Dangers of Hypothermia: Avoiding the Cold

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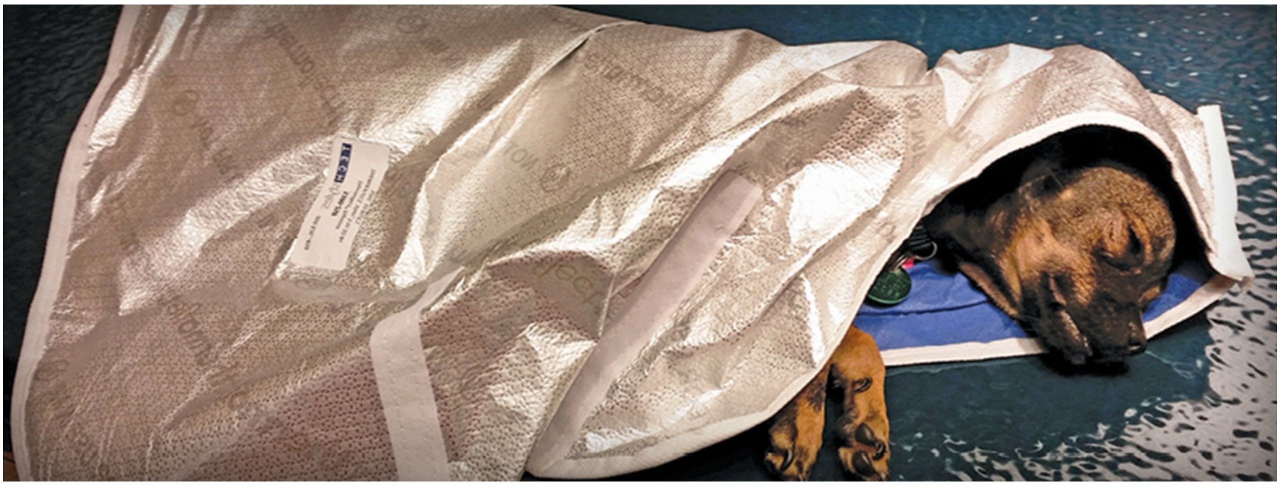

Hypothermia is a common yet preventable side effect of anesthesia and surgery. Too often, intraoperative hypothermia is overlooked or ignored.[1] Unfortunately, many practices become accustomed to intraoperative and postoperative hypothermia because it is so common, or they are unaware that their patients are experiencing hypothermia because of lack of monitoring. However, just because patients routinely experience hypothermia does not make it acceptable.

In this article, I will describe hypothermia dangers, causes, and risk factors; how to prevent or detect hypothermia; and how to treat it should it occur.

What Is Hypothermia?

Hypothermia under anesthesia is defined as a drop in body temperature below reference ranges. It is subclassified as mild (98°F to 99.9°F), moderate (96°F to 98°F), severe (92°F to 96°F), and critical (below 92°F) (**TABLE 1**).[1]

TABLE 1 Stages of Hypothermia in an Anesthetized Patient

STAGE	TEMPERATURE RANGE
Mild	>98°F
Moderate	96°F–98°F
Severe	92°F–95°F
Critical	<92°F

Why Is Hypothermia a Concern?

Hypothermia creates a variety of abnormal reactions in the body (**TABLE 2**). It affects metabolism, blood viscosity, cardiovascular function, and the amount of anesthetic drugs needed. It can also increase risk for infection and decrease immune function. For example, a possible link has been shown between the length and degree of hypotension that determines the degree of immune system dysfunction.[2]

TABLE 2 Effect of Hypothermia on Body Systems

System	Dysfunction
Cardiovascular	Thermoregulatory dysfunction resulting in arterial vasodilation, increased blood viscosity, decreased cardiac output, increased cardiac dysrhythmia, coagulopathies, hypotension, bradycardia
Respiratory	Decreased respiratory rate, minute volume, and tidal volume
Neurological	Disrupted cerebral autoregulation and cerebral blood flow
Immune	Impaired wound healing and increased risk for infection
Metabolic	Decreased metabolism, leading to drug overdoses and prolonged recoveries

