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Original Article

Application of subspecialty standardized temperature management process in a hybrid surgery for acute aortic dissection

Mingyue Zhang, Lijuan Zhang

Department of Anesthesiology, Huai'an First People's Hospital, Huai'an, Jiangsu, China

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Abstract: Objective: To evaluate the clinical effect of a subspecialty standardized temperature management process in a hybrid surgery for treating acute aortic dissection. Methods: From January 2020 to June 2021, 102 patients who underwent hybrid surgery for acute aortic dissection in the Department of Cardiovascular Surgery at the Huai'an First People's Hospital were selected as the control group, receiving routine temperature maintenance measures. From August 2021 to November 2022, 105 similar patients from the same hospital were enrolled in the experimental group, where a subspecialty standardized temperature management process was implemented. The incidence of hypothermia, Grade 4 shivering, and temperature changes at different time points during surgery were compared between the two groups. Results: The experimental group had significantly lower rates of postoperative hypothermia (7.62% vs. 17.65%, P=0.03) and Grade 4 shivering (0.00% vs. 6.86%, P=0.019) compared to the control group. Furthermore, temperature monitoring at different time points during surgery showed that patients in the experimental group had higher temperatures than those in the control group upon entering the operating room (P=0.000), half an hour after anesthesia induction, at the end of surgery, upon leaving the operating room, and upon leaving the post-anesthesia care unit (all P<0.001). Conclusion: The implementation of a subspecialty standardized temperature management process in hybrid surgery operating rooms effectively maintains the required body temperature during hybrid surgery for acute aortic dissection, thereby reducing the incidence of postoperative hypothermia and shivering.

Keywords: Subspecialty standardized temperature management process, acute aortic dissection, hypothermia, hybrid surgery, clinical effect

Introduction

Acute aortic dissection is a common and life-threatening cardiovascular emergency, with an incidence rate exceeding 300 per million. It is classified into Stanford Type A and Type B based on the extent of vascular involvement. Among cardiovascular surgical conditions, it has the highest surgical mortality and morbidity rates. Without prompt surgical intervention, the mortality rate within 48 hours can exceed 30% [1, 2]. Traditionally, surgical treatment for acute Stanford Type A aortic dissection has involved ascending aortic replacement combined with arch reconstruction, which is crucial for saving patients' lives [3]. However, this procedure requires deep hypothermic circulatory arrest, and despite advancements in monitoring technologies, there remains a significant risk of multi-organ damage, potentially compromising surgical outcomes and long-term survival [4].

In contrast, Stanford Type B aortic dissection is primarily managed with interventional techniques, which have shown promising results. Recently, the hybrid approach, combining both surgical and interventional methods, has been increasingly applied to acute Stanford Type A aortic dissection [5]. This technique involves open surgery to address ascending aortic lesions, combined with endovascular stent graft isolation and fenestration in the aortic arch. It avoids the systemic effects of deep hypothermia and reduces extracorporeal circulation time, particularly benefiting the postoperative

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recovery of elderly patients [6]. Consequently, the proportion of aortic dissections managed with hybrid surgery is increasing [5].

Research indicates that reducing body temperature during surgery can lower metabolic demands, thus enhancing surgical safety [4]. While simple interventional procedures do not require hypothermia, inadequate temperature management can still result in hypothermia in patients. Therefore, effective temperature management is crucial in hybrid surgery settings [6]. Currently, no standardized temperature management process exists for hybrid surgery rooms [7].

The subspecialty model is a nursing care approach that integrates the characteristics of specialized diseases with professional knowledge in the operating room, providing patients with higher quality temperature management services. This model effectively improves nursing quality and reduces the incidence of intraoperative hypothermia [8]. This study applied a subspecialty standardized temperature management process to the treatment of acute aortic dissection, significantly reducing the incidence of hypothermia and yielding favorable results. The detailed findings are presented below.

Materials and methods

General information

A total of 102 patients from Huai'an First People's Hospital between January 2020 and June 2021 were selected as the control group for a retrospective analysis. Another 105 patients, matched for baseline data such as age, body mass index (BMI), and gender, were selected as the experimental group from the same hospital between August 2021 and November 2022.

Inclusion criteria were: (1) acute aortic dissection diagnosed by coronary CT angiography; (2) age <80 years; (3) preoperative core body temperature within the normal range; and (4) all patients underwent hybrid surgery for vascular lesions.

