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Standardized Hypothermia Prevention Strategy Improves Short-Term Prognosis of Patients Undergoing Video-Assisted Thoracoscopic Lobectomy

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Abstract

Objective: This study aims to explore the impact of a standardized hypothermia prevention strategy on postoperative hypothermia and hemodynamics in patients undergoing video-assisted thoracoscopic (VATS) lobectomy under general anesthesia. **Methods:** A total of 120 patients who underwent VATS lobectomy under general anesthesia in our hospital from June 2025 to November 2025 were selected and randomly divided into two groups. Patients in the control group received conventional thermal insulation measures, while those in the observation group implemented comprehensive thermal insulation based on a standardized hypothermia prevention strategy. The incidence of postoperative hypothermia and shivering, preoperative and postoperative heart rate (HR), preoperative and postoperative systolic blood pressure (SBP), preoperative and postoperative diastolic blood pressure (DBP), postoperative blood loss, frequency of postoperative thermal insulation adjustment, awakening time after admission to the Anesthesia Intensive Care Unit (AICU), time to first ambulation, time to first oral intake, surgical site infection, and length of hospital stay were recorded in both groups. **Results:** The observation group showed significantly lower postoperative shivering rate, hypothermia rate, postoperative HR, postoperative blood loss, time to first ambulation, time to first oral intake, and length of hospital stay compared with the control group ($P<0.05$). **Conclusion:** The standardized hypothermia prevention strategy has a significant effect on preventing postoperative shivering and improving the prognosis of patients undergoing VATS lobectomy. Its implementation can reduce the occurrence of postoperative shivering and improve the short-term prognosis of patients.

Keywords: Standardized hypothermia prevention strategy; Video-assisted thoracoscopic lobectomy; Hemodynamics

Introduction

In modern clinical diagnosis and treatment of thoracic surgery, video-assisted thoracoscopic surgery (VATS) has become an important method for treating diseases of the lungs, esophagus, mediastinum, and other parts due to its unique technical advantages. Compared with traditional open surgery, VATS inserts a thoracoscope and surgical instruments through small incisions to complete surgical operations with the assistance of a high-definition imaging system. It has significant characteristics such as minimal trauma, mild postoperative pain, rapid recovery, and low infection risk, which greatly reduces the physical and psychological burden on patients and promotes the development of thoracic surgery towards minimally invasive and precise directions. However, VATS needs to be performed under general anesthesia. Under general anesthesia, the function of the patient's thermoregulatory center is inhibited, the thermal defense system is weakened, and the use of muscle relaxants makes it difficult for the body to generate heat through shivering, leading to an imbalance in heat distribution in the body, a tendency for core temperature to decrease, and thus perioperative hypothermia[1]. Perioperative hypothermia refers to a condition where the patient's body temperature is lower than 36℃ within a period of time before and after surgery. Its incidence in various clinical surgeries is about 50%-90%[2], and in thoracic surgeries, this probability is as high as 78.3%[3]. This high-incidence problem is not merely an abnormal temperature value but a potential risk factor that may trigger a series of chain reactions. Perioperative hypothermia can lead to various complications such as shivering, increased cardiovascular burden, coagulation disorders, immunosuppression, and delayed awakening. It not only exacerbates the patient's pain but also increases the risk of postoperative infection, seriously affecting the patient's treatment effect and rehabilitation process[4].

In view of the many adverse effects of perioperative hypothermia, China has included the incidence of perioperative hypothermia as a quality control indicator for anesthesia in 2020, highlighting the high attention paid to this issue in clinical practice[5]. At the same time, relevant studies have shown that the intraoperative lateral decubitus position required for VATS is positively correlated with the high risk of perioperative hypothermia. The main reason is that in the lateral decubitus position, the patient's body is under uneven pressure, and passive thermal insulation measures are difficult to fully cover all parts of the body, increasing the ways of heat loss and further exacerbating the possibility of hypothermia[6]. Therefore, the implementation of scientific and effective perioperative temperature management for patients undergoing VATS lobectomy has become an important clinical issue that urgently needs to be solved.

In recent years, with the transformation of the medical model to "patient-centered", the comprehensiveness and refinement of postoperative recovery have become the focus of clinical attention. In addition to traditional prognostic indicators, indicators directly related to the patient's quality of life and rehabilitation experience, such as postoperative blood loss, surgical site recovery, and length of hospital stay, have also gradually attracted the attention of medical staff and patients. At present, most conventional clinical thermal insulation measures are passive, such as covering with quilts and using intraoperative forced-air warming blankets. These measures lack systematic and individualized considerations, making it difficult to carry out precise interventions according to the specific conditions of patients and unable to meet the multi-dimensional recovery needs of patients.

