Prevention of Inadvertent Perioperative Hypothermia

ABSTRACT

Perioperative hypothermia may result in serious cardiac, coagulation, and wound-healing complications, especially among vulnerable pediatric and elderly patients. More than 50 reports have been submitted through PA-PSRS about patients experiencing perioperative hypothermia. Many reports involved hypothermia that was detected in the postanesthesia care unit. Only a few reports indicated that measures were in place to prevent hypothermia. Risk reduction strategies to prevent perioperative hypothermia include assessing the patient for increased risk of hypothermia, monitoring temperature throughout the perioperative period using optimal temperature monitoring sites, and using active and/or passive warming measures as appropriate. (Pa Patient Saf Advis 2008 Jun;5[2]:44-52.)

Physiology of Thermoregulation

Humans are homeothermic mammals who strive to maintain core temperature within a narrow range regardless of the environment. Normal body core temperature is controlled within tight parameters, generally within 0.2°C of 37°C, ensuring a constant rate of metabolism, enhanced nervous system conduction, and optimal skeletal muscle contraction. Thermoregulation is the process of maintaining normal core temperature and involves positive and negative feedback by the brain to minimize variations from preset normal values, or thresholds. The primary thermoregulatory control center is the hypothalamus, which acts as a thermostat. Thermoregulation is also based on signals from other areas of the body, including the midbrain, medulla, spinal cord, cortex, and deep abdominal and thoracic structures.

Patients Experiencing Perioperative Hypothermia Reported through PA-PSRS

An elderly patient following abdominal surgery had a temperature of 95°F with a fluid warmer in use. The room temperature was less than 70°F. The error was noted, and a [forced-air warming device] was applied.

An elderly patient had a temperature of 94°F postoperatively in the recovery room. The patient was in the [operating room (OR)] for less than an hour and had been lying on wet linens. A [forced-air warmer] was applied in the recovery room.

An elderly patient was admitted to the [postanesthesia care unit (PACU)] after a procedure in the OR with a temperature of less than 95°F. The OR room temperature remained cold despite increasing the thermostat. Intraoperatively, a fluid warmer and multiple warm blankets were used. A [forced-air warmer] was applied in the PACU.

An elderly patient arrived in the PACU with a tympanic temperature of less than 92°F. No warming devices were used during the surgery. Warm blankets and a [forced-air warmer] were applied in the PACU. The patient had a prolonged stay in the PACU related to the patient’s decreased temperature.

An elderly patient had a temperature of 97°F in the PACU after bilateral total knee replacements. A prolonged PACU stay was required to warm the patient.

An elderly patient undergoing a thoracotomy had an intraoperative temperature of less than 93°F. The [ambient air] temperature was less than 65°F. Thermal pads were in use during surgery. The patient had to remain on a ventilator due to hypothermia.
A core temperature below the threshold for cold response will produce vasodilatation and shivering; nonshivering thermogenesis occurs in infants. A core temperature above the threshold for heat response will produce vasodilation and sweating.11,14,15

**Thermoregulation during Anesthesia**

The cold temperatures of a typical operating room (OR) generally will not cause hypothermia in an unanesthetized patient due to the thermoregulatory response of shivering or vasconstriction that acts to maintain core temperature.16 However, the induction of general anesthesia results in a three-phase decrease in core temperature. Initially, redistribution of heat from the core to the periphery occurs as a result of vasodilatation because anesthetics inhibit the tonic vasconstriction that normally maintains a core-to-periphery temperature gradient.16 Following redistribution, core temperature decreases in a slow, linear manner for two to four hours, mostly due to loss of heat greater than metabolic heat production.11,17 After three to four hours, core temperature reaches a plateau and remains steady throughout the duration of surgery.11,18 This plateau is thought to reflect the state in which heat loss is equal to heat production and is more likely to occur in patients who are well insulated or effectively warmed.11,18,22

Epidural and spinal regional anesthesia decrease the threshold for the protective thermoregulatory responses of vasconstriction and shivering.11 Regional anesthesia decreases the threshold triggering the thermoregulatory responses of vasconstriction and shivering above the level of the block.11,13,15 In addition, regional anesthesia is frequently supplemented with analgesics and sedatives, which, with the exception of midazolam, significantly impair thermoregulatory responses.11,13,21,26,27

**Factors Contributing to Hypothermia in the OR Environment**

Perioperative hypothermia results from impaired thermoregulation induced by anesthetic agents;16,28 a number of other factors in the operative environment have been suggested as causes, including the following:

- Exposure of a large body surface area to the typical low temperature and humidity in the OR environment.29
- Administration of cold IV fluids.30
- Evaporation from surgical sites.30
- Administration of unwarmed irrigation fluid.30
- Use of certain skin preparation methods that result in evaporation.31

**Patients at Increased Risk for Hypothermia**

Certain characteristics may increase the risk of patients developing perioperative hypothermia. Older adults have less subcutaneous tissue and are less effective than younger adults at thermoregulating by means of vasconstriction and shivering, even in the absence of anesthesia.32 Neonates are at increased risk because of disproportionately larger heads and thinner skulls and scalps, which allow greater heat loss from the brain than occurs in adults.33 Neonates, infants, and children have a greater surface area to body mass ratio, small stores of subcutaneous fat, and poor vasomotor control, making them more susceptible to intraoperative hypothermia.32 Burn patients are also at increased risk, as well as patients with small body mass, impaired muscle mass, circulatory compromise, muscle atrophy, or thyroid disease.32

**Complications of Inadvertent Hypothermia**

Perioperative hypothermia may result in serious complications affecting the cardiovascular system, coagulation, and wound infection and healing.34 The effect of hypothermia on drug metabolism may also lead to complications.35

**Cardiac Events**

Two thermoregulatory responses to hypothermia may have detrimental cardiovascular effects. The first response is sympathetically mediated vasconstriction, which increases arterial blood pressure.34-36 The second is shivering, which increases metabolic demands.35,36 Studies conflict regarding the extent to which an increased metabolic rate results in increased oxygen consumption, which may in turn lead to hypoxemia and myocardial ischemia.35,37,39 Hypothermia depresses myocardial contraction and slows conduction velocity through the heart.39 Atrial fibrillation may occur when core temperature approaches 30°C.39 Profound hypothermia, a core temperature between 24° and 28°C, results in ventricular fibrillation.39 Hypothermia-induced ventricular fibrillation is refractory to pharmacologic therapy.39 High-risk surgical patients with a core temperature of less than 35°C have a two- to threefold increased incidence of early postoperative myocardial ischemia, independent of age and anesthetic technique.39 Patients who are aggressively warmed during surgery have been shown to experience a decreased incidence of postoperative cardiac morbidity.35

**Coagulation and Need for Transfusion**

Hypothermia significantly impairs the coagulation system through three mechanisms: platelet function, the coagulation cascade, and fibrinolysis.37 Platelet numbers remain normal during mild hypothermia,37 but their function is impaired because of inhibition of the formation of the initial platelet plug.40 The function of enzymes in the coagulation cascade is slowed by hypothermia.37,42 Studies suggest that fibrinolysis is enhanced by hypothermia, impairing clot formation.37,43 Studies conflict about whether hypothermia increases blood loss and the need for transfusions. However, a meta-analysis of study results from randomized controlled trials indicated that even mild hypothermia (less than 1°C) significantly increases blood loss by approximately 16% and increases the risk of requiring a transfusion by approximately 22%.44
**Wound Infection and Healing**

Hypothermia may contribute to postoperative wound infection by directly impairing immune function and by triggering vasoconstriction, which decreases cutaneous blood flow and reduces the oxygen delivery to tissues.\(^3\),\(^7\),\(^4\),\(^6\) A randomized controlled study demonstrated that patients with a drop of average core temperature of approximately 2°C were three times more likely to develop surgical site infections.\(^4\) This effect was thought to be due to decreased macrophage function and decreased tissue oxygen tension, the latter of which is related to decreased tissue perfusion.\(^4\) The same study found that hypothermia contributed to delay in the time thought appropriate to remove sutures. Hospitalizations in hypothermic patients were demonstrated to be 20% longer than those of normothermic patients.\(^4\)

**Pharmacokinetics and Pharmacodynamics**

Perioperative hypothermia affects the metabolism of drugs because the enzymes that moderate organ function and metabolize duration of action drugs are highly temperature sensitive.\(^3\),\(^5\),\(^6\) Several anesthetic drugs have been studied; however, the mechanism by which hypothermia may prolong the effects of muscle relaxants is not clear.\(^7\) The pharmacodynamics of vecuronium has been found to be unaffected by mild hypothermia.\(^8\) Mild hypothermia alters propofol pharmacokinetics and increases the duration of action of atracurium.\(^7\),\(^8\) During a constant infusion of propofol, the plasma concentration is approximately 30% greater than normal when individuals are 3°C hypothermic.\(^9\),\(^7\)