Exclusion criteria included: (1) history of hypothermia or recent infection; (2) body weight ≥100 kg; (3) intraoperative core temperature <36.5°C or >37.5°C; and (4) patients who had their surgical procedures changed during the operation. This study was approved by the ethics committee of Huai'an First People's Hospital.

Sample size calculation

To estimate the sample size for a 1:1 parallel design with two equal groups, a parallel control design was employed, consisting of an observation group and a control group. Based on similar studies evaluating the effectiveness of subspecialty temperature care, the average temperature of the control group was 35.9°C, while that of the observation group was 36.9°C, with a standard deviation of σ=1. Considering a 10% dropout rate, and assuming a Type I error probability (α) of 0.05 and a power (1-β) of 80%, the sample size was calculated using the following formula:

$$n1 = 2\,(Za/2 + Z\beta)$$

$$n2 = \frac{2 \times \sigma 2}{(\mu 1 - \mu 2)\,2}$$

Where μ1=35.9, μ2=36.9, σ=1, a=0.05, β=0.2. Substituting these values into the formula yields n1=n2=21 cases. Therefore, the minimum sample size required for this study was 42 cases. To enhance the reliability of the research results, all 207 patients who met the inclusion criteria during the study period were included.

Temperature management methods

Establishment of the research team: The research team was composed of one head nurse who specialized in cardiovascular operations, one nursing department director, two leaders of operating room specialty groups, one graduate nurse, and one deputy chief perfusionist. (1) Literature Review: Systematic searches were conducted in PubMed, MEDLINE, Web of Science, China National Knowledge Infrastructure (CNKI), Wanfang Data, and China Biomedical Literature Database, covering the period from the inception of the databases until July 31, 2021. The current status and intervention measures related to temperature management during hybrid treatment of acute aortic dissection in China were reviewed and summarized to develop the initial version of the standardized temperature management protocol for the hybrid operation. (2) Protocol Refinement: Two senior operating room nursing experts and one cardiac surgery perfusion expert were invited to review and refine the protocol based on a structured questionnaire, resulting in the final standardized temperature management protocol for the hybrid operating room subspecialty care.

Temperature management methods for the control group: Temperature management for patients before, during, and after surgery followed routine procedures. Different communication strategies were employed based on the type of surgery: patients scheduled for elective surgery participated in preoperative discussions, while those undergoing emergency surgery communicated directly with the surgeon regarding the procedure. Temperature management varied depending on whether cardiopulmonary bypass (CPB) was utilized during surgery.

For the CPB group: 1. Upon entering the operating room, the ambient temperature was set to 23°C, and a circulating water heating blanket was activated with the water temperature set to 37.5°C. 2. After successful anesthesia induction, nasal and bladder temperature probes were inserted to monitor intraoperative temperature. 3. When CPB commenced, the room temperature was lowered to 22°C, and ice water was used for cooling the surgical field. 4. Rewarming began half an hour before aortic unclamping using a room heater, water blanket, and extracorporeal membrane oxygenation (ECMO) heating, with circulating water temperature set to 37.5-37.8°C, ensuring that the temperature at the arterial end of the ECMO circuit remained below 37.5°C. 5. After restoring normal heart rhythm post-aortic unclamping, the pericardial sac was flushed with 38°C solution. 6. All fluids and blood products administered post-CPB were warmed to 38°C. 7. After closing the pericardial sac, an inflatable warming blanket and warm air blower were used for patient warming.

For the non-CPB group: 1. Upon entering the operating room, the ambient temperature was set to 23°C, and a circulating water heating blanket was activated with the water temperature set to 37.5°C. 2. An axillary temperature probe was placed after successful anesthesia induction to monitor intraoperative temperature. 3. Intraoperative fluids and blood products were pre-warmed to 37°C before administration. 4. Warm water was used during the procedure, and before the end of surgery, an inflatable warming blanket and warm air blower were used to maintain the patient's body temperature. Additional blankets were provided as necessary to ensure normothermia. 5. After surgery, patients were transferred using a specialized warming bed to the intensive care unit (ICU) with minimal exposure of limbs to reduce the risk of hypothermia during transportation, as detailed in **Figure 1**.