Based on the above clinical status, this study developed a standardized hypothermia prevention strategy on the basis of evidence-based medicine combined with clinical practice experience. This strategy not only focuses on the prevention of hypothermia and shivering and the stability of hemodynamics but also incorporates postoperative prognosis-related indicators into the evaluation system, aiming to comprehensively explore the comprehensive impact of this strategy on patients undergoing VATS lobectomy. Through scientific research design and rigorous clinical observation, it provides a more targeted and operable plan for clinical perioperative temperature management, which has important theoretical significance and clinical application value for safeguarding patients' health, preventing and treating related diseases, and controlling infections.

1 Materials and Methods

1.1 Study Participants

The study participants were patients who underwent VATS lobectomy in our hospital from June 2025 to November 2025. To ensure the scientificity and reliability of the research results, strict inclusion and exclusion criteria were formulated.

Inclusion criteria: (1) American Society of Anesthesiologists (ASA) physical status classification Ⅰ-Ⅲ. This classification standard is an important basis for evaluating the patient's anesthetic risk. Patients with ASA Ⅰ-Ⅲ have relatively good physical conditions, can better tolerate surgery and anesthesia, and reduce the interference of patients' underlying health problems on the research results; (2) Planned VATS lobectomy under general anesthesia to ensure the consistency of the surgical method of the research participants, facilitating intergroup comparison; (3) Patients and their families fully understand the purpose, methods, potential risks, and benefits of this study, voluntarily participate in the study, and sign the informed consent form to protect the patients' right to know and right to choose.

Exclusion criteria: (1) Patients with massive intraoperative or postoperative hemorrhage. Massive hemorrhage will have a serious impact on the patient's vital signs and coagulation function, which may mask or confuse the effect of the hypothermia prevention strategy; (2) Patients with language, cognitive, or mental dysfunction. Such patients cannot accurately express their own feelings and are also difficult to cooperate in completing the evaluation of postoperative relevant indicators and data collection; (3) Patients with severe cardiopulmonary dysfunction. Such patients have relatively serious underlying diseases, poor tolerance to surgery and anesthesia, and a high risk of postoperative complications, which may affect the authenticity and effectiveness of the research results.

After strict screening, a total of 120 eligible cases were selected and randomly divided into two groups using a random number table: the observation group (n=60) and the control group (n=60). To ensure the comparability of the two groups of patients, baseline comparisons were made on the general data of the two groups, including gender, age, anesthesia duration, intraoperative fluid input, intraoperative blood loss, etc. The results showed that there were no significant differences in the above general data between the two groups ($P>0.05$), indicating that the two groups of patients had good homogeneity, laying a foundation for the reliability of subsequent research results.

1.2 Nursing Interventions

1.2.1 Control Group

Patients in the control group adopted the traditional passive thermal insulation mode, which has been a commonly used thermal insulation method in clinical practice for a long time. The specific operation process is as follows: After the patient enters the operating room, to reduce heat loss caused by body exposure, a quilt is promptly added for warmth. During the operation, a forced-air warming blanket is used to keep the patient warm. The forced-air warming blanket continuously outputs warm gas to form a layer of warm air on the patient's body surface to reduce heat loss. After the operation, the patient is transferred to the Anesthesia Intensive Care Unit (AICU), and quilts are continued to keep the patient warm. During the entire nursing process, the patient's temperature change is closely monitored. When the patient's temperature is monitored to be <36℃ or shivering occurs, a forced-air warming blanket is immediately used for rewarming treatment to help the patient recover normal body temperature. At the same time, attention is paid to the patient's psychological care. Since surgery and unfamiliar environments may cause patients to have negative emotions such as tension and anxiety, nursing staff communicate with patients, provide psychological support and comfort, alleviate the patient's psychological pressure, and promote the patient's physical and mental recovery.