Metabolism

A patient's metabolic rate decreases approximately 10% for each 1.8°F loss of body temperature.[2] This lower metabolic rate results in reduced drug metabolism and elimination, which can lead to overdoses and prolonged recoveries.[3] Cell sodium pump activity is decreased, which may cause cell edema. Electrolyte and pH imbalances may result in conditions such as hyperkalemia and acidosis.[4]

Blood Viscosity

During hypothermic episodes, blood viscosity (thickness, stickiness) and packed cell volume (PCV) can increase after possible splenic contraction. Increased blood viscosity increases the amount of work the myocardium must do. Prothrombin time (PT) and partial thromboplastin time (PTT) increase, resulting in hypocoagulability, which can lead to excessive bleeding.[4]

Cardiovascular Response

In addition to the increased demands on the myocardium, hypotension is common in hypothermic patients because of reduced sensitivity and reflexes of the baroreceptors, resulting in reduced cardiac output.[4] Electrophysiologic changes can lead to bradycardia that is nonresponsive to anticholinergics, and myocardial irritability can increase the incidence of arrhythmias.[4] At a body temperature around 95°F, active vasodilation occurs, which will lead to hypotension. Below this temperature, thermoregulatory shivering does not occur.[2] When the core body temperature falls below 94°F, thermoregulation is impaired and peripheral vasoconstriction is replaced with vasodilation, which promotes core body heat loss.[5]

Amount of Anesthetic Drug Needed

As the patient's temperature drops, so do the anesthetic requirements. Depression of central nervous system activity results in a reduced minimal alveolar concentration (MAC) (the amount of anesthetic gas vapor in the lungs needed for anesthesia). It is imperative that as the patient's body temperature decreases, the amount of anesthetic drug be reduced to prevent overanesthetizing the patient.[2] If the vaporizer is not reduced as the body temperature drops, the patient may go into a deeper plane of anesthesia and may hypoventilate. Hypoventilation in a hypothermic patient may result in hypercapnia (increased carbon dioxide in the blood).[2]

What Causes Hypothermia?

Before hypothermia can be addressed, you must recognize why the patient is losing heat. The main causes are cold environment, altered thermoregulation of the body, and heat-loss mechanisms.

Cold Environment

Exposure to a cold environment is the most common cause of hypothermia.[5] Environmental temperature is often beyond the technician's control. For their own comfort, many surgeons prefer a cooler environment while gowned.

Altered Thermoregulatory Response

Alteration of the patient's normal thermoregulatory response is the second most common cause of hypothermia.[5] This alteration may be caused by agents used in anesthesia but alone is not a reason to change the protocol; the benefits of these agents outweigh their potential side effects. In an awake patient, body heat is not distributed uniformly. The periphery (tail, legs) release or absorb heat as needed to maintain normothermia.[2] During the first hour of anesthesia, a centrally mediated decrease in temperature threshold causes the body to redistribute blood flow to the periphery to compensate for the body's misconception of excess heat, resulting in a drop in core body temperature.[2] Many other physical factors contribute to heat loss during surgery, including lack of body fat, large body surface areas, vasodilation,[6,7] and changes to hypothalamus function. Specific vasodilatory agents commonly used in anesthesia are acepromazine and gas inhalants. Gas inhalants cause dose-related vasodilation: the higher the vaporizer setting, the more vasodilation will occur and, thus, the potential for hypothermia will increase.

Heat-Loss Mechanisms

Heat loss can be categorized by mechanism. The 4 mechanisms are radiation, convection, conduction, and evaporation.

Radiation: In the anesthetized patient, the most common mechanism for heat loss is radiation.[2] Radiation occurs when an exchange of heat takes place between the body and environmental objects that are not actually in contact with the patient, independent of moving air. There is a loss of energy by transfer of infrared waves.[2] Body heat, especially if the patient is experiencing vasodilation, is transferred to the cooler air surrounding it (eg, the heat dissipates away from the body).

Convection: The second most common mechanism of heat loss is convection,[2] which occurs as body heat is transferred to the air moving over the skin surface.[2] The larger the body surface area, the more prone the patient is to hypothermia. In veterinary patients, although hair helps insulate the body to some degree, heat loss is accelerated from areas of exposed skin where the hair has been shaved. A shaved area or open body cavity can create extreme heat loss.

