reduce Perioperative Hypothermia-Related Complications in Patients Under General Anesthesia

Due to hypothermia after general anesthesia triggered by restlessness and chills is a common complication of perioperative patients, the main reason is that when the patient's body temperature is reduced, the body's cryogenic defense response will be triggered through the involuntary contraction of skeletal muscle and brown fat decomposition to provide heat for the body to promote the recovery of the body temperature, and chills will lead to an increase in the body's oxygen consumption, causing the accumulation of lactic acid in the body, the patient appears to be hypoxemia and metabolic acidosis, and further stimulate the patient sympathetic nerve excitation, resulting in increased heart rate and elevated blood pressure, thus causing patients to appear agitation. Although hypothermia, chills and agitation will not directly lead to the patient's death, but they will induce the patient to appear coagulation dysfunction, infection and other adverse surgical outcomes (Yin et al., 2024). As for general anesthesia surgery patients, necessary thermal insulation measures could effectively improve the status quo of patients' hypothermia and reduce the incidence of postoperative chills and agitation. In the present study, we have achieved better control of perioperative hypothermia by applying passive insulation measures and inflatable heating blankets with active insulation measures, which was also verified by the significant reduction in the incidence of perioperative hypothermia and related complications in the observation group compared with the control group.

6.3 Multi-modal Thermal Insulation Nursing Measures Could Effectively Improve the Satisfaction of General Anesthesia Patients with Perioperative Thermal Insulation Measures

Due to the impact of perioperative hypothermia, patients will experience postoperative chills and agitation, resulting in increased muscle oxygen consumption of patients as well as inducing wound pain and fatigue. The occurrence of hypothermia will lead to increased heart rat and cardiac load, which in turn aggravates the patient's postoperative weakness, plus the inadequacy of perioperative thermal insulation measures will also make patients feel that caregivers are not good at caring for them, which in turn will cause a decrease in the degree of satisfaction of patients (Al-Dardery et al., 2023). Related studies have pointed out that by implementing active thermal insulation measures can lead to an increase in patient comfort and improve patient satisfaction during surgery, which was also confirmed in the present study (Liu & Qi, 2021; Wang et al., 2022). In this study, through the implementation of multi-modal thermal insulation nursing measures, patients were provided with comprehensive care during the perioperative period, which not only effectively maintained body temperature, but also avoided complications such as postoperative chills and agitation. Compared with the single warming measure in the control group, the multi-modal thermal insulation nursing measures in the patients of the observation group were more in line with the practical needs of the patients, thus it could be well explained that the degree of satisfaction of the patients in the observation group was significantly higher than that of the control group.

7. Summary and Limitations

The implementation of multi-modal thermal insulation nursing measures could effectively improve the perioperative temperature of general anesthesia patients, reduce the perioperative hypothermia-related complications of general anesthesia patients, and improve the patient's satisfaction with thermal insulation measures. However, this study still has some limitations, for example, in this study, we monitor the patient's body temperature using an ear thermometer instead of an anal thermometer which could monitor the core body temperature of the patient more accurately. But since the operation was performed at a fast rate and to alleviate the patient's discomfort to the maximum extent, anal thermometer monitoring was hard to be carried out. As a consequence, the monitoring data may not be 100% as accurate as the core body temperature and exist some minor errors, which still needs to be improved in the future research and calls for surgical equipment advancement and method improvement urgently. As is known and shown in this study, the results of the application of multi-modal thermal insulation nursing measures in improving patients' perioperative hypothermia are worthy of affirmation, and it is worthwhile to popularize the application in the clinic in a larger scale in major cities in China and other countries across the world.

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Authors contributions

Authors contributed equally to the study.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Obtained.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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