1.2.2 Observation Group

Patients in the observation group implemented an evidence-based standardized temperature management plan. The formulation process of this plan is rigorous and scientific, as follows: The formulation of the plan was jointly completed by a special team composed of the director of the Anesthesia Intensive Care Unit (AICU), the head nurse, and medical staff with intermediate or higher professional titles. First, the special team extensively reviewed relevant domestic and foreign literature to gain an indepth understanding of the latest research progress on the occurrence mechanism, influencing factors, and preventive measures of perioperative hypothermia. Based on evidence-based medical evidence and combined with clinical practice experience, brainstorming was used to comprehensively analyze and propose possible influencing factors of postoperative hypothermia, such as patient age, underlying diseases, surgical duration, intraoperative fluid input, and operating room environment temperature. Subsequently, according to the evidence-based results and combined with the actual situation of the department in our hospital, such as medical equipment configuration, medical staff technical level, and patient condition characteristics, a comprehensive temperature management model with operability and simplicity was formulated. The specific contents are as follows: (1) Preoperative thermal insulation preparation: After the patient is admitted to the operating room, quilts are provided for warmth in the preoperative waiting area and pre-anesthesia room to avoid heat loss caused by low ambient temperature or body exposure during the waiting period before surgery. At the same time, nursing staff explain the purpose and importance of preoperative thermal insulation in detail to patients and their families to improve patient compliance. (2) Operating room environment temperature regulation: Before the operation, the room temperature of the operating room is adjusted to 21℃-25℃ in advance. This temperature range has been verified by a large number of clinical practices. It can not only provide a suitable surgical environment for patients and reduce temperature loss but also not cause inconvenience to medical staff's operations or patient discomfort due to excessively high temperature. At the same time, a forced-air warming blanket is laid flat on the operating table and preheated in advance to ensure that the patient can get warmth in time when lying down. (3) Patient risk assessment and warming parameter setting: After the patient enters the operating room, a comprehensive risk assessment is performed on the patient with reference to the hypothermia risk probability (Predictors score)[7]. The Predictors score is a scientific and effective hypothermia risk assessment tool, which can comprehensively judge the risk level of perioperative hypothermia in patients according to multiple indicators such as patient age, gender, weight, surgical type, and surgical duration. Personalized warming parameters are set for patients according to the assessment results: 38℃ for low-risk patients, 40℃ for medium-risk patients, and 43℃ for high-risk patients. At the same time, nursing staff promptly inform the patient of the purpose and specific parameters of this operation, so that the patient understands the safety and pertinence of the thermal insulation measures, and avoids the patient's anxiety due to fear of excessive thermal insulation. (4) Intraoperative fluid warming treatment: All intraoperative fluids, blood products, and irrigation solutions are warmed to 37℃ using special fluid warming equipment before use. The normal human body temperature is about 37℃. Warming the infused fluid to a temperature close to the human body temperature can avoid the decrease in core temperature caused by the entry of low-temperature fluid into the body and reduce the adverse effects on the patient's cardiovascular system and coagulation function. (5) Real-time intraoperative temperature monitoring and adjustment: After the patient enters the operating room, a temperature sensor is placed in the nasopharynx to monitor the patient's temperature change in real-time through a monitor. The nasopharyngeal temperature can accurately reflect the patient's core temperature, facilitating medical staff to timely grasp the patient's temperature dynamics. According to the temperature monitoring results, the temperature of the warming blanket is adjusted in real-time to ensure that the patient's core temperature is maintained within the normal range and avoid excessive or insufficient temperature. (6) Postoperative AICU thermal insulation care: After the operation, the patient is transferred to the AICU. Nursing staff appropriately use a rewarming blanket to keep the patient warm according to the monitored temperature value. Continue to closely monitor the patient's temperature change, observe the patient's consciousness state, vital signs, etc., and promptly detect and handle possible abnormal temperature conditions. (7) Shivering emergency treatment: If the patient develops shivering after being admitted to the AICU, a forced-air warming blanket is immediately used for rewarming treatment. Shivering is one of the common manifestations of perioperative hypothermia, which not only increases the patient's oxygen consumption and cardiovascular burden but also brings discomfort to the patient. Timely and effective rewarming treatment can quickly relieve shivering symptoms, help the patient recover normal body temperature, and reduce the risk of related complications.

1.3 Outcome Measures

The outcome measures of this study cover multiple aspects such as the incidence of postoperative hypothermia and shivering, hemodynamic indicators, and postoperative recovery-related indicators, aiming to comprehensively and systematically evaluate the clinical effect of the standardized hypothermia prevention strategy.

(1) Incidence of hypothermia and shivering: Hypothermia is defined as a body temperature <36℃, and the incidence of hypothermia (%) = (number of hypothermia cases / 60) × 100%; shivering is defined as visible intense muscle activity, and the incidence of shivering (%) = (number of shivering cases / 60) × 100%. By recording the number of cases of postoperative hypothermia and shivering in the two groups, the incidence rates are calculated and compared between groups to directly evaluate the effects of the two thermal insulation strategies on preventing hypothermia and shivering.