Conduction: The transfer of body heat to a cooler surface is called conduction and occurs when any part of the body touches a cool surface. For example, conduction occurs when a patient is placed on a metal table or when a footpad touches a metal IV pole. To prevent heat loss from conduction, ensure that the patient is fully insulated from any cool object.

Evaporation: This mechanism of heat loss occurs when moisture on the skin or in the respiratory tract dissolves into the air, pulling with it heat from the body. Heat loss from evaporation can be prevented by being conscious of the amount of prep solution used, attempting to keep the patient dry, and carefully using a hair dryer after surgery to dry a wet patient. To prevent evaporation from the respiratory tract, carefully lowering the oxygen flow, if compatible with the breathing system and vaporizer, can be helpful in preventing heat loss.[2]

Which Patients Are at Highest Risk?

Some patients are more prone than others to hypothermia, and they must be identified so special precautions can be instituted. Higher-risk patients include pediatric patients, geriatric patients, patients with very little body fat (eg, sight hounds and cachectic animals), and patients whose surgery involves an open body cavity.[3]

Pediatric Patients

Physiologic differences in pediatric patients predispose them to hypothermia. Several factors increase this risk. Their ability to thermoregulate is immature; they have a high metabolic rate, a large body surface to body mass ratio, limited subcutaneous fat, and deterrents that limit shivering in the event of hypothermia.[8]

Geriatric Patients

At the other end of life are the geriatric patients. These patients are likely to become hypothermic during anesthesia for the following reasons: decreased muscle mass prevents an effective shivering response, central nervous system changes decrease the ability to thermoregulate, basal metabolic rate is decreased, the patient may have hormonal alopecia or hair thinning, and distribution of fat diminishes its insulating properties. As an insulator, fat conducts one third as readily as other tissues, slowing the transfer of body heat.[2] Geriatric patients tend to have more adipose tissue in the abdominal cavity than in subcutaneous areas.[9]

Thin Patients

Patients who are cachectic, have some type of wasting disease, or are naturally thin (such as sight hounds) are prone to hypothermia while anesthetized. These patients have little muscle mass and minimal insulating fat.[3]

Patients Undergoing Open Body Cavity Procedures

Among surgical procedures that promote hypothermia, those that promote the most heat loss involve open abdominal or thoracic cavities. These surgical patients will be at higher risk for heat loss while under anesthesia.

What Is the Connection Between Anesthesia and Hypothermia?

Although the patients listed above are at higher risk, all patients under anesthesia probably experience some degree of hypothermia. Overall, anesthesia decreases the basal metabolic rate by anywhere from 15% to 40%, which inhibits muscular activity and leads to decreased heat production.[5] Inhalant gasses and injectable drugs can contribute to hypothermia.

Oxygen

The oxygen used with inhalation anesthesia is cold and can contribute to heat loss in patients during general anesthesia. Heat loss should be a consideration when choosing the type of anesthetic circuit to use. Nonrebreathing systems require a higher oxygen flow rate and, thus, are more apt to promote hypothermia.[5]

Other Anesthetic Drugs

Some anesthetic drugs can lead to vasodilation, which can contribute to hypothermia. Fully dilated blood vessels lose heat 8 times faster than fully constricted vessels.[5] Two of the most common vasodilatory drugs used in anesthesia are acepromazine and gas inhalants. It is important to remember that vasodilation caused by gas inhalants is dose dependent. Body temperature can be conserved by incorporating a multimodal anesthesia protocol allowing the vaporizer to be set at the lowest acceptable level for surgery. Thermoregulation can be altered by drugs such as alpha-2 agonists (dexmedetomidine), opioids, (hydromorphone, morphine, oxymorphone, fentanyl, and methadone), and gas inhalants.[6] In humans, a temperature drop of 3.6°F to 5.4°F doubles the duration of nondepolarizing neuromuscular blocking agents.[2] These effects do not indicate that these drugs should not be used in veterinary patients. Rather, they indicate that you should be aware of them and should plan interventions to prevent heat loss in these patients.

How Can Hypothermia be Prevented?

