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Prevalence and Influencing Factors of Postoperative Hypothermia in Patients Undergoing Cardiac Thoracotomy

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Abstract: *Objective*: To explore independent risk factors for postoperative hypothermia and effective management strategies among patients undergoing cardiac thoracotomy. *Methods*: Clinical data of 206 patients who received cardiac thoracotomy in the Department of Cardiovascular Surgery of a tertiary-level hospital between July 2025 and June 2026 were retrospectively collected. Patients were stratified into a normal-temperature group and a hypothermia group according to the initial core body temperature measured upon admission to the Surgical Cardiac Intensive Care Unit (SCICU). Univariate analysis was performed to identify correlates of postoperative hypothermia, followed by multivariate Logistic regression to determine independent risk factors. *Results*: Among the 206 enrolled patients, 138 (66.99%) developed postoperative hypothermia. Univariate analysis showed that postoperative hypothermia after cardiac thoracotomy was significantly associated with disease diagnosis, cardiopulmonary bypass (CPB) application, and operative duration ($p < 0.05$). Multivariate Logistic regression identified Stanford type A aortic dissection (OR = 2.147), use of cardiopulmonary bypass (OR = 1.988), and prolonged operative time (OR = 1.408) as independent risk factors for postoperative hypothermia ($p < 0.05$). *Conclusion*: Postoperative hypothermia in patients undergoing cardiac thoracotomy is closely related to Stanford type A aortic dissection, cardiopulmonary bypass, and prolonged operative duration. Clinicians should strengthen preoperative risk assessment for these high-risk factors. Multi-strategy collaborative thermal interventions for high-risk patients can reinforce precise perioperative temperature management and improve surgical outcomes.

Keywords: Cardiac thoracotomy; Perioperative period; Postoperative hypothermia; Risk factors; Temperature management

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1. Introduction

Perioperative hypothermia is defined as an unintended core body temperature below 36 °C without therapeutic cooling intervention. It represents a common perioperative surgical complication with an overall incidence ranging from 20 % to 90 % [1]. Cardiac thoracotomy is characterized by substantial surgical trauma, long operative duration, and extensive thoracic cavity exposure. Cardiopulmonary bypass is frequently implemented for organ protection, and controlled hypothermia is applied to reduce systemic metabolism and preserve vital organ function. Nevertheless, these procedural features disturb physiological thermoregulation and contribute to a high rate of unintended postoperative hypothermia. Reportedly, the incidence of postoperative hypothermia can reach 50 % in patients undergoing off-pump cardiac thoracotomy, and more than one-third of patients are admitted to the intensive-care unit with subnormal core temperature [2].

General anesthesia suppresses the central thermoregulatory center in cardiac-surgical patients. Combined with heat loss from open thoracic cavities, infusion of cold crystalloids and blood products, and temperature fluctuation during postoperative transport, patients are highly susceptible to postoperative hypothermia. Even mild hypothermia may induce metabolic disturbance, coagulation dysfunction, surgical-site infection, postoperative shivering, and myocardial ischemia. It can prolong mechanical ventilation and postoperative recovery time and may be life-threatening in severe cases [3]. At present, no unified consensus exists regarding high-risk precipitating factors for hypothermia after cardiac thoracotomy, and targeted prevention frameworks remain incomplete. This retrospective study analyzed clinical data of cardiac-thoracotomy patients to screen independent risk factors for postoperative hypothermia, aiming to provide evidence-based references for optimizing perioperative temperature protocols, reducing complications, and improving postoperative prognosis.

2. Subjects and methods

2.1. Study subjects

Two hundred and six patients undergoing cardiac thoracotomy in the Department of Cardiovascular Surgery from July 2025 to June 2026 were enrolled.

2.1.1. Inclusion criteria

(1) Age 18-45 years;
(2) Diagnosed with cardiac disease and treated via median sternotomy;
(3) Complete clinical records with preoperative axillary temperature ranging from 36.0 ℃ to 37.3 ℃.

2.1.2. Exclusion criteria

(1) Pre-operative active infection;
(2) Pre-existing disorders impairing autonomic thermoregulation;
(3) Intra-operative or 24-hour postoperative mortality.

This study was approved by the Hospital Medical Ethics Committee. Written informed consent was obtained from all participants.

2.2. Data collection and grouping

2.2.1. Data collection

General clinical information including diagnosis, age, sex, operative duration and cardiopulmonary-bypass status was retrospectively extracted from electronic medical records. Core-temperature indices such as initial postoperative core temperature and rewarming duration were obtained from the intensive-care monitoring system.