(2) Hemodynamic indicators: Preoperative and postoperative heart rate (beats/min), preoperative and postoperative systolic blood pressure

(mmHg), and preoperative and postoperative diastolic blood pressure (mmHg) of the two groups of patients are recorded. Heart rate, systolic blood pressure, and diastolic blood pressure are important indicators reflecting the patient's cardiovascular function status. By comparing the changes of these indicators before and after surgery in the two groups, the impact of the standardized hypothermia prevention strategy on the stability of the patient's hemodynamics is analyzed.

(3) Postoperative recovery-related indicators: Including postoperative blood loss (ml), frequency of postoperative thermal insulation adjustment (times), awakening time after admission to the AICU (min), time to first ambulation (days after surgery), time to first oral intake (hours after surgery), surgical site infection, and length of hospital stay (days). Postoperative blood loss reflects the surgical trauma and the recovery of the patient's coagulation function; the frequency of postoperative thermal insulation adjustment reflects the effectiveness and stability of the thermal insulation strategy; the awakening time after admission to the AICU is related to the patient's anesthesia recovery; the time to first ambulation and time to first oral intake are important signs to evaluate the recovery of the patient's postoperative physical function; the surgical site infection is directly related to the patient's postoperative rehabilitation process and prognosis; the length of hospital stay comprehensively reflects the patient's overall recovery and the efficiency of medical resource utilization.

Through the monitoring and comparison of these indicators, the comprehensive impact of the standardized hypothermia prevention strategy on the patient's postoperative recovery can be fully evaluated.

1.4 Statistical Analysis

In this study, SPSS 27.0 (IBM, USA) statistical software was used for data analysis to ensure the scientificity and accuracy of data processing. For normally distributed measurement data, it is expressed as mean ± standard deviation ($\bar{x} \pm s$). First, a homogeneity of variance test is performed. If the variance is homogeneous, an independent samples t-test is used for intergroup comparison; if the variance is heterogeneous, a corrected t-test is used. For non-normally distributed measurement data, it is expressed as median (25th percentile, 75th percentile) [M ($Q1$, $Q3$)], and the Mann-Whitney U test is used for intergroup comparison. Categorical data are expressed as frequency and percentage (%), and the χ^2 test is used for intergroup comparison. A P-value <0.05 is considered statistically significant. Through rigorous statistical analysis, it is judged whether the differences in various observation indicators between the two groups of patients are significant, thereby verifying the effectiveness of the standardized hypothermia prevention strategy.

2 Results

2.1 Baseline Characteristics of the Two Groups

In the control group, there were 20 males and 40 females, with an age range of 38-69 years and an average age of (54.8 ± 7.3) years; in the observation group, there were 21 males and 39 females, with an age range of 40-69 years and an average age of (56.0 ± 7.2) years. Statistical analysis of the gender ratio and age of the two groups of patients showed that for gender, *P*=0.874; for age, *P*=0.402, with no statistically significant differences (*P*>0.05). This indicates that the two groups of patients have good balance in basic demographic characteristics such as gender and age, laying a solid foundation for the comparability of subsequent research results and excluding the interference of differences in basic conditions on the research outcomes.

Table 1 Comparison of Baseline Characteristics Between the Two Groups

Variable	Subgroup	Control Group (n=60)	Observation Group (n=60)	t/χ2 value	P value
Gender (%)	Male	20/60	21/60	0.037	0.874
	Female	40/60	39/60		
Age (years)		54.8±7.3	56.0±7.2	-0.841	0.402

2.2 Comparison of Postoperative Indicators Between the Two Groups

Through the monitoring and statistical analysis of various postoperative observation indicators of the two groups of patients, the results show that the observation group is superior to the control group in multiple key indicators, as follows:

(1) Incidence of hypothermia and shivering: The incidence of shivering in the observation group was 1.7% (1/60), which was significantly lower than

that in the control group (13.3%, 8/60), *P*=0.015; the incidence of hypothermia in the observation group was 1.7% (1/60), which was significantly lower than that in the control group (11.7%, 7/60), *P*=0.028, with statistically significant differences (*P*<0.05). This result indicates that the standardized hypothermia prevention strategy has a significant effect on preventing postoperative hypothermia and shivering, and can effectively reduce the risk of perioperative hypothermia-related adverse events in patients.