Preventing hypothermia involves consideration of several factors: common sense, mechanical intervention, and use of everyday objects that may be around a clinic. If your patients routinely have been experiencing hypothermia, you should try to understand when and how the heat loss is occurring, keeping in mind that using a multimodal approach will result in the best outcome (**TABLE 3**).

TABLE 3 Ways to Combat Hypothermia

Type	Material	Objective	indication

Type	Material	Objective	indication
Passive	· Flannel blanket · Space blanket · Bubble wrap · Plastic wrap	Prevent heat loss	Normothermic or mildly hypothermic patient
Active **External**	· Circulating warm water blankets · Forced warm air blankets · Inline IV warmer · Conductive fabric	Provides heat to body surface	Anesthetized patient experiencing moderate/severe/critical hypothermia
Active **Internal**	· Sterile, warm, pleural/peritoneal lavage · Warm IV fluids	Provides heat to body core	Patient undergoing open chest/abdomen surgeries or experiencing severe or critical hypothermia

The first step is identification of the problem, which is accomplished by monitoring body temperature. One way to monitor the temperature of an anesthetized patient is to use an esophageal thermometer. Most multimodal monitors come with the option that will supply a real-time, constant core temperature. If this option is not available, a manual rectal temperature taken every 5 minutes is usually adequate. However, rectal temperatures can be inaccurate, especially if fecal material is present.[4]

WARM RECEPTION When the patient arrives avoid patient contact with metal surfaces. Conduction occurs when a patient is placed on a metal table or when a footpad touches a metal IV pole. To prevent heat loss from conduction, ensure that the patient is fully insulated from any cool object. Heat loss is prevented by placing a blanket between the metal table and patient.

Temperature should be monitored from the time of premedication until the patient is well into recovery. Ideally, the patient’s temperature should be obtained at intake, before leaving the prep area, continuously during surgery, and postoperatively until the patient has maintained a normal body temperature for 2 to 3 consecutive hours.

Every patient needs a warm environment from the time it receives premedication until it is fully recovered. We will now discuss heat-loss prevention according to surgical phase: preoperative, intraoperative, and postoperative.

Preoperative Phase

Prewarming

An effective way to prevent hypothermia is to prewarm the patient before surgery. Prewarming raises the peripheral body temperature, which reduces the initial drop in core body temperature.[2] However, the patient should not be overheated. Safe ways to prewarm a patient before surgery include putting hot water bottles (that have been warmed in the fluid incubator and insulated) in the cage of a conscious patient, supplying warm blankets, ensuring that the patient doesn’t come in contact with the cold metal cage walls, and adding a cage dryer on a low setting.[10]

Presurgical Preparation

Surgical preparation can be a time of significant loss of body temperature. It is not unusual for a patient to lose up to 2.0°F during the first hour of anesthesia.[6] To prevent heat loss during this phase, the patient should be insulated from cold surfaces. Techniques include padding the cage or run so the patient is not lying on a cold surface after premedication has been administered, padding the prep and surgery tables with bubble wrap and towels, and even ensuring that footpads are not touching cold surfaces such as an IV pole (**FIGURE 1**).

FIGURE 1. Layers, Hug-U-Vac, warm water blanket, huck pad. *Image courtesy of Brenda Feller.*

The choice of scrub solutions can also contribute to heat loss. For most preparations, the initial surgical scrub used in the prep area can be warmed. If the patient is at a higher risk for hypothermia, substituting warm sterile saline for alcohol will help reduce heat loss.[6] Do not oversaturate the patient. Being prepared and preparing the patient quickly and efficiently can help reduce heat loss.

Intraoperative Phase

Active Warmers

The best defense against intraoperative hypothermia is use of an active multimodal approach. Maintaining body heat is much easier than regaining it after it is lost. There are 4 types of active, or mechanical, methods of warming an anesthetized patient that are approved for use with veterinary patients: inline fluid warmers, forced warm air systems, conductive fabrics, and circulating warm water blankets. These 4 methods are routinely used in human medicine and have proven effective and safe when used as directed.