Hypothermia alters the pharmacodynamics of volatile anesthetics.\(^7\) The solubility of inhaled anesthetics is increased with hypothermia; consequently, at a steady-state plasma partial pressure, body anesthetic content increases.\(^7\) Inhaled anesthetic potency is related to partial pressure, not concentration, and remains unaffected.\(^7\) The increased solubility of volatile anesthetics and increased duration of action of muscle relaxants suggests that hypothermia may delay emergence and recovery from general anesthesia.\(^3\),\(^7\)

**Core Temperature Monitoring**

Some risk factors for inadvertent perioperative hypothermia, such as age or body mass, may not be changed or avoided. Consequently, monitoring of core temperature and prevention of hypothermia are indispensable in preventing the complications associated with inadvertent perioperative hypothermia.

**When to Measure**

Core temperature usually decreases 1°C during the first 30 to 40 minutes of anesthesia induction due to initial core-to-peripheral redistribution of body heat.\(^3\),\(^5\),\(^7\),\(^8\) Monitoring core temperature alerts the provider to the need for preventative and corrective action.\(^8\)

Several professional groups, including the Association of periOperative Registered Nurses (AORN) Recommended Practices Committee, the American Society of Anesthesiologist (ASA), and the American Association of Nurse Anesthetists (AANA), have made recommendations regarding when to monitor patient temperature.\(^3\),\(^5\),\(^7\),\(^8\) The recommendations from the groups include the following:

1. Monitoring temperature on an ongoing basis during the perioperative period\(^3\)
2. Monitoring temperatures of patients given general anesthesia and expected to undergo procedures exceeding 30 minutes and during regional anesthesia when changes are anticipated or suspected.\(^1\),\(^2\)
3. Continuously monitoring temperature “when clinically significant changes in body temperature are intended, anticipated or expected.”\(^1\)
4. Continuously monitoring temperature in pediatric patients receiving general anesthesia\(^3\)
5. Monitoring of temperature when patients undergo large procedures under regional anesthesia\(^3\),\(^5\),\(^7\)
6. Postoperatively monitoring temperature to provide a basis for evaluation of the effectiveness of intraoperative measures to prevent hypothermia\(^1\)
7. Communicating abnormal patient temperatures to the appropriate patient care providers.\(^1\)

**How to Measure Temperature Perioperatively**

Core temperature may be monitored during general anesthesia in the pulmonary artery, nasopharynx, tympanic membrane, and distal esophagus, which are all sites that are reliable and accessible during surgery.\(^3\)

- Pulmonary artery catheters allow measurement of central blood temperature, which is considered the gold standard for the measurement of core temperature.\(^9\),\(^12\) However, pulmonary artery catheters are generally reserved for patients requiring intensive hemodynamic monitoring due to the invasiveness and cost of the catheters.\(^3\)
- Distal esophageal temperature accurately reflects core temperature, but may be affected by the use of humidified gases if the probe is not inserted far enough and may be affected during open heart or lung surgery because the chest cavity is exposed to ambient air.\(^3\)
- Nasopharyngeal temperature is measured with an esophageal probe above the soft palate and is close to brain and core temperature. Temperature measurement may be affected by inspired gases.\(^3\),\(^28\),\(^30\)
- Tympanic membrane temperature monitoring is often the preferred method in the preoperative and perioperative areas. The tympanic membrane is close to the carotid artery and hypothalamus and is a noninvasive and accurate measure of core temperature.\(^3\),\(^30\)
If the above-mentioned core temperature sites cannot be used in a particular clinical setting, the bladder, rectum, axilla, and skin may be used.\(^9\)

- Temperature in the bladder can be measured with a urinary catheter containing a temperature transducer.\(^2,28\) Accuracy of bladder temperature monitoring decreases with low urine output and during procedures of the lower abdomen.\(^4,50\)
- Rectal temperature measurement approximates core temperature but may be affected by the presence of stool and bacteria that generate heat.\(^9,30\)
- Axillary temperature may accurately reflect core temperature if the arm is positioned at 0 degrees adduction and the probe is placed over the axillary artery.\(^9,30\)
- Skin temperature may be measured with a crystal skin-surface thermometer.\(^28\) Skin surface temperature is affected by several factors, including core-to-peripheral redistribution, intraoperative thermoregulatory vasoconstriction, and changes in ambient temperature.\(^9,28,30,52,53\)

Hypothermia during regional anesthesia may be undetected because temperature may not be routinely monitored.\(^9,54\) A study comparing temperature monitoring sites during regional anesthesia found that rectal temperature monitoring was the most accurate. Measurements at other sites underestimated core temperature due to compensatory cutaneous vasoconstriction above the level of the regional block and effects of thermoregulatory vasoconstriction on skin temperature.\(^55\)

### Methods of Preventing Hypothermia

To prevent hypothermia, the body’s heat balance must be maintained by balancing heat loss with heat gain, either from the body’s own internal metabolic heat production or from an external source of heat. A number of methods and devices may be used to maintain perioperative normothermia.

