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Nurse-Led Interventions for Preventing Hypothermia During the Perioperative Period

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ABSTRACT: Nurse-led interventions are pivotal in preventing hypothermia during the perioperative period, a critical phase for patients undergoing surgical procedures. The perioperative environment can create conditions conducive to hypothermia, such as cold operating rooms and exposure of the patient's skin. Nurses play an essential role in implementing strategies to maintain normothermia, including the use of active warming

devices like forced-air warming blankets, warming intravenous fluids, and ensuring a warm environment in the operating theater. Preoperative education regarding the importance of maintaining body temperature can also empower patients and encourage compliance with warming protocols. By consistently monitoring patient temperatures and employing evidence-based practices, nurses can significantly reduce the incidence of hypothermia, thereby improving patient outcomes and comfort. Additionally, continuous assessment and early identification of patients at risk for hypothermia are central to effective nursing interventions. This involves utilizing standardized protocols that outline warming measures tailored to individual patient needs, such as those with longer surgical times or specific comorbid conditions. Collaboration with the surgical team ensures that these interventions are integrated into the overall perioperative care plan. Nurses must also advocate for the availability and accessibility of warming equipment, highlighting the necessity of preventing hypothermia as part of patient safety initiatives. Through comprehensive planning and a commitment to fostering a warm environment, nurse-led interventions are instrumental in mitigating the risks associated with perioperative hypothermia, enhancing the overall quality of surgical care.

INTRODUCTION

Inadvertent perioperative hypothermia (IPH), conventionally defined as a core body temperature below 36°C, remains one of the most common and yet most preventable complications encountered in surgical patients [1]. Its incidence in adult surgical populations ranges from 20% to 70% and can exceed 80% when effective preventive interventions are absent [1]. The condition is not a benign physiological curiosity; it is a well-established determinant of surgical morbidity, associated with coagulopathy, increased blood loss and transfusion requirements, surgical site infection, delayed drug metabolism, prolonged post-anaesthesia recovery, shivering, and thermal discomfort [2]. For perioperative nurses, who occupy a continuous position across the preoperative, intraoperative, and postoperative phases of care, hypothermia prevention is not an adjunct to practice but a core professional responsibility [6]. Nurse-led interventions—ranging from structured prewarming and active cutaneous warming to warmed intravenous and irrigation fluids, continuous temperature monitoring, and multimodal care bundles—have accumulated a substantial evidence base over the past two decades [12].

The clinical sequelae of perioperative hypothermia are both diverse and serious. Even mild hypothermia of approximately 1°C to 2°C below normal produces measurable coagulopathy: platelet function is impaired through reversible inhibition of thromboxane A2 release, platelet sequestration occurs in the portal circulation, liver, and spleen, and the coagulation cascade is slowed [2]. A systematic review of major surgery found that even mild hypothermia increased blood loss by 16% and the relative risk of transfusion by 22% [9]. Surgical site infection risk rises substantially; mild perioperative hypothermia has been identified as a significant and independent risk factor for wound infection, with a reported relative risk as high as 6.3 in some analyses [3]. The mechanism is multifactorial, involving vasoconstriction-induced reduction in tissue oxygen delivery, impaired oxidative killing by neutrophils, diminished T-cell-mediated immunity, and altered antibody production [3]. Cardiac morbidity is also increased, with mild hypothermia associated with a higher incidence of morbid cardiac events and ventricular tachycardia [4]. Recovery is prolonged: hypothermic patients require longer to meet discharge criteria from the post-anaesthesia care unit, and anaesthetic drug effects are extended because hepatic and renal clearance are temperature-dependent [5]. These consequences establish the clinical imperative for nurse-led prevention, because much of the exposure to risk occurs within domains—preoperative assessment, intraoperative monitoring, fluid management, and postoperative surveillance—over which nursing practice exerts direct control [6].