2.2.2. Measurement and grouping

A nasopharyngeal temperature probe was placed intraoperatively for continuous real-time core-temperature monitoring. For patients receiving CPB, gradual rewarming was performed via the heat-exchange system before CPB weaning to achieve a core temperature of 36–37 ℃. All patients received basic thermal preservation after surgery and were transported to SCICU by a multidisciplinary team with the nasopharyngeal probe kept in-situ for continued temperature surveillance.

According to the Expert Consensus on Prevention and Management of Perioperative Hypothermia (2023 Edition), patients were divided into a hypothermia group (initial core temperature < 36 ℃ on SCICU admission) and a normal-temperature group (≥ 36 ℃). Total rewarming time was recorded for hypothermic subjects.

2.3. Statistical analysis

Statistical analyses were performed using SPSS 26.0. Measurement data were expressed as mean ± standard deviation and compared by independent-samples *t*-test. Categorical variables were presented as n (%) and compared using χ^2 test. Postoperative hypothermia (yes/no) was set as the dependent variable. Independent variables included age, sex, disease diagnosis, operative duration and CPB use. Variables yielding $p < 0.05$ in univariate screening were entered into multivariate Logistic regression to identify independent risk factors. A two-tailed $p < 0.05$ was considered statistically significant.

3. Results

3.1. Univariate analysis

Of the 206 patients, 68 (33.01 %) had an initial core temperature ≥ 36 °C upon SCICU admission, whereas 138 patients developed postoperative hypothermia, with an incidence of 66.99 %. Mean rewarming time was (136.35 ± 0.48) min. Disease diagnosis, CPB application, and operative duration showed statistically significant inter-group differences ($p < 0.05$). Age and sex were not significantly associated with postoperative hypothermia (**Table 1**).

Table 1. Univariate analysis of postoperative hypothermia in patients undergoing cardiac thoracotomy [n (%)]

Factors		Normal-temperature group (n = 68)	Hypothermia group (n = 138)	χ^2/t	p
Age (years, $\bar{x}$ ± s)		52.39 ± 6.48	53.47 ± 5.73	1.218	0.225
Sex(Male/Female)		49(72.06)/19(27.94)	96(69.56)/42(30.43)	0.136	0.712
Disease diagnosis	Stanford type A aortic dissection	28	79	8.426	0.038
	Coronary heart disease	24	45		
	Valvular heart disease	12	9		
	Others	4	5		
Cardiopulmonary bypass (Yes/No)		38(55.55)/30(44.12)	98(71.01)/40(28.99)	4.650	0.031
Operative duration ($\bar{x}$ ± s, min)		304.55 ± 105.64	336.43 ± 100.76	2.102	0.037

3.2. Multivariate logistic regression analysis

Variables with $p < 0.05$ in univariate analysis were included in multivariate Logistic regression. Variable assignments are shown in **Table 2**. Stanford type A aortic dissection, cardiopulmonary-bypass use, and longer operative duration emerged as independent risk factors for postoperative hypothermia ($p < 0.05$) (**Table 3**).

Table 2. Variable assignment for Logistic regression

Item	Assignment
Disease diagnosis	Coronary heart disease = 1; Stanford type A aortic dissection = 2; valvular heart disease = 3; others = 4
Cardiopulmonary bypass	Yes = 1; No = 2
Operative duration(min)	< 180 = 1; 181–240 = 2; 241–300 = 3; 301–360 = 4; ≥ 360 = 5
Postoperative hypothermia	Yes = 1; No = 2

Table 3. Multivariate logistic regression of risk factors for postoperative hypothermia after cardiac thoracotomy

Variable	β	SE	Wald	OR	95%CI	*p*
Stanford typeA aortic dissection	0.764	0.308	6.162	2.147	1.174–3.928	0.013
Cardiopulmonary bypass(Yes)	0.687	0.291	5.573	1.988	1.124–3.514	0.018
Operative duration	0.342	0.151	5.134	1.408	1.048–1.892	0.024

4. Discussion

4.1. Mechanisms of high-risk factors and priority populations for prevention

The present study revealed a postoperative-hypothermia incidence of 66.99 % among cardiac-thoracotomy patients, consistent with previous domestic reports and confirming that cardiac open-chest surgery carries a high risk of perioperative hypothermia. Multivariate regression identified Stanford type A aortic dissection, intraoperative CPB, and prolonged operative time as independent risk factors.