### Cutaneous Warming

Room temperature is the most critical factor in preventing perioperative heat loss from the patient because it determines the rate at which heat is lost by radiation and convection from the skin and by evaporation from within surgical incisions.\(^18,30\) Increasing the ambient OR temperature to 26\(^\circ\)C (79\(^\circ\)F) has been found to reduce the incidence of core hypothermia in younger and older patient populations.\(^9,30\) However, most OR personnel find this temperature uncomfortably warm.\(^18,30\) Nonetheless, about 90% of metabolic heat is lost through the skin surface, making it imperative to prevent cutaneous heat loss through other methods, which may include passive insulation and the use of active cutaneous warming systems.\(^18,30\)

### Passive Insulation

Passive insulators readily available in most ORs include cotton blankets, surgical drapes, plastic sheeting, and reflective composites or “space blankets.” A study found that a single layer of each type of insulator may reduce heat loss by 30% with no differences noted among the insulation types.\(^57\) The comparable efficacy between different types of insulators was credited to the still layer of air between the cover and the skin.\(^57\) A subsequent study found relevant differences among types of insulating materials and that the addition of layers of insulating material increases efficacy.\(^58,59\) Despite conflicting findings regarding the efficacy of types and layers of insulation, cutaneous heat loss is roughly proportional to the surface area of the entire body. Accordingly, the efficacy of passive insulators is directly proportional to the covered surface area.\(^11,18,30\)

### Active Cutaneous Warming Systems

Active skin warming systems include the following:

- Forced-air warming is widely used and usually maintains normothermia even during extended operations.\(^30\) Forced-air uses convective heating, (heat absorbed from air passing over the skin) to warm the patient.\(^29,30\) The system includes a thermostatically controlled fan heater (blower) and a warming blanket. Warm air entering the blanket fills channels in the blanket, causing them to inflate and flex concavely around the patient.\(^52\) Air slits or small holes on the patient side of the blanket allow warmed air to flow over the patient. The efficacy of forced-air warming system in preventing perioperative hypothermia is well supported by a number of clinical trials.\(^7,8,61\)
- Circulating-water garments circulate warm water through a conductive heating garment wrapped around the patient. Circulating-water devices use convective heating (heat absorbed from hotter objects in contact with the skin) to warm the patient.\(^29\) This method has been found effective with both adult and pediatric patients and has been demonstrated to transfer more heat to patients than forced air, especially during the first hour of warming.\(^62,64\) Circulating-water mattresses have been found to be ineffective since the back represents only a small percentage of surface area available for heat exchange. Moreover, the combination of heat and decreased local perfusion due to compression by the patient’s weight increases the risk for pressure and/or heat necrosis.\(^37,63\)
- Resistive heating (an electric blanket) has been found to be as effective as forced-air heating.\(^57,66\) Another type of resistive heating, consisting of energy pads containing circulating heated water that are in contact with the patient’s skin, was found to be more effective than a combination of warmed IV fluids, increased OR temperature, and the use of a convective forced-air warming system in reducing hypothermia in patients undergoing off-pump cardiac surgery.\(^28,67\)

### Other Warming Methods

- Warming of IV fluids and blood is indicated when more than two liters of fluid per hour are
administered to an adult, because of potential heat loss from cold IV fluids or blood.\textsuperscript{5,50,57} In volumes of less than two liters, warming has little effect because fluid-induced cooling is minimal. For example, a unit of refrigerated blood or one liter of an IV solution administered at room temperature only decreases mean body temperature by 0.25°C in adults.\textsuperscript{68} However, warming of IV fluids alone may not maintain normothermia, and studies support the use of this method as an adjunct to forced-air warming to decrease the risk of hypothermia.\textsuperscript{9,28,37,68,69}