(2) Hemodynamic indicators: In terms of preoperative heart rate, the control group was 74 (67, 76) beats/min, and the observation group was 74 (67, 77) beats/min, *P*=0.966; the preoperative systolic blood pressure in the control group was 128 (119, 132) mmHg, and the observation group was 128 (122, 132) mmHg, *P*=0.411; the preoperative diastolic blood pressure in the control group was 70 (66, 75) mmHg, and the observation group was 72 (66, 88) mmHg, *P*=0.950. There were no statistically significant differences in various preoperative hemodynamic indicators between the two groups (*P*>0.05). The postoperative heart rate in the control group was 80 (73, 89) beats/min, and the observation group was 75 (70, 79) beats/min, *P*<0.001. The postoperative heart rate in the observation group was significantly lower than that in the control group, with a statistically significant difference (*P*<0.05); the postoperative systolic blood pressure in the control group was 128 (120, 155) mmHg, and the observation group

was 127 (121, 132) mmHg, P=0.232; the postoperative diastolic blood pressure in the control group was 69 (66, 74) mmHg, and the observation group was 70 (68, 73) mmHg, P=0.185. There were no statistically significant differences in postoperative systolic blood pressure and diastolic blood pressure between the two groups (P>0.05). This indicates that the standardized hypothermia prevention strategy can effectively maintain the stability of the patient's postoperative heart rate, reduce the abnormal increase in heart rate caused by factors such as hypothermia, and has a certain protective effect on the patient's cardiovascular function.

(3) Postoperative recovery-related indicators: The postoperative blood loss in the control group was 120 (80, 140) ml, and the observation group was 70 (90, 125) ml, P=0.027. The postoperative blood loss in the observation group was significantly less than that in the control group, with a statistically significant difference (P<0.05); the frequency of postoperative thermal insulation adjustment in the control group was 0 (0, 0) times, and the observation group was 0 (0, 0) times, P=0.111, with no statistically significant difference between the two groups (P>0.05); the awakening time after admission to the AICU in the control group was 0 (0, 44) min, and the observation group was 0 (0, 0) min, P=0.101, with no statistically significant difference between the two groups (P>0.05); the time to first ambulation in the control group was 2 (2, 3) days, and the observation group was 2 (2, 2) days, P=0.009. The time to first ambulation in the

observation group was significantly earlier than that in the control group, with a statistically significant difference (P<0.05); the time to first oral intake in the control group was 7 (6, 10) hours, and the observation group was 6 (6, 6) hours. The time to first oral intake in the observation group was significantly earlier than that in the control group, with a statistically significant difference (P<0.05); in terms of surgical site infection, there were 58 cases (96.7%) without infection and 2 cases (3.3%) with infection in the control group, and 59 cases (98.3%) without infection and 1 case (1.7%) with infection in the observation group, P=0.559, with no statistically significant difference between the two groups (P>0.05); the length of hospital stay in the control group was 6 (5, 8) days, and the observation group was 6 (5, 6) days, P=0.017. The length of hospital stay in the observation group was significantly shorter than that in the control group, with a statistically significant difference (P<0.05).

In summary, the observation group was significantly superior to the control group in key indicators such as postoperative shivering rate, hypothermia rate, postoperative heart rate, postoperative blood loss, time to first ambulation, time to first oral intake, and length of hospital stay (P<0.05), and there were no statistically significant differences in other indicators (P>0.05). This fully indicates that the standardized hypothermia prevention strategy can effectively improve the postoperative recovery of patients undergoing VATS lobectomy and has important clinical application value.

Table 2 Comparison of Postoperative Related Indicators Between the Two Groups

Variable	Subgroup	Control Group (n=60)	Observation Group (n=60)	Z/χ^2 value	*P* value
Shivering (%)	No	86.7 (52/60)	98.3 (59/60)	5.89	0.015
	Yes	13.3 (8/60)	1.7 (1/60)		
Hypothermia (%)	No	88.3 (53/60)	98.3 (59/60)	4.82	0.028
	Yes	11.7 (7/60)	1.7 (1/60)		
Preoperative HR (bpm)		74 (67, 76)	74 (67, 77)	-0.042	0.966
Postoperative HR (bpm)		80 (73, 89)	75 (70, 79)	-3.597	<0.001
Preoperative SBP (mmHg)		128 (119, 132)	128 (122, 132)	-0.823	0.411
Postoperative SBP (mmHg)		128 (120, 155)	127 (121, 132)	-1.196	0.232
Preoperative DBP (mmHg)		70 (66, 75)	72 (66, 88)	-0.063	0.950
Postoperative DBP (mmHg)		69 (66, 74)	70 (68, 73)	-1.325	0.185
Postoperative blood loss (ml)		120 (80, 140)	70 (90, 125)	-2.217	0.027
Frequency of thermal insulation adjustments (times)		0 (0, 0)	0 (0, 0)	-1.594	0.111
Awakening time after AICU admission (min)		0 (0, 44)	0 (0, 0)	-1.642	0.101
Time to first ambulation (days postop)		2 (2, 3)	2 (2, 2)	-2.627	0.009
Time to first oral intake (hours postop)		7 (6, 10)	6 (6, 6)	-3.204	0.001
Incision infection (%)	No	96.7 (58/60)	98.3 (59/60)	0.34	0.559
	Yes	3.3 (2/60)	1.7 (1/60)		
Length of hospital stay (days)		6 (5, 8)	6 (5, 6)	-2.387	0.017