Inline Fluid Warmers

FIGURE 2. Inline fluid warmer. *Image courtesy of Brenda Feller.*

An inline fluid warmer keeps IV fluids warm as they enter the patient and can be used along with other options to help maintain normothermia (**FIGURE 2**). Although using an incubator to warm the IV fluid bag before administration may seem like a good idea, most fluid pumps are incapable of delivering fluids at a rate that will not result in the fluid being at room temperature when it reaches the patient. Cooling begins the minute a bag of warmed fluids is removed from the incubator. Even with use of some type of insulation around the bag during surgery, cooling happens rapidly. But the real cooling occurs at the administration set. The average IV administration set has a priming volume of around 15 to 19 mL, which does not include the fluid held in the priming bulb at the top. Use of an extension set or T-port will add volume. If you consider an average 20-kg patient receiving fluids at 5 mL/kg/hour through a 15-mL IV administration set, the fluid will stay in the fluid line approximately 9 minutes (**BOX 1**). Because the environmental temperature of many surgery suites is in the 62°F to 68°F range (much lower than body temperature), 9 minutes is sufficient time for warmed fluid to cool to room temperature by the time it actually reaches the patient. For a cat, because of the lower flow rates, the fluid could be in the line for over 30 minutes! Inline fluid warmers are great for counteracting this heat loss if placed close to the patient. However, if the inline fluid warmer is close to the fluid bag, there is little to no advantage in using it. Placing the warmer close to the IV catheter, keeping in mind individual instructions on how close to the patient it can be, will promote heat conservation. This piece of equipment is easy to use and requires little maintenance to provide years of service.

BOX 1 Calculating Heat Loss in an IV Fluid Line

The following example shows how to calculate the length of time fluid stays in an IV administration set. A 20-kg patient is receiving fluid at 5 mL/kg/hour via an administration set with a 15-mL priming volume.

Step 1. Calculate the fluid rate by multiplying body weight by fluid rate.

20 kg × 5 mL/hour = 100 mL delivered per hour

Step 2. Divide the hourly rate by the administration set priming volume to discover how many times per hour the fluid in the administration set will be exchanged.

100 mL/15 mL = 6.66 times per hour

Step 3. Calculate how many minutes the fluid will stay in the IV line by dividing 60 minutes by the times per hour the fluid will be exchanged.

60/6.66 = approximately 9 minutes

This calculation indicates that the fluid stays in the administration line about 9 minutes before it reaches the patient. This calculation does not consider the fluid in the priming bulb, which will increase the time that the fluid is outside the fluid bag and exposed to room air. Because the amount in the bulb will vary and is not considered in the volume of the administration set, it cannot be accurately calculated.

Forced Warm Air Systems

Another type of mechanical device is the forced warm air system, such as the Bair Hugger System (**3m.com**) (**FIGURE 3**). When used as directed, with the blankets supplied by the company, this system provides excellent body heat retention and maintains surgery site sterility.[8] The blankets that come with the unit are designated for 1-time use and provide some degree of safety from contamination from the air that is being provided to the patient.[8]

FIGURE 3. Bair Hugger unit. *Image courtesy of Brenda Feller.*

Similar units have reusable blankets (**FIGURE 4**). Cloth blankets can be purchased for use with forced warm air systems and laundered between patients. Follow manufacturer's instructions for cleaning and use. When using cloth blankets, I have successfully placed a fleece blanket over the cloth blanket to trap heat close to the body if the warming blanket is placed over the torso of the patient.

If the surgeon is concerned about the circulating air these devices emit, one option is to start the unit after the patient is fully draped for surgery. Maintenance consists of changing an internal filter after a set number of hours of use.

FIGURE 4. Forced warm air with cloth blanket. *Image courtesy of Jorvet.*

Conductive Fabrics

Other mechanical devices specifically designed for veterinary patients are conductive fabric warming devices (**FIGURE 5**).

A product commonly used in veterinary medicine is the Hot Dog warming system (**hotdogwarming.com**). Conductive fabric warming devices do not blow hot air and have reusable blankets that can withstand cleaning. They have alarms that alert the team if the patient is overheated. Recently, the manufacturer has recommended replacing the blankets every 2 years. As always, follow manufacturer's instructions.