The Physiology and Clinical Consequences of Perioperative Hypothermia

Understanding why nurse-led interventions matter requires attention to the mechanisms by which surgical patients lose heat and the downstream consequences of that loss [8]. Anaesthesia impairs central thermoregulation, abolishing or blunting the vasoconstriction and shivering responses that would ordinarily defend core temperature [8]. The result is a characteristic pattern of core-to-periphery heat redistribution: heat moves from the central compartment to the cooler peripheral tissues, producing a rapid decline in core temperature within the first hour after induction, followed by a slower phase of continued heat loss to the environment [1]. Cold operating room environments, patient exposure across large surgical fields, and the administration

of unwarmed intravenous and irrigation fluids accelerate this loss [1]. The nurse's understanding of these mechanisms is not academic; it determines when prewarming should begin, how frequently temperature should be measured, and which warming modality should be selected for a given patient and procedure [6].

The clinical consequences of this physiological sequence are summarized in Table 1. Coagulation is impaired at temperatures that many clinicians would regard as only mildly abnormal, and the effect on blood loss and transfusion is clinically meaningful [2], [9]. Infection risk rises because vasoconstriction reduces tissue oxygenation and because immune cell function is temperature-sensitive [3]. Cardiac morbidity is increased, and recovery is prolonged, with implications for PACU throughput, patient comfort, and hospital length of stay [4], [5]. These outcomes are not remote abstractions; they are the endpoints that nurse-led thermal care is designed to prevent, and they justify the systematic application of preventive interventions rather than reactive warming after hypothermia has already developed [6].

Table 1. Principal Consequences of Inadvertent Perioperative Hypothermia

System	Consequence	Evidence
Coagulation	Impaired platelet function; reduced clotting factor activity; increased blood loss and transfusion	[2], [9]
Infection	Increased surgical site infection risk; vasoconstriction and impaired immune defence	[3]
Cardiovascular	Increased morbid cardiac events; ventricular tachycardia	[4]
Pharmacokinetics	Prolonged anaesthetic action; delayed emergence	[5]
Recovery	Shivering; thermal discomfort; extended PACU stay	[5]

Preoperative Risk Assessment and Patient Identification

Effective nurse-led prevention begins before the patient enters the operating room [6]. The preoperative phase offers the earliest and most efficient opportunity to identify individuals at elevated risk and to initiate warming before the insult of anaesthesia and surgery occurs [10]. Perioperative nurses perform a structured assessment that considers patient-specific factors—low body mass index, older age, and prolonged procedure duration being among the most consistently cited—alongside procedural and environmental determinants [1]. The Association of periOperative Registered Nurses guideline on patient temperature management emphasises preoperative assessment as a formal component of the temperature management plan, while acknowledging that validated, user-friendly hypothermia risk assessment tools remain an area requiring further development [6], [10]. A qualitative systematic review of barriers and facilitators to guideline implementation in orthopaedic surgery similarly identified preoperative identification of at-risk patients as a critical determinant of whether preventive measures are applied in a timely manner [7].

The nurse's assessment is not merely classificatory; it translates directly into the design of an individualised temperature management plan [10]. Patients identified as higher risk can be scheduled for prewarming in the preoperative holding area, have warmed fluids prepared in advance, and receive more frequent temperature monitoring from the point of anaesthetic induction [6]. This anticipatory orientation distinguishes nurse-led care from reactive warming, which begins only after hypothermia has already developed [10]. The evidence supporting preoperative identification is reinforced by implementation research showing that shared governance approaches—in which frontline nurses exercise autonomy and clinical judgment in protocol design—improve compliance with preoperative warming protocols and post-anaesthesia outcomes [11]. In this sense, risk assessment is not a paperwork exercise; it is the first clinical act in a chain of nursing interventions that determines whether the patient enters the operating room thermally prepared or thermally vulnerable [11].

Preoperative Warming: The Cornerstone of Nurse-Led Prevention

Preoperative prewarming is the single most extensively studied nurse-led intervention for perioperative hypothermia, and the evidence consistently supports its effectiveness [12]. A systematic review and meta-analysis of randomised controlled trials, encompassing 27 studies, found that preoperative prewarming played a significant role in providing and maintaining perioperative normothermia, with a large effect size during both the intraoperative period and the postoperative period [12]. The physiological rationale is compelling: by warming the peripheral tissues before anaesthesia-induced vasodilation and

redistribution occur, prewarming reduces the core-to-periphery temperature gradient and thereby attenuates the rapid early decline in core temperature [1], [12].