3 Discussion

3.1 Impact of the Standardized Hypothermia Prevention Strategy on the Incidence of Hypothermia and Shivering

The results of this study show that the postoperative incidence of hypothermia (1.7%) and shivering (1.7%) in the observation group are significantly lower than those in the control group (11.7%, 13.3%). This significant difference is closely related to the systematicness, pertinence, and individualization of the standardized hypothermia prevention strategy.

The occurrence of perioperative hypothermia is the result of the combined action of multiple factors, among which the core temperature upon admission to the operating room and the surgical preparation time are the main influencing factors for hypothermia in patients undergoing VATS lobectomy[10]. In the traditional passive thermal insulation mode, attention is often only paid to thermal insulation during the operation, while ignoring the temperature protection during the preoperative waiting time and pre-anesthesia time, leading to a certain degree of heat loss in patients before entering the operating room, which lays a hidden danger for the occurrence of postoperative hypothermia. However, the standardized plan formulated in this study precisely strengthens interventions for these key links. After the patient is admitted to the operating room, quilts are promptly provided for warmth in both the preoperative waiting area and the pre-anesthesia room, reducing heat loss from the source. At the same time, by adjusting the temperature of the operating room to 21℃-25℃ in advance and preheating the forced-air warming blanket laid flat on the operating table, a warm surgical environment is created for the patient, avoiding the rapid decrease in body temperature caused by the low ambient temperature after the patient enters the operating room.

In addition, the standardized plan also introduces the hypothermia risk probability (Predictors score) to assess the patient's risk and sets personalized warming parameters according to the assessment results, reflecting the individualized advantage of the plan. Patients with different risk levels have different needs for thermal insulation temperature. Low-risk patients can meet their needs with a relatively low thermal insulation temperature, while high-risk patients need a higher thermal insulation temperature to effectively prevent hypothermia. This personalized thermal insulation method avoids the drawbacks of the "one-size-fits-all" approach in traditional thermal insulation measures, ensuring the thermal insulation effect and preventing discomfort to patients caused by excessive thermal insulation. At the same time, during the operation, the patient's temperature change is monitored in real-time through the temperature sensor placed in the nasopharynx, and the temperature of the warming blanket is adjusted in a timely manner according to the temperature monitoring results to ensure that the patient's core temperature is always maintained within the normal range, further improving the accuracy and effectiveness of thermal insulation.

Compared with simple passive thermal insulation, the standardized hypothermia prevention strategy not only reflects the scientificity of evidence-based medicine but also fully takes into account the individual differences of patients, effectively avoiding the problems of excessive thermal insulation or insufficient thermal insulation, thereby significantly reducing the risk of hypothermia and shivering. This research result is consistent with the research conclusions of Cui Ying[8] et al. in urological robotic surgery and Wang Yun[9] et al. in aortic dissection surgery on the application of standardized temperature management, confirming that this type of standardized temperature management plan has good applicability and effectiveness in different surgical types, and provides valuable reference for perioperative temperature management in various clinical surgeries.

3.2 Impact of the Standardized Hypothermia Prevention Strategy on Hemodynamics

Circulatory dynamic parameters are important indicators for evaluating cardiac pump function and hemodynamic status, including heart rate and blood pressure. Their stability is directly related to the patient's postoperative recovery and life safety. When hypothermia occurs, the body's metabolism slows down, and both oxygen intake and consumption decrease. To maintain the normal blood circulation of the body, the heart compensates by accelerating the heart rate, leading to an increase in heart rate and a decrease in stroke volume. The occurrence of shivering significantly increases the body's oxygen consumption and cardiovascular oxygen demand. In addition, the pain stimulation caused by surgical incisions can reflexively cause an increase in blood pressure. This situation is more obvious for patients with preoperative hypertension, and may even trigger cardiovascular adverse events in severe cases[11-12].