FIGURE 5. Space blanket–type device. *Image courtesy of Jorvet.*

Circulating Warm Water Blankets

These devices consist of a pump that warms water (**FIGURE 6**), which is then delivered to a water blanket that can be placed over or under a patient (**FIGURE 7**).

One disadvantage of these systems is that the blanket is made of a plastic material and can be damaged by puncture. To avoid blanket puncture, you can purchase a product that can be placed over the blanket to protect it or use the product only after the patient is anesthetized. The warm water blanket can also serve as an inline fluid warmer if the IV line is run under the blanket.

FIGURE 6. Warm water circulating pump. *Image courtesy of Jorvet.*

Caution!

It is important to note that using unapproved methods for heat support may cause thermal burns. Patients who experience thermal burns experience severe pain and protracted healing of burned tissue and, in severe cases, may require euthanasia. Unfortunately, I have witnessed all of these side effects from use of unapproved heating sources during anesthesia. There are many products on the market that are not safe for patients that are unconscious and unable to move away from the heat source. Unsafe products include any product that is placed in the microwave (eg, discs, hot water bottles, rice socks), no matter how well they are insulated. When the products are microwaved, there are no safeguards to monitor the actual temperature of the products. These products are acceptable when the patient has the ability to move away from the source if they are too warm but not when the patient is unconscious or heavily sedated.[6] Never use an electric heating pad made for humans on a veterinary patient because of the risk for burns and electric shock.

FIGURE 7. Warm water blanket. *Image courtesy of Jorvet.*

Passive Warmers

A wide variety of passive, or nonmechanical, methods can be used to help maintain a normal body temperature range in an anesthetized patient. Several items in this category are found in most practices.

Bubble Wrap

Most practices have access to bubble wrap, which can be used in a variety of ways (**FIGURE 8**). It can be placed on a metal table, covered by a thick towel, to insulate the patient from the cold table and prevent conductive heat loss. Smaller pieces can be placed around limbs for insulation, or if the procedure is to be performed on a limb, the torso can be wrapped.[2] Bubble wrap can be used in addition to some type of mechanical warming device that traps heat near the body. Bubble wrap should not be used on a conscious patient because of the risk of its being ingested. Bubble wrap should be discarded after use.

FIGURE 8. Layering, bubble wrap/towel. *Image courtesy of Brenda Feller.*

Clothing

Heat loss can be reduced by placing baby socks, sweaters, or any other type of clothing on the patient anywhere not involved in the surgery site. These items can be placed on the extremities or torso.

Plastic Wrap

Plastic wrap can be used for patients undergoing surgery on a limb. Simply covering the torso and the table, including a mechanical heat source like a circulating warm water blanket, will keep the heat produced by the body and the blanket contained within the plastic wrap. Patients undergoing dental prophylaxis should be kept dry to prevent heat loss through evaporation. An easy way to accomplish this is to place plastic wrap over the patient’s torso and then place a blanket over the plastic wrap. Plastic wrap should be used only for anesthetized patients. If plastic wrap is ingested by the patient, it has the possibility of becoming an intestinal obstruction.

Blankets

Flannel blankets and space blankets placed over the patient trap the warm air near the patient and can mitigate heat loss (**FIGURE 9**). For best results, cover all parts of the patient, including the head and extremities. Although blankets alone will not keep patients warm, they are a great addition to other methods.

FIGURE 9. Flannel blanket. *Image courtesy of Brenda Feller.*

Low Oxygen Flow

A high oxygen flow rate can contribute to hypothermia; however, this risk can be reduced if the oxygen flow rate is calculated for the patient instead of being set arbitrarily high. An oxygen flow rate of 20 to 22 mL/kg/minute, which is more than twice the normal oxygen demand for a patient on a rebreathing circuit, provides adequate oxygen flow and reduces the amount of cool oxygen delivered to the patient.[4] This means that a 20-kg dog would require only 400 mL (or 0.4 L) of oxygen per minute. The caveat to this rule is that to ensure accurate delivery of the gas inhalant, all vaporizers have a minimum low oxygen flow rate. This information is located in the instruction booklet, or technical services can provide this information about the vaporizer. Until the minimum flow rate for a particular vaporizer is verified, for safety, a minimum oxygen flow rate of 500 mL/minute can be used. Nonrebreathing systems require a higher oxygen flow rate based on the weight of the patient (**FIGURE 10**). This rate will vary slightly among types of system and results in a 5-kg cat often requiring a higher oxygen flow rate (150 to 300 mL/kg/minute) on a nonrebreathing system than a 40-kg dog on a rebreathing system.