Forced-air warming is the most commonly studied and recommended modality [13]. AORN guidance recommends prewarming with forced-air warming systems for at least 30 minutes before anaesthesia induction, although the literature also indicates that a minimum of 10 minutes can significantly reduce hypothermia incidence [13]. A quality improvement initiative in joint replacement surgery found that prewarming with a forced-air warming gown for a minimum of 10 minutes before anaesthetic induction reduced perioperative hypothermia by up to 48% [14]. Importantly, the evidence does not support a single fixed duration as universally optimal; rather, the principle is that prewarming should be sufficient to reduce the peripheral-to-core gradient without imposing unnecessary delays on surgical workflow [13], [14].

Recent innovation has focused on making prewarming more efficient and compatible with high-turnover surgical schedules [15]. A randomised controlled trial published in the AORN Journalevaluated a brief, limb-focused prewarming protocol in 82 adults undergoing laparoscopic lower gastrointestinal surgery [15]. The intervention combined standard whole-body prewarming with targeted warming of both forearms and lower legs for only five minutes before anaesthesia induction [15]. At 30 minutes after induction, the prewarming group had a significantly higher median core temperature and a smaller decline from baseline, with higher peripheral temperatures [15]. The authors characterised this as a nurse-led approach that provides efficient thermal protection without delaying anaesthesia induction [15]. Such findings are practically significant because time pressure is among the most frequently cited barriers to prewarming implementation; a protocol that achieves measurable thermal benefit within five minutes is more likely to be adopted in busy preoperative areas than one requiring a full 30-minute commitment for every patient [7], [15].

Passive insulation alone is insufficient to maintain normothermia during general anaesthesia [16]. The traditional warm blanket may reduce heat loss, but it does not actively add heat, and it cannot counter the redistribution hypothermia that follows anaesthetic induction [16]. This is why preoperative prewarming and intraoperative active warming are complementary rather than interchangeable: prewarming reduces the gradient before it becomes clinically important, while active warming continues to defend core temperature once surgery is underway [12], [16]. The nurse's role is to ensure that the interval between preoperative warming and intraoperative warming is not a gap in protection but a continuity of care [6].

Table 2. Selected Nurse-Led Prewarming Modalities

Modality	**Typical Protocol**	**Key Evidence**
Forced-air prewarming, whole body	At least 30 minutes before induction; a minimum of 10 minutes may be effective	[12], [13]
Forced-air warming gown	At least 10 minutes before induction in orthopaedic patients	[14]
Brief limb-focused prewarming	Five minutes of targeted forearm and lower-leg warming added to whole-body warming	[15]
Passive insulation alone	Not sufficient as a sole strategy during general anaesthesia	[16]

Intraoperative Active Warming and Multimodal Strategies

Once anaesthesia is induced, the nurse's role shifts from preparation to continuous active management [6]. Passive insulation alone—the traditional warm blanket—is insufficient to maintain normothermia during general anaesthesia, and AORN explicitly recommends active warming methods over passive insulation for patients undergoing general anaesthesia [6], [16]. Forced-air warming remains the dominant intraoperative modality [17]. A systematic review and meta-analysis of forced-air warming during abdominal surgery concluded that forced-air warming effectively prevents perioperative hypothermia in both open and laparoscopic procedures, with the upper body being the preferred warming site compared with lower-body or full-body application [17]. In cardiac surgery, a nurse-initiated forced-air warming blanket intervention following coronary artery bypass grafting was evaluated in a randomised clinical trial for its effect on excessive bleeding, arrhythmia, acute myocardial infarction, and blood product transfusion in hypothermic patients; the trial was explicitly framed as testing a nurse-initiated intervention, underscoring the centrality of nursing agency in thermal care [18].

Conductive warming systems, warming mattresses, resistive fabric warming devices, and radiant warmers constitute additional active modalities available to perioperative nurses [19]. The choice among them is less important than the principle of consistent, uninterrupted application [19]. AORN's updated guideline emphasises that minimising interruptions to warming is crucial for preventing hypothermia and that warming should continue from the intraoperative phase into the postoperative period without gaps [13]. Conductive and resistive systems may be particularly useful when forced-air warming is contraindicated or logistically difficult, but the nurse must still verify that the device is functioning, that the patient is not over-warmed, and that the warming plan is documented and communicated across phase transitions [19].