In this study, patients in the observation group adopted the standardized hypothermia prevention strategy, and the incidence of postoperative hypothermia and shivering was significantly reduced through a series of scientific and effective thermal insulation measures. Since the patient's core temperature is effectively maintained, the adverse stimulation of hypothermia on the cardiovascular system is avoided, so the postoperative heart rate of the observation group is significantly lower than that of the control group, and the change compared with the preoperative heart rate is small, with a more stable hemodynamic state. This result indicates that the standardized hypothermia prevention strategy has a positive impact on postoperative hemodynamic parameters. The main reasons are as follows: First, through effective hypothermia prevention measures, the incidence of postoperative hypothermia is reduced, the patient's body temperature is maintained within the normal range, which is conducive to maintaining the normal operation of cardiac function and avoiding the abnormal increase in heart rate caused by excessively low body temperature; second, timely and effective temperature management can reduce the occurrence of shivering, reduce the body's oxygen consumption and cardiovascular burden, keep the heart rate within the normal level, and ensure the stability of cardiac pump function; in addition, a stable temperature environment can also reduce the impact of hypothermia on blood pressure, avoid the sharp change in blood pressure caused by temperature fluctuations, maintain the patient's blood pressure in a relatively stable state, and thus maintain the balance of the overall hemodynamic state.

3.3 Impact of the Standardized Hypothermia Prevention Strategy on Postoperative Recovery-Related Indicators

3.3.1 Impact on Postoperative Blood Loss

The postoperative blood loss in the observation group is significantly less than that in the control group. The core mechanism of this result may lie in the protective effect of temperature stability on coagulation function. Perioperative hypothermia has a significant adverse impact on the body's coagulation function. When the body temperature is lower than 36℃, the activity of coagulation factors decreases, and the adhesion and aggregation ability of platelets also decreases, leading to coagulation dysfunction and an increased risk of bleeding at the surgical site[13]. The control group adopts the traditional passive thermal insulation mode, with a relatively high incidence of hypothermia. Some patients have a body temperature lower than 36℃, and their coagulation function is inhibited, resulting in a relatively large amount of postoperative blood loss. However, the observation group effectively maintains the stability of the patient's core temperature by implementing the standardized hypothermia prevention strategy, avoids the inhibition of hypothermia on coagulation factors and platelet function, ensures the normal play of coagulation function, reduces the bleeding at the surgical site, and thus significantly reduces the postoperative blood loss. This result is also consistent with the emphasis on the importance of temperature management for coagulation function in the Expert Consensus on Perioperative Hemostasis and Coagulation Management in Anesthesia, further confirming the important role of the standardized hypothermia prevention strategy in protecting the patient's coagulation function and reducing postoperative bleeding.

3.3.2 Impact on Time to First Ambulation and Time to First Oral Intake

The time to first ambulation and time to first oral intake in the observation group are significantly earlier than those in the control group, which fully reflects the promoting effect of standardized temperature management on postoperative functional recovery. On the one hand, hypothermia inhibits gastrointestinal peristalsis and delays the recovery of gastrointestinal function. The observation group maintains the stability of core temperature, avoids the inhibition of low temperature on the contractile function of gastrointestinal smooth muscle, accelerates gastrointestinal peristalsis and digestive juice secretion, enables the patient's gastrointestinal function to recover to normal faster, and creates good conditions for early oral intake. Early oral intake can not only provide the patient with the necessary nutrition and energy but also stimulate intestinal peristalsis, reduce the occurrence of postoperative complications such as abdominal distension, and promote the patient's overall recovery. On the other hand, postoperative hypothermia and shivering will exacerbate the patient's muscle soreness and fatigue, increase the discomfort of the patient's ambulation, reduce the patient's willingness to ambulate, and thus delay the time to first ambulation. However, the observation group has an extremely low incidence of hypothermia and shivering, and the patient has higher physical comfort after surgery, faster physical recovery, and correspondingly improved pain tolerance, so they can ambulate earlier. Early ambulation helps to promote blood circulation, prevent the occurrence of complications such as deep vein thrombosis of the lower extremities, and at the same time can promote the recovery of lung function, reduce the risk of pulmonary infection, which is of great significance for the patient's overall rehabilitation.