- Warmed irrigation fluids decrease intraoperative heat loss as an adjunct to other methods and alone are insufficient to prevent intraoperative hypothermia.\textsuperscript{28,70} A study of patients undergoing arthroscopic surgery of the shoulder concluded that core temperature may be influenced by irrigation fluid temperature and recommended that fluid be warmed to 36°C.\textsuperscript{71} AORN recommends warming irrigation fluids to body temperature, or 37°C.\textsuperscript{28}

- Prewarming of patients before induction of anesthesia has been studied as a method to maintain perioperative normothermia.\textsuperscript{7,72,74} Studies have demonstrated the efficacy of intraoperative methods to prevent hypothermia; however, intraoperative cutaneous heat transfer, such as in forced-air warming, does not prevent initial redistribution-induced hypothermia.\textsuperscript{75,77} This initial hypothermia results from redistribution of heat from the warm core compartment to cold peripheral tissues, due to anesthesia-induced vasodilation.\textsuperscript{37,75} Several studies have evaluated the effect of preoperative warming on this initial redistribution-induced hypothermia. One determined that redistribution hypothermia in surgical patients would be markedly reduced by the use of forced-air prewarming for 30 minutes and almost eliminated if active warming was maintained for 1 hour.\textsuperscript{74} However, this study was performed using a group of seven healthy volunteers in a laboratory. Another randomized controlled study of women undergoing elective cesarean sections found that 15 minutes of prewarming in addition to routine intraoperative warming was sufficient to maintain core temperature and prevent hypothermia and shivering.\textsuperscript{7,75} One study of patients receiving 45 minutes of forced-air prewarming found that patients reported increased thermal comfort and decreased complaints of shivering and that the patients maintained a significantly higher mean temperature on arrival to the postanesthesia care unit (PACU).\textsuperscript{7,72} This result was supported by a later study demonstrating that 90 minutes of preinduction skin-surface warming reduced initial postinduction hypothermia and postoperative shivering for procedures lasting three hours or longer.\textsuperscript{73}

### Additional Strategies

Professional societies including ASA, the American Society of PeriAnesthesia Nurses (ASPAN), and AORN endorse recommended practices for the prevention and management of unplanned perioperative hypothermia. A summary of their recommendations includes the following.

#### Preoperative Period

- **Assessment**
  - Identifying risk factors for unplanned hypothermia through patient interview, chart review, physical assessment, review of anesthesia plan, and planned procedure.\textsuperscript{8,28}
  - Measuring a preoperative baseline temperature.\textsuperscript{8,28}
  - Determining patient’s thermal comfort level.\textsuperscript{8}
  - Assessing the patient for signs and symptoms of hypothermia (e.g., shivering, piloerection, cold extremities).\textsuperscript{8}

- **Intervention**
  - Instituting preventive warming measures for patients who are normothermic, such as using passive insulation and increasing ambient room temperature.\textsuperscript{8}
  - Considering whether to prewarm patients for a minimum of 15 minutes immediately prior to induction of anesthesia for patients at risk of unplanned hypothermia.\textsuperscript{28}
  - Instituting active warming measures for patients who are hypothermic.\textsuperscript{8}

#### Intraoperative Period

- **Assessment**
  - Selecting equipment to monitor core temperature based on reliability and accessibility of the monitoring site.\textsuperscript{28}
  - Monitoring core temperature intraoperatively to allow early identification of temperature changes.\textsuperscript{5,28,77} (ASA recommends that patient temperature be continually monitored and evaluated when "clinically significant changes in body temperature are intended, anticipated or expected."\textsuperscript{8,51} AANA recommends monitoring of core temperature continuously in pediatric patients undergoing general anesthesia and in patients undergoing general anesthesia continuously or intermittently.\textsuperscript{8,78} ASPAN recommends that temperature be monitored at least every 30 minutes if a procedure lasts longer than 30 minutes.)\textsuperscript{8}
  - Communicating abnormal temperature to the perioperative team.\textsuperscript{28}

- **Interventions**
  - Measures to prevent unplanned hypothermia may include the following:
    - Minimization of skin exposure by covering parts of the body not involved in the surgical procedure.\textsuperscript{28}
    - Passive insulation.\textsuperscript{8}
Forced-air warming\(^8,28\)
- Circulating-water garments\(^28\)
- Energy transfer pads\(^28\)
- Warming IV fluids\(^8,28\)
- Warming irrigation fluids to body temperature\(^8,28\)
- Increasing ambient room temperature (minimum 20° to 24°C or 68° to 75°F)\(^8,28\)
- Warming and humidifying inspired gases\(^8,28\)
- Increasing ambient room temperature to higher than 26°C (78.8°F) for neonates\(^28\)
- Increasing ambient temperature to greater than 29.4°C (85°F) for patients with severe trauma or extensive burns\(^1,28\)
- Continuous monitoring of intraoperative temperatures in infants, neonates, severe trauma patients and patients with extensive burns\(^28\)