Temperature management process for the observation group: The preoperative, intraoperative, and intraoperative temperature management of patients used a sub-specialty standardized temperature management process. Preoperative discussions on temperature management were carried out similarly to those in the control group. In the CPB group, temperature management was tailored according to the specific surgical methods employed. At the same time, carbon dioxide was introduced into the surgical field during the procedure to assist in temperature regulation, enabling precise control of myocardial temperature. When rewarming was needed, the speed and timing of rewarming were determined in consultation with the surgeon and perfusionist, ultimately minimizing exposure after surgery [9]. Details of temperature adjustments and carbon dioxide use are illustrated in **Figures 2** and **3**.

Evaluation indicators

Primary outcome indicators: The primary objective of this study is to evaluate the incidence of hypothermia at different time points from patient entry to exit. Body temperature was measured in the study group at the following time points: upon entering the operating room (T1), before the start of CPB (T2), after CPB cessation (T3), 30 minutes after stent implantation (T4), during incision closure (T5), and 30 minutes after the end of surgery (T6). Hypothermia is defined as a body temperature below 36°C. The incidence of hypothermia was calculated as the number of hypothermic cases divided by the total number of cases in the group, multiplied by 100%, based on previous literature.

Secondary outcome indicators: The incidence of Grade 4 shivering was assessed using the

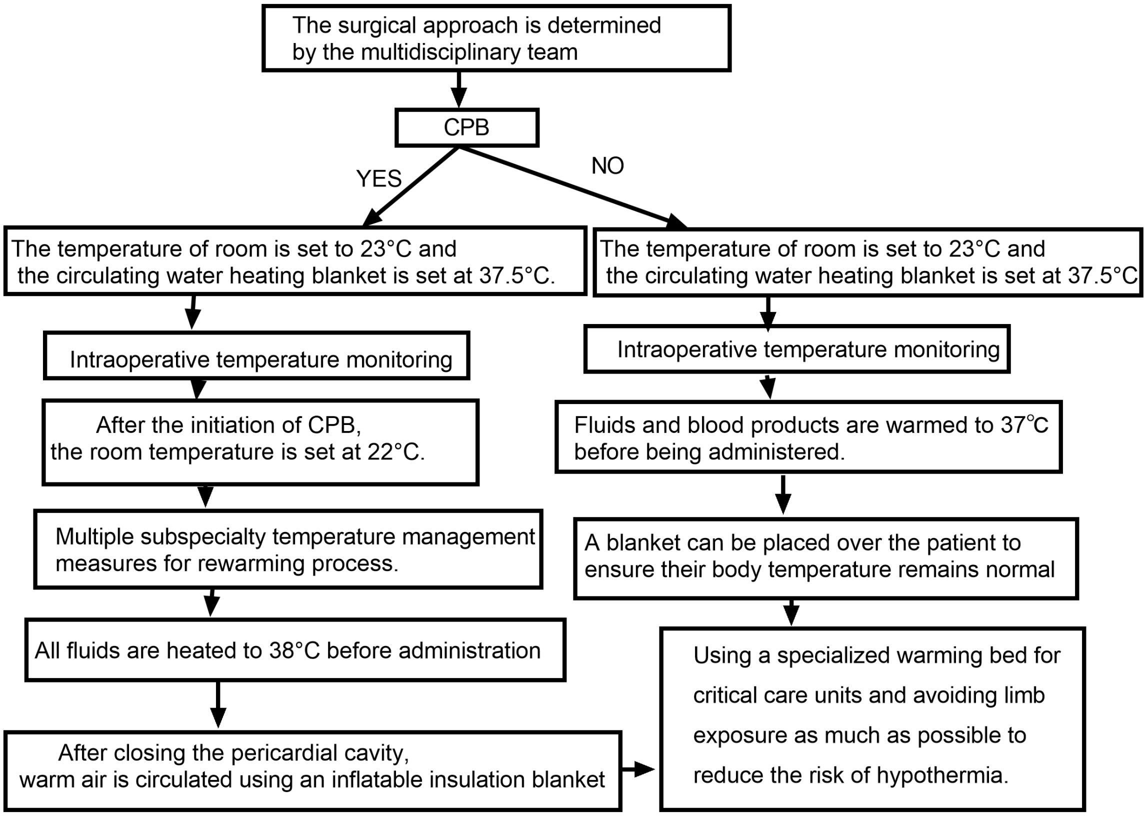

Figure 1. Temperature management process for the control group.

classification criteria proposed by Guffin [10], which consists of five grades: Grade 0: No shivering. Grade 1: Peripheral vasoconstriction or piloerection. Grade 2: Mild muscle activity in a single muscle group. Grade 3: Moderate muscle activity involving more than one muscle group. Grade 4: Continuous intense muscle activity throughout the body. Due to the difficulty in distinguishing shivering of Grade 3 and below in clinical settings, this study focused on the incidence of Grade 4 shivering.