3.3.3 Impact on Length of Hospital Stay

The length of hospital stay in the observation group is significantly shorter than that in the control group, which is a concentrated reflection of the comprehensive benefits of the standardized hypothermia prevention strategy. The length of hospital stay is an important comprehensive indicator reflecting the patient's postoperative recovery, and its duration is affected by multiple factors such as postoperative complications and rehabilitation progress. By implementing the standardized hypothermia prevention strategy, the observation group shortens the hospital stay in multiple aspects: first, it significantly reduces the incidence of hypothermia and shivering, reduces the risk of related complications such as increased cardiovascular burden, coagulation disorders, and infection caused by hypothermia, thereby reducing the treatment and nursing time for these complications; second, the reduction of postoperative blood loss reduces the possibility of secondary treatment or prolonged observation caused by bleeding, avoiding the extension of hospital stay due to bleeding-related issues; third, the advancement of the time to first ambulation and oral intake accelerates the patient's physical recovery, gastrointestinal function improvement, and surgical site healing, shortening the overall rehabilitation cycle. This result is highly consistent with the concept of Enhanced Recovery After Surgery (ERAS). ERAS emphasizes reducing perioperative stress and accelerating patient recovery through multi-dimensional and refined intervention measures, and standardized temperature management is an important part of ERAS[14]. By implementing the standardized hypothermia prevention strategy, not only the patient's treatment effect and rehabilitation quality are improved, but also the occupation of medical resources is reduced, which has significant social and economic benefits.

3.4 Strengths and Limitations of the Study

3.4.1 Strengths

On the basis of traditional studies, this study adds postoperative prognostic indicators such as postoperative blood loss, time to first ambulation, time to first oral intake, and length of hospital stay, which more comprehensively evaluates the clinical value of the standardized hypothermia prevention strategy. Previous related studies have mostly focused on the preventive effect of hypothermia and shivering, and paid relatively little attention to the overall postoperative recovery. This study includes multiple indicators closely related to the patient's postoperative recovery into the observation scope, which can more systematically and comprehensively reflect the comprehensive impact of the standardized hypothermia prevention strategy on patients, and provide more abundant and valuable reference for clinical practice. At the same time, the standardized hypothermia prevention strategy formulated in this study is based on evidence-based medical evidence and combined with clinical actual conditions, which has strong pertinence and operability, and can provide a scientific and standardized temperature management plan for clinical medical staff, helping to improve the overall level of perioperative temperature management.

3.4.2 Limitations

Although this study has achieved certain research results, there are still some limitations: First, the sample size is relatively small, which may lead to selection bias, and the extrapolation of the research results may be limited; second, the follow-up time is short. This study mainly focuses on the short-term prognosis of patients, and does not evaluate the impact of this strategy on the long-term prognosis of patients, such as the long-term recovery of cardiovascular function and lung function; in addition, this study is a single-center study. Differences in medical equipment configuration, medical staff technical level, and patient condition characteristics among different hospitals may also have an impact on the research results.

In the future, multi-center, large-sample studies can be carried out to expand the scope of research objects, reduce selection bias and the limitations of single-center studies; at the same time, the follow-up cycle can be extended to further evaluate the long-term effectiveness and safety of the standardized hypothermia prevention strategy; in addition, the impact of the standardized hypothermia prevention strategy on different populations (such as elderly patients, patients with underlying diseases, etc.) can be further explored to provide a basis for clinical formulation of more personalized temperature management plans.

4 Conclusion

In summary, the standardized hypothermia prevention strategy has a significant impact on postoperative hypothermia and hemodynamics in patients undergoing VATS lobectomy. Through the implementation of this plan, it can effectively reduce the occurrence of hypothermia and shivering, maintain the stability of the patient's hemodynamics after surgery, and reduce the risk of complications; at the same time, it can also reduce postoperative blood loss, shorten the time to first ambulation, time to first oral intake, and length of hospital stay, and promote the patient's postoperative recovery. This strategy is based on evidence-based medical evidence, with systematicness, pertinence, and operability, which is in line with the "patient-centered" medical model and the concept of enhanced recovery after surgery. It provides a scientific and effective reference plan for perioperative temperature management of patients undergoing clinical VATS lobectomy, has important clinical application value, and is worthy of clinical promotion and application.

Author contributions

QL: Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing.

YXZ: Writing – review & editing, Investigation.

SC: Investigation, Writing – review & editing.

HC: Conceptualization, Formal analysis, Methodology, Software, Supervision, Writing – review & editing.

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