Stanford type A aortic dissection involves complex surgical procedures and extensive trauma. Controlled hypothermia is applied intraoperatively to protect cerebral and myocardial perfusion, and peripheral warming devices are often turned off, leading to substantial cutaneous heat loss. Although rewarming is performed via the CPB heat-exchanger before weaning, a core-peripheral temperature gradient persists, and core temperature may drop again during transport and ICU resuscitation, predisposing patients to postoperative hypothermia. Compared with aortic-dissection repair, routine operations for coronary-artery or valvular heart disease are less complex, do not require deep controlled hypothermia, and entail shorter thoracic exposure, hence lower hypothermia risk [4].

Prolonged operative time represents a modifiable risk factor. Extended thoracic exposure under general anesthesia, combined with infusion of ambient-temperature fluids and banked blood, disturbs the balance between heat production and dissipation and increases hypothermia likelihood [5]. Rewarming after CPB must proceed slowly; rapid rewarming may cause cerebral hyperthermia and neurological injury, and clinical protocols commonly limit rewarming rate to ≤ 0.5 ℃/min. This prolonged rewarming process adds complexity to temperature management and mandates meticulous continuous core-temperature monitoring for high-risk individuals [6].

4.2. Combined passive and active warming as core preventive strategy

Perioperative thermal protection consists of passive insulation and active warming. Passive insulation reduces cutaneous heat loss and is easy to implement, decreasing skin heat dissipation by more than 30 %. However, superimposed insulating layers cannot offset sustained heat loss during long cardiac operations, so passive measures alone are insufficient to maintain normothermia [7]. Active warming is therefore essential for high-risk surgical patients.

In line with the Chinese expert consensus on perioperative hypothermia, non-invasive, practical active-warming modalities include pre-induction pre-warming, intraoperative forced-air warming, fluid-and-blood product warming, and heated humidification of anesthetic circuits. Pre-induction pre-warming narrows the core-peripheral temperature gradient and mitigates anesthesia-related core-temperature redistribution [8]. Forced-air blankets deliver uniform cutaneous heat and are compatible with thoracotomy positioning. Warming infused fluids and blood products prevents cold-infusion-induced thermal dilution. Heated breathing circuits reduce airway heat loss. Clinical teams should combine these modalities according to surgical type, duration, and patient characteristics. Quality of CPB-termination rewarming and operating-room ambient temperature should also be optimized to mitigate hypothermia triggers comprehensively.

4.3. Multidisciplinary collaboration for perioperative temperature management in cardiac-thoracotomy patients

Multiple perioperative phases, including CPB-associated cooling, surgical manipulation, anesthesia monitoring and ICU resuscitation, influence patient temperature. Therefore, a collaborative team consisting of cardiac surgeons, anesthesiologists, perfusionists, operating-room nurses and SCICU nurses is required to build a closed-loop temperature-management workflow covering preoperative evaluation, intraoperative intervention and postoperative surveillance [9].

The multidisciplinary team can formulate individualized thermal-protection protocols, screen high-risk patients preoperatively, implement tiered intraoperative warming, and standardize postoperative rewarming with continuous core-temperature monitoring. Such practices may reduce hypothermia-related complications such as shivering, coagulopathy, and surgical-site infection [10]. Standardized training should unify temperature-management protocols and refine thermal-protection details for surgery, patient transport, and ICU recovery. Informatics-assisted temperature documentation can further improve procedural standardization.

This is a single-center retrospective study with limitations including a limited sample size and the absence of interventional control groups. Findings may have institutional and geographic constraints. Future multicenter prospective interventional studies are warranted to validate these risk factors and refine perioperative temperature-management pathways for constructing standardized clinical prevention systems.

5. Conclusion

In conclusion, this retrospective study confirmed a high prevalence of postoperative hypothermia among patients undergoing cardiac thoracotomy. Stanford type A aortic dissection, intraoperative cardiopulmonary bypass use, and extended operative duration were verified as independent risk factors for this complication, which increases the risk of postoperative adverse events and hinders patient recovery. To optimize clinical outcomes, precise preoperative risk screening, individualized perioperative thermal protection strategies, and continuous intraoperative and postoperative core temperature monitoring are essential for high-risk patients. A multidisciplinary, full-cycle closed-loop temperature management system integrating preoperative assessment, intraoperative active warming interventions, and standardized postoperative rewarming care can effectively reduce the incidence of postoperative hypothermia and related complications. This study provides reliable clinical evidence for improving standardized perioperative temperature management and prognosis in cardiac thoracotomy patients.

Disclosure statement

The author declares no conflict of interest.

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