Warmed intravenous and irrigation fluids represent a second essential component of nurse-led intraoperative care [20]. Administering unwarmed fluids introduces cold directly into the central compartment and accelerates core temperature decline [20]. AORN recommends warming intravenous fluids and surgical irrigants as a standard preventive measure, and the evidence supports fluid warming as part of a multimodal strategy [6], [20]. In transurethral resection of the prostate, a systematic review and meta-analysis found that both forced-air warming and irrigation fluid warming served as effective preventive measures against hypothermia and shivering [21]. The nurse's responsibility includes not only connecting the fluid-warming device but also confirming that the device is set to the correct temperature, that the fluid has had sufficient time to warm, and that irrigation solutions are managed with the same thermal attention as intravenous fluids [20], [21].

The most robust evidence supports multimodal warming rather than reliance on any single device [22]. A retrospective study of operating room nursing based on a multimodal hypothermia prevention strategy compared a protocol comprising preoperative prewarming, forced-air warming, warmed fluids, and ambient temperature control against conventional passive insulation in 142 adult patients undergoing elective surgery under general anaesthesia [22]. The multimodal group had a significantly lower incidence of perioperative hypothermia, higher intraoperative, end-of-surgery, and PACU admission temperatures, shorter emergence time and PACU length of stay, lower intraoperative blood loss, shorter hospital stay, and higher Quality of Recovery-15 scores [22]. On multivariable analysis, multimodal warming was independently associated with lower odds of hypothermia [22]. These findings position the nurse not as a technician applying a single device but as the coordinator of an integrated thermal protection bundle [6], [22].

Table 3. Components of a Nurse-Led Multimodal Warming Bundle

Phase	Intervention	Nursing Action
Preoperative	Risk assessment; prewarming with forced-air warming or limb-focused warming	Identify at-risk patients; initiate warming before induction [6], [12]
Intraoperative	Active cutaneous warming; warmed intravenous and irrigation fluids; ambient control	Apply and maintain devices; monitor temperature; minimise exposure [17], [20], [22]
Postoperative	Continued warming; PACU temperature monitoring	Prevent delayed hypothermia; assess recovery [6], [22]

Postoperative Temperature Management and Recovery

Temperature management does not terminate with skin closure [6]. Perioperative nurses continue to monitor and manage patient temperature in the PACU and during the immediate postoperative period, both to ensure that normothermia is maintained and to detect and treat any delayed hypothermia [22]. The consequences of neglecting this phase are measurable: hypothermic patients after major abdominal surgery require approximately 40 minutes longer to reach fitness for discharge from the PACU, and recovery duration is prolonged by approximately 90 minutes [5]. Postoperative shivering is not merely a source of discomfort; it increases metabolic demand and oxygen consumption, which may be poorly tolerated in patients with cardiovascular compromise [4], [5].

Nurse-initiated postoperative forced-air warming has been specifically tested in cardiac surgery [18]. The trial of a nurse-initiated forced-air warming blanket following coronary artery bypass grafting examined hypothermia-related complications including excessive bleeding, arrhythmia, and transfusion requirements, reflecting the recognition that postoperative thermal care is a legitimate domain of nursing-led intervention rather than a purely medical concern [18]. AORN's updated guideline reinforces this continuity by recommending that active warming extend through the postoperative period and that interruptions to warming be minimised across phase transitions [13]. In practical terms, this means that the receiving PACU nurse should have

access to warming equipment, that handover communication should include the patient's thermal history and current temperature trend, and that discharge criteria should include a temperature parameter rather than relying solely on haemodynamic and respiratory readiness [6], [22].