Statistical analysis

All data were analyzed using SPSS 24.0 statistical software. Normally distributed continuous variables are presented as mean ± standard deviation ($\bar{x}$±sd). Independent sample t-tests were used to compare continuous variables between the two groups. Categorical data were presented as frequencies and percentages (n, %). Within-group comparisons of body temperature at different time points were conducted using repeated measures analysis of variance (ANOVA). Post hoc Bonferroni or Tukey pairwise comparisons were performed following repeated measures ANOVA. The comparison of incidence rates between the two groups was assessed using the chi-square test, with a significance level set at d=0.05. A *P*-value of less than 0.05 was considered statistically significant.

Results

Comparison of baseline data

The results of this study indicate that there were no statistically significant differences between the two groups in baseline characteristics, including type of surgery, gender, age, comorbidities, and BMI (all P>0.05). See **Table 1**.

Comparison of temperatures at different time points

The study results show that body temperatures in both groups changed over time, with significant differences in body temperature between

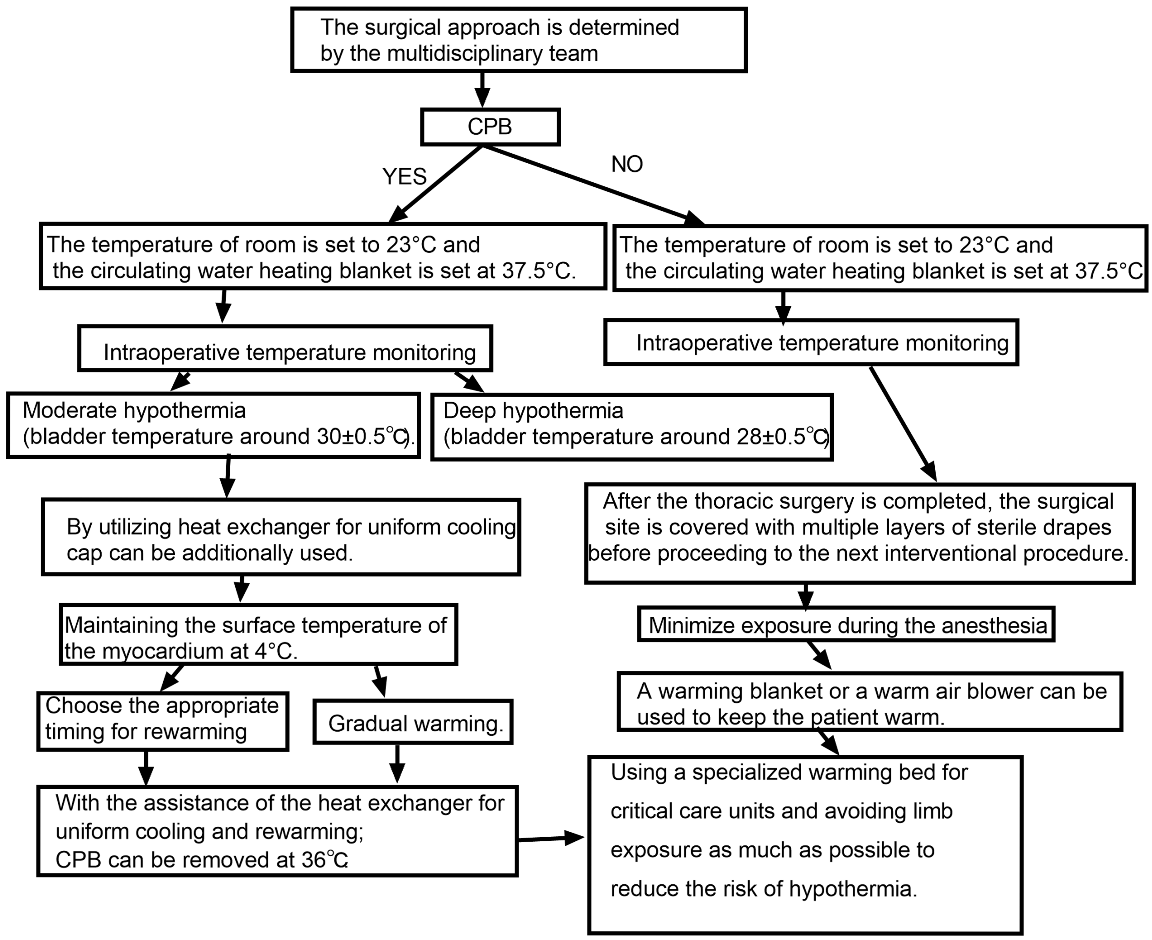

Figure 2. Standardized temperature management process for subspecialties. CPB: Cardiopulmonary bypass.

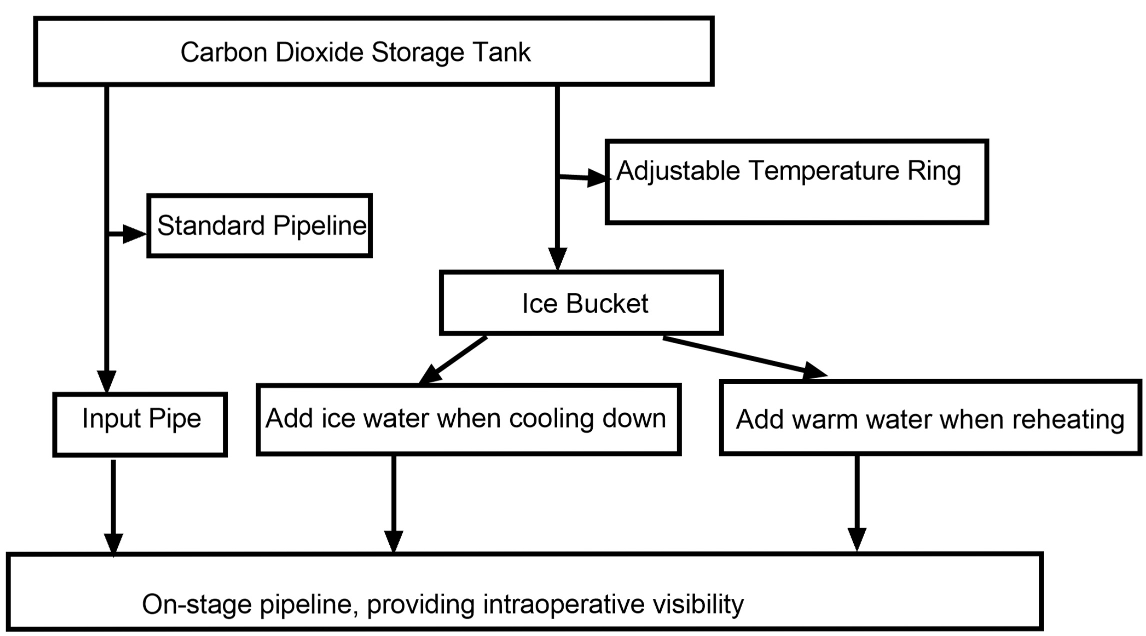

Figure 3. Carbon dioxide insufflation and warming-cooling tubing for the cardiac surgical field.

Table 1. Comparison of general data between the two groups of patients (mean ± standard deviation, n)

Category		Control group (n=102)	Experimental group (n=105)	χ^2/t value	*P* value
CPB	Yes	56	65	1.045	0.307
	No	46	40		
Age (yr)		65.7±4.6	66.3±4.9	-0.908	0.365
CPB time (min)		140.5±7.8	141.4±8.5	-0.793	0.429
Lowest temperature (°C)		30.4±1.6	30.3±1.4	0.479	0.632
Gender (M/F)		68/34	63/42	0.989	0.320
ASA (Classification)	I-II	78	85	0.620	0.430
	III	24	20		
BMI (kg/m^2)		25.6±2.4	25.9±2.1	-0.958	0.339
Surgery time (h)		8.1±3.3	8.5±3.2	-0.885	0.377
Diabetes		12	14	0.116	0.734
Hypertension		87	90	0.007	0.932

CPB: Cardiopulmonary bypass; BMI: Body mass index; ASA: American society of Anesthesiologists.

