**Not Too Hot or Too Cold – Getting Conductive Layer Warming Units Just Right**

When the body loses too much heat and cannot maintain its normothermia of 36.6° to 37.5° C (97.9° to 99.5° F), it is considered to be in a state of hypothermia. Even mild hypothermia (a core temperature of 34° to 36° C [93.2 to 96.8° F]) can have severe repercussions for the patient, such as delayed wound healing, reduced resistance to infection, impairment of platelet function, increased intraoperative blood loss, and prolonged postoperative recovery time. Inadvertent perioperative heat loss typically results in average temperature drops of 0.5° to 1.5° C, but in severe cases the body temperature may drop 2° to 3° C. Surgical patients are at risk of becoming hypothermic due to significant heat loss sustained during surgery for a number of reasons, including:

- Exposure of large areas of the patient’s body to the operating room environment, where humidity is low and room temperatures are typically between 18° and 19° C (64.4° and 66.2° F)
- Evaporative heat loss from open body cavities
- Application of volatile cleaning solutions to the skin and/or surgical wound(s)
- Infusion of cold or room-temperature fluids

- Evaporative heat loss due to the inhalation of dry anesthetic gases
- Impairment of normal thermoregulatory responses by anesthesia
- Use of metabolism- or respiration-suppressing pharmacologic agents

The body attempts to regain heat lost in the OR by shivering during the postoperative period. Shivering, which can intensify to tremors or violent shaking, poses extreme danger to the patient due to the increased metabolic demand. One study revealed a 92 percent increase in oxygen (O2) consumption in response to a drop in temperature of only 0.2° to 1.3° C; a 500 percent increase in O2 consumption was observed in response to violent shaking. The adverse consequences of the metabolic stress imposed by this increased energy demand include the following:

- Increased risk of ventricular fibrillation, stroke, postoperative deep-vein thrombosis, and pulmonary embolization
- Inhibition of hepatic and pancreatic activity, leading to changes in glucose metabolism
- Decreased renal blood flow, resulting in decreased glomerular filtration, loss of proteins, and subsequent increased risk of wound infection
- Interference with a patient’s emergence from anesthesia

In addition, tremors and shaking from shivering may adversely affect patient monitoring equipment.

**PRINCIPLES OF OPERATION**

Thermal conduction refers to the transfer of energy (heat) between adjacent molecules of a conducting medium in response to a temperature gradient. With conductive layer warming methods, effective warming of the patient is dependent upon direct contact between the patient and heated surfaces, in contrast with forced-air warming which involves moving heated air across the patient’s skin to raise the core body temperature. Conductive layer patient warming units are comprised of a heat-conducting (e.g., carbon polymer) layer in a blanket and/or a compressible underbody mattress. They are powered by a low voltage power source that is regulated by a temperature controller.

The blanket(s) and/or mattress pad may contain water or gel to allow the warming layer to conform to the shape of the patient’s body for optimal heating. They should be made of a latex-free material that can withstand repeated cleaning and disinfection (e.g., urethane); they should also be nonflammable. Blankets are available in various sizes, including pediatric, adult, lower body, upper body, and full body.
body. Specialized sizes designed for pre- and postoperative care are available from some manufacturers. Warming blankets used in the OR are designed to cover only the upper or lower body; a full blanket cannot be used because of the need to establish the operating field and to maintain sterility. Blankets for the post-anesthesia care unit (PACU) or emergency department are full-body blankets. Both reusable and disposable blankets are available. Mattresses have straps or clips to secure them to an operating room table and may also be radiolucent. Some manufacturers offer mattress pads of pressure-reducing foam to reduce instances of vascular occlusion and heat-accelerated necrosis. The foam pad may be enclosed in a shell made of antimicrobial or disinfectable material.

Conductive layer patient warming units have a controller for setting and regulating temperature and activating alarms, and some means (e.g., blankets) to deliver heat to the patient. The controller converts the mains input to a low voltage to achieve and maintain the required heating of the conductive blanket(s) and/or mattress layer(s). The controller may be mounted on a stand or IV pole, or attach to the bedrail via a hook or clip. At least one manufacturer offers a controller capable of regulating multiple blankets and a mattress simultaneously. Blanket temperature is monitored by one or more thermistors, and controllers typically have primary and secondary alarms to ensure that clinicians are alerted if maximum temperature is exceeded.

**REPORTED PROBLEMS**

Conductive layer warming units, like other heating devices, have the potential to cause burn injuries. Patient burns can result from use of the device for extended periods of time on high temperature settings.

A general guideline to follow is that the maximum temperature setting should not be used on patients in the presence of the following conditions, which could increase the risk of thermal injury:

- Low cardiac output
- Peripheral vascular disease (occlusive or diabetic)
- Total immobilization
- Unconsciousness
- Poor peripheral perfusion
- Marginal cutaneous perfusion

The operator should frequently check patient temperature and vital signs during extended usage. In all cases, operators should reduce the temperature or end treatment when normothermia is achieved.

**ECRI INSTITUTE RECOMMENDATIONS**

As with any device or technology used in health care, organizations planning to purchase conductive layer patient warming units need to consider a wide variety of factors, including performance, safety, and maintenance.

ECRI Institute recommends that conductive patient warming unit controllers have audible and visual overtemperature and malfunction alarms because they increase the likelihood that a caregiver will quickly respond to a device-related problem. The highest temperature setting should be limited to 43°C (109.4°F) and blankets and mattresses should not be capable of reaching temperatures greater than 46°C (114.8°F); higher temperatures increase the risk of thermal skin injury. The cable/hose connecting the blanket(s) and/or mattress to the control unit should be at least 3 m (9.8 ft) in length, and the unit should be equipped with adequate storage for the device components. For a warming unit that will be used in a post-anesthesia care unit, it would be advantageous for the controller to have outputs for more than one blanket and/or mattress.

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