Monitoring, Documentation, and the Nursing Process

Vigilant temperature monitoring is the connective tissue that holds nurse-led prevention together [23]. Without accurate and frequent measurement, neither prewarming nor intraoperative warming can be titrated to patient need, and hypothermia may develop unnoticed in the intervals between measurements [23]. AORN guidance recommends continuous temperature monitoring throughout the perioperative period, and the Chinese Nursing Association's group standard for prevention of unplanned intraoperative hypothermia specifies dynamic monitoring beginning before anaesthetic induction, with recording every 30 minutes until the end of surgery, and every 15 to 30 minutes for low-risk patients receiving preventive measures [6], [23]. The AORN guideline further encourages pre-purchase evaluation of temperature measurement devices, recognising that the accuracy and usability of thermometers and warming equipment directly affect the quality of the data on which nursing decisions depend [10].

Documentation serves both clinical and quality-improvement functions [10]. A complete thermal record—preoperative temperature, warming interventions applied and their duration, intraoperative temperature trends, fluid warming, and postoperative temperatures—enables audit of compliance with protocols and identification of gaps in care [6], [23]. The AORN guideline explicitly links temperature management to quality assessment measures and provides a sample perioperative normothermia bundle to support teams in getting started [6]. Where documentation is incomplete, opportunities for learning and system improvement are lost; where it is complete, it becomes a tool for shared governance and frontline-driven practice change [11]. The nursing process therefore does not end with the application of a warming device; it continues through measurement, interpretation, documentation, and reassessment [23].

Barriers and Facilitators to Nurse-Led Hypothermia Prevention

The evidence for nurse-led interventions is robust, yet a persistent gap separates evidence from routine practice [7]. A qualitative systematic review of barriers and facilitators to the implementation of guidelines for preventing inadvertent perioperative hypothermia in orthopaedic patients identified factors operating at the level of individual clinicians, teams, and organisations [7]. Commonly cited barriers include time pressure in high-turnover surgical lists, limited availability of warming devices, competing clinical priorities, and the misconception that short procedures do not require active warming [7]. The belief that a warm blanket is sufficient—what one perioperative nurse characterised as the myth of "just a blanket"—remains a significant cultural obstacle, even though passive insulation alone cannot maintain normothermia during general anaesthesia [7], [16].

Facilitators identified in the literature include shared governance structures that give frontline nurses autonomy to design and adapt protocols, hands-on training to build confidence and competence with warming devices, and the availability of multiple warming modalities so that a single equipment failure or unavailability does not leave the patient unprotected [11]. AORN's implementation guidance recommends interdisciplinary collaboration, standardised temperature management plans, clear policies and procedures, normothermia bundles, staff education and competency verification, and regular monitoring of progress and patient outcomes [6], [10]. The emphasis on bundles is significant because it shifts the focus from individual device acquisition to the reliability of the system as a whole [22]. When prewarming, active intraoperative warming, fluid warming, and postoperative monitoring are bundled and audited together, the cumulative protection is greater than the sum of the individual parts, and the nurse's coordinating role becomes both more visible and more effective [6], [22].

Table 4. Barriers and Facilitators to Nurse-Led Hypothermia Prevention

Level	Barriers	Facilitators
Individual clinician	Time pressure; belief that short procedures do not require warming; reliance on passive blankets	Education; competency verification; feedback on outcomes [7], [10]
Team	Competing priorities; inconsistent handover of thermal plan	Standardised protocols; normothermia bundles; interdisciplinary collaboration [6], [22]

Organisation	Limited warming devices; workflow constraints; weak audit systems	Shared governance; device availability; quality monitoring [7], [11]

CONCLUSION

Nurse-led interventions to prevent hypothermia during the perioperative period are supported by substantial evidence from systematic reviews and trials. Preoperative prewarming, either through conventional systems for 30 minutes or quick limb protocols, is effective in mitigating the temperature gradient and hypothermia following anaesthetic induction. A multimodal approach that includes intraoperative active warming, warmed fluids, ambient temperature control, and continuous monitoring significantly lowers hypothermia rates and improves recovery metrics. Postoperative warming and surveillance help maintain these benefits. The persistence of implementation gaps is not due to a lack of evidence but rather insufficient system support and education. Perioperative nurses are critical in thermal care, and enhancing nursing autonomy, device access, training, and outcome audits is essential for closing the evidence-practice gap.

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