Table 2. Comparison of temperatures ($\bar{x}$ ± sd)

Group	Cases	T1	T2	T3	T4	T5	T6	F-value
Control group	102	36.6±0.8	35.3±0.4	35.2±0.6	35.3±0.3	35.5±0.6	35.6±0.4	F_{group}/P_{time}=12.336/<0.001
Experimental group	105	36.8±0.7	35.8±0.5	35.9±0.4	35.8±0.4	36.0±0.5	36.3±0.6	F_{time}/P_{time}=45.687/<0.001
P value	-	0.057	0.000	0.000	0.000	0.000	0.000	

Table 3. Comparison of incidence rates of shivering in different hypothermia severity levels (n, %)

Group	Cases	Low body temperature	Level 4 chills
Control group	102	18 (17.65)	7 (6.86)
Experimental group	105	8 (7.62)	0 (0.00)
χ^2 value	-	4.737	5.506
P value	-	0.030	0.190

the two groups (P=0.000 for both). Moreover, there was a significant interaction between group and time points (P=0.024). No significant difference in body temperature was observed between the two groups upon entering the operating room (T1). However, the experimental group had significantly higher body temperatures than the control group at CPB initiation (T2), after CPB cessation (T3), 30 minutes after stent implantation (T4), during wound closure (T5), and 30 minutes after the end of surgery (T6) (all P<0.05). See **Table 2**.

Comparison of incidence of hypothermia and Grade 4 shivering

The study findings indicate that the incidence of Grade 4 shivering in hypothermic patients was significantly lower in the experimental group compared to the control group (both P<0.05). See **Table 3**.

Comparison of postoperative data

There were no statistically significant differences between the two groups regarding hospital stay, time to first mobilization, or length of ICU stay (all P>0.05). See **Table 4**.

Comparison of patient satisfaction

Patient satisfaction was higher in the observation group than in the control group. See **Table 5**.

Discussion

Cardiovascular diseases are the second leading cause of mortality, and with the increasing prevalence of chronic conditions such as hypertension and diabetes, the incidence of cardiovascular diseases in China is rising annually. Among these, aortic diseases pose the greatest threat [11-14]. Treatment strategies for aortic dissection have evolved from deep hypothermic circulatory arrest to relatively minimally invasive interventional therapies. With the emergence of multidisciplinary professionals with

Table 4. Comparison of postoperative data between the two groups

Group	Length of Hospital Stay (days)	Time to first get out of bed (d)	Length of ICU stay (days)
Control group (n=102)	15.6±4.9	7.5±3.0	3.1±1.2
Experimental group (n=105)	16.9±5.0	7.6±2.9	3.2±1.3
T value	-1.889	-0.244	-0.575
P value	0.060	0.808	0.566

ICU: Intensive Care Unit.

Table 5. Comparison of patient satisfaction

Group	Cases	Extremely satisfied	Satisfied	Not satisfied
Control group	105	78	22	5
Experimental group	102	67	22	13
χ^2 value	-	4.153		
P value	-	0.042		

dual expertise, hybrid management of aortic diseases has become a prominent area of research, forming a subspecialty that integrates the strengths of both internal medicine and surgery. This approach aims to minimize the use of deep hypothermic circulatory arrest, thereby reducing postoperative complications such as brain injury, kidney damage, and other organ dysfunctions associated with this procedure, while promoting rapid patient recovery [15-17].

Nursing, as a vital component of medical care, plays a crucial role in the development of subspecialty fields. Subspecialty nursing refers to more specialized and meticulous care tailored to specific diseases, populations, or medical settings, beyond the scope of general nursing. Compared to general nursing practice, subspecialty nursing emphasizes understanding and addresses individual patient differences that requires a deeper knowledge of specific disease conditions [18]. This nursing model necessitates practitioners have a solid foundation in nursing knowledge, as well as advanced skills and expertise to conduct precise assessments and interventions. The advancement of subspecialty nursing not only enhances patient care quality and satisfaction but also contributes to the overall optimization and progress of the healthcare system [19]. As public health awareness increases and medical technology advances, the demand for subspecialty nursing will continue to grow. Therefore, strengthening the development of subspecialty nursing is essential for the medical field and aligns with broader societal trends [20].