Carbon Dioxide Absorbent

Viable (fresh) carbon dioxide absorbent acts as a natural heating source. The chemical reaction between the granules and carbon dioxide produces heat and moisture within the rebreathing circuit. This heating effect is another reason to change your carbon dioxide absorbent on a regular basis. The larger the patient, the more heat and moisture will be produced. Although this alone is not enough to keep a patient warm, it may help conserve heat.[9]

FIGURE 10. Nonrebreathing circuit with warm water bottle on oxygen line. *Image courtesy of Brenda Feller.*

Postoperative Phase

Postoperative shivering, in addition to prolonging recovery, increases oxygen demand, which may lead to the need for oxygen supplementation during recovery (**FIGURE 5** and **FIGURE 11**). Severe shivering may induce pain through movement of areas that underwent surgery.[2] In humans, hypothermia contributes to delayed wound healing and extended hospital stays even in the absence of wound infection.[2]

FIGURE 11. Space blanket type blanket. *Image courtesy of Jorvet.*

During the recovery period, you can use items you have around the hospital to keep your patient warm. A cage dryer is acceptable for warming patients conscious enough to be able to move away from the heat source. For small patients, an oxygen cage can provide heat, with or without the oxygen flowing. If the cage is not supplying oxygen and the patient is conscious, you can add insulated hot water bottles that have been warmed in a fluid incubator to produce heat in the oxygen cage.[4]

To prevent hyperthermia during the postoperative phase, active body warming should be discontinued after the rectal temperature reaches 98.5°F.[5] However, a return of the patient’s body temperature to normal does not mean that the anesthetist’s job is done. The core body temperature can continue to drop. This phenomenon is called “afterdrop” and is a result of the cold peripheral blood being circulated back to the body core.[5] The patient should be actively monitored until the body temperature is stable for 1 to 2 hours.

Summary

Hypothermia is an often overlooked condition that is easier to prevent than to treat. If not treated in a timely manner, hypothermia can have grave consequences. Postoperative hypothermia can cause prolonged recoveries and increased wound infections. Better anesthesia outcomes can be achieved when we identify causes of heat loss, take measures to avoid or counteract them, and incorporate active warming into our surgical protocols.

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1. A patient is said to experience severe hypothermia when the core body temperature is:
    1. 92°F–96°F
    2. below 92°F
    3. 96°F–98°F
    4. 99°F –100°F
2. The breathing circuit that will contribute the most to hypothermia is a:
    1. rebreathing circuit
    2. nonrebreathing circuit

3. Which warming device is approved for anesthetized patients?
    1. hot water bottles
    2. electric heating pads
    3. forced warm air system
    4. rice sock
4. A Hot Dog warming system
    1. circulates warm air
    2. circulates warm water
    3. uses conductive fabric
    4. is an inline fluid warmer
5. A disadvantage of using a high oxygen flow rate is that it:
    1. causes no change in body temperature
    2. causes a decrease in body temperature
    3. causes an increase in body temperature
    4. causes marked fluctuation in body temperature
6. During hypothermia, the blood viscosity:
    1. stays neutral
    2. decreases
    3. increases
    4. varies unpredictably
7. Vasodilation due to hypothermia occurs at a body temperature of about:
    1. 92°F
    2. 90°F
    3. 95°F
    4. 98°F
8. Shivering causes:
    1. an increase in oxygen demand
    2. an increase in recovery time
    3. a decrease in oxygen demand
    4. a decrease in recovery time
9. When a patient has a footpad touching a metal IV pole, the patient is said to be losing heat through:
    1. Radiation
    2. Convection
    3. Evaporation
    4. Conduction
10. Afterdrop occurs when:
    1. the blood from the core is circulated back to the periphery
    2. the blood from the head is circulated to the core
    3. the blood from the major organs is circulated to the head
    4. the blood from the periphery is circulated to the core

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