### Postoperative Period

**Assessment**
- Obtaining patient’s temperature on admission to PACU\(^8\)
  (If hypothermic, monitor serial temperatures every 30 minutes at a minimum until patient becomes normothermic. If normothermic, assess the patient’s temperature before discharge from the PACU or as ordered.\(^9\))
- Determining the patient’s thermal comfort level every 30 minutes\(^8\)
- Assessing for signs and symptoms of hypothermia\(^8\)

**Interventions**
- If normothermic, initiating appropriate preventive warming measures\(^8\)
- If hypothermic, initiating appropriate passive and active warming measures, in addition to warming IV fluids and humidifying and warming inspired gases\(^8\)
- Assessing temperature every 30 minutes or as appropriate if the patient’s thermal comfort level decreases or signs of hypothermia are present\(^8\)
- Measuring the patient’s temperature discharge from the PACU\(^8\)
- Maintaining ambient room temperature (minimum 20° to 24°C or 68° to 75°F)\(^8,28\)

In addition to the above practices, the AORN promotes the following:\(^28\)
- Providing personnel with initial education and competence evaluation on the prevention of unplanned hypothermia
- Documenting on the patient record patient assessment and evaluation, the plan of care, and any interventions undertaken to prevent unplanned hypothermia
- Developing and periodically reviewing policies and procedures for the prevention of unplanned hypothermia in collaboration with anesthesia care providers
- Evaluating the structures, process, and outcomes of interventions used to prevent unplanned hypothermia through a performance improvement plan

### Potential Barriers to Maintaining Normothermia

The Anesthesia Patient Safety Foundation has identified the following potential barriers to maintaining normothermia in the perioperative environment:\(^7,8\)

- Staff turnover may contribute to inconsistent practice patterns.
- Appropriate monitoring sites (e.g., the esophagus, nasopharynx, tympanic membrane, pulmonary artery) may be unavailable during certain types of procedures.
- Lack of evidence-based guidelines on how to best warm patients (especially ASA guidelines) results in practice guidelines that are general and nonspecific.
- The benefits of warming may not be immediately apparent. Changes in body temperature occur slowly, so despite active warming, the clinician may doubt the effectiveness of the intervention.
- The appropriate stakeholder may not make the decisions about what happens in the OR. Decisions about adopting warming technology may be made at an institutional level without regard to the benefits of normothermia.
- Some patients are difficult to warm effectively despite appropriate interventions to maintain normothermia (e.g., trauma patients undergoing multiple operations, patients undergoing major cardiac and vascular procedures in which poor perfusion in the lower extremities is common.)

### Conclusion

Despite the potential barriers to maintaining perioperative normothermia, the literature suggests that, for patients at risk for complications, monitoring perioperative temperature and maintaining normothermia will improve outcome. However, hypothermia may occur in any patient and may result in serious postoperative complications. Fortunately, a number of methods exist to detect and prevent hypothermia, allowing the prevention of perioperative hypothermia to be an obtainable goal.

### Notes

2. Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurological...


Self-Assessment Questions

1. Factors in the operating room (OR) environment that may contribute to perioperative hypothermia include all of the following EXCEPT?
   a. Exposure of a large body surface area
   b. Administration of cold intravenous (IV) fluids
   c. Evaporation from the surgical site
   d. Ambient OR temperatures of 21° to 23°C

2. During general anesthesia, a patient’s core temperature will continue to decrease in a gradual, linear manner unless warming devices are applied.
   a. True
   b. False

3. Sites that provide an accurate measurement of a patient’s core temperature include all of the following EXCEPT?
   a. Pulmonary artery
   b. Axilla
   c. Nasopharynx
   d. Tympanic membrane
   e. Distal esophagus

4. Hypothermia may affect the coagulation system in all of the following ways EXCEPT?
   a. Platelet numbers decrease
   b. Formation of the initial platelet plug is inhibited
   c. The function of enzymes in the coagulation cascade is slowed
   d. Fibrinolysis is enhanced

5. Methods that have been shown to be adequate to maintain core body temperature intraoperatively include all of the following EXCEPT?
   a. Forced-air warming devices
   b. Ambient OR temperature greater than 26°C
   c. Circulating water garments
   d. Warmed IV fluids