Recent data indicate that implementing subspecialty operational models has significantly improved the efficiency of various specialized surgeries, yielding positive outcomes. Based on these observations, it is both feasible and necessary to establish aortic subspecialties and corresponding subspecialty nursing professions.

Temperature management is a critical aspect of operating room care, especially during aortic surgeries. Under general anesthesia, the patient's core body temperature gradually dissipates to the periphery, resulting in a significant temperature drop. Anesthetics also directly affect the central nervous system, reducing the sensitivity of the body's thermoregulatory center. Moreover, patients are exposed to the relatively cold environment of the operating room, and cooling agents such as ice-cold saline are often used during the procedure, all of which contribute to a gradual decrease in body temperature [21]. Studies have shown that the incidence of hypothermia can reach approximately 50% after general anesthesia without intervention. Hypothermia is associated with complications such as coagulation disorders, prolonged endotracheal intubation time, pressure injuries, and delayed wound healing [22].

In aortic dissection surgeries, procedures often need to be performed at low temperatures, and the combination of large incisions and extended operation times increases the risk of postoperative hypothermia. Thus, active and effective nursing interventions for temperature management are crucial in clinical practice [23]. Additionally, some aortic dissection surgeries may require reconstruction of the three main branches of the aorta. In these cases, improper timing of rewarming can lead to elevated core temperatures, potentially causing neurological damage ranging from postoperative cognitive dysfunction to life-threatening stroke [24]. Therefore, adhering to a standardized temperature management protocol specific to these subspecialties is essential for ensuring patient safety.

Preventing potential air embolism due to the opening of the thoracic and pericardial cavities during direct-vision cardiac surgeries (such as aortic replacement or valve replacement surgeries) is a key intervention point for perioperative cardiac function recovery [25]. Currently, many cardiac centers are adopting the intraoperative injection of carbon dioxide into the surgical field to facilitate effective gas evacuation, leveraging its physical properties of high density and easy solubility in blood. The presence of carbon dioxide in the thoracic cavity during cooling and rewarming can help maintain optimal thoracic and cardiac surface temperatures, protecting the myocardium, accelerating the rewarming process, reducing extracorporeal circulation time, and minimizing systemic damage [26].

Temperature adjustment, including both cooling and rewarming, is critical during aortic dissection surgeries and requires close coordination between operating room nurses and perfusionists. The standardized temperature management process for subspecialties provides comprehensive guidance for temperature regulation during these surgeries. It sets clear requirements for every stage, from patient admission to transfer to the intensive care unit, ensuring precise temperature control. This process includes specific temperature management protocols for various types of aortic surgeries, such as timing for rewarming and cooling and setting appropriate temperature gradients, ensuring that temperature management meets surgical demands throughout the procedure.

This study results demonstrated that patients in the observation group had higher temperatures at various monitoring points compared to those in the control group, with significantly lower incidences of hypothermia and Grade 4 shivering. This outcome may be attributed to the clear surgical protocols and corresponding temperature management requirements outlined in the process, as well as the standardized temperature protection measures implemented in the operating room. These measures included pre-setting the room temperature, warming all fluids used during surgery, and employing various insulation strategies, thereby ensuring comprehensive temperature care throughout the surgical process. These findings further validate the effectiveness of the standardized temperature management process for subspecialties in aortic dissection surgeries and are consistent with previous research [27, 28].

This study has a few limitations, including being a single-center study with a small sample size and focusing on a specific case type; necessitating large-scale, multicenter prospective studies to confirm the clinical benefits of subspecialty temperature management in hybrid aortic dissection surgeries. Additionally, more objective evaluations are needed to further substantiate the findings of this study and solidify the clinical utility of subspecialty temperature management in these procedures.

In conclusion, this study applied a subspecialty standardized temperature management process in the hybrid aortic dissection surgeries, which effectively reduced the incidence of hypothermia and Grade 4 shivering, demonstrating significant practical value. The process is purposeful and provides more specific standardization of intraoperative temperature care, ultimately improving the quality of temperature management.

Disclosure of conflict of interest

None.

Address correspondence to: Lijuan Zhang, Department of Anesthesiology, Huai'an First People's Hospital, No. 1, Huanghe West Road, Huaiyin District, Huai'an, Jiangsu, China. E-mail: huaianzmy@163.com

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