

Not Too Cold, Not Too Hot

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Patients often become cold before, during, and after surgery and this can decrease the patient's immunity and increase their risk of contracting a surgical site infection (SSI). Fortunately, several studies show that proper use of temperature management devices preoperatively and intraoperatively can reduce SSIs.

Hypothermia occurs when the body is below 35 degrees C (95 degrees F). It can be more specifically classified as mild (32.2 - 35 degrees C), moderate (27 - 32.2 degrees C) or severe (27 degrees C).¹ Low body temperatures are most dangerous for very young and very old patients, as well as immuno-compromised patients.

Cold as Ice

The immune system just doesn't work as well when it's cold, says Judson Boothe, a director at Surgical Solutions (a division of Kimberly-Clark Health Care).

"Think about it this way," he says. "What is the body's natural reaction when you get an infection? It's to develop a fever. This is the body's way of kicking the immune system into action and that isn't as effective when the body is hypothermic."

Researchers at the Institute for Healthcare Improvement (IHI) recommend that surgical teams keep a patient's temperature above 36 degrees C preoperatively and suggest the use of warming devices such as hot air blankets, IV fluid heaters and filter heater hydrators for laparoscopic procedures.

A fortunate factor is that healthcare teams can actually control temperature, as opposed to other health factors — such as whether a patient smokes, exercises, drinks, etc, Boothe says.

"Hypothermia is dangerous for the patient because anesthesia disrupts the body's already sensitive temperature regulation," Boothe says. "Hypothermia, even by only one degree below normal, can cause excess bleeding, longer recovery times and increased risk of infection."

Coronary Artery Bypass

Temperature management is important during any procedure, particularly off-pump coronary artery bypass surgery, says Thomas Vassiliades, Jr, MD. Vassiliades practices at the Division of Cardiothoracic Surgery at Emory University School of Medicine in Atlanta.

"Every surgeon is aware that immediately after the induction of general anesthesia, patient temperature may drop by as much as 2 degrees C," he says. "In addition to the effects of general anesthesia on the body's thermoregulatory response, the prolonged exposure of vital organs to room temperature may cause a further drop in core body temperature."

This can be even worse for patients who are undergoing off-pump coronary artery bypass (OPCAB) grafting, since the open chest is exposed to room temperature air. This prolongs the extubation time and contributes to coagulopathy, since patients in this type of surgery cannot be immediately extubated unless they are warm, Vassiliades says.

"If you can't find an efficient device to keep the patient warm and at the same time stay out of your field, you have resolved that the patient will stay in ICU longer, which can compromise outcomes and increase costs," he adds.

Controlling temperature is not always easy. Conventional methods are sometimes inflexible and cannot be manipulated accurately enough, Vassiliades says. Warming the overall temperature of the operating room is a partial

solution, but it can make working conditions uncomfortable for the surgery team.

According to clinicians at the IHI, if the ambient temperature in the operating room is increased, humidity should also be increased to prevent the drying of staff member's eyes and skin.

Vassiliades has experimented with several pieces of equipment including sterile forced-air warming blankets, but feels they compromise an OPCAB surgeon's flexibility and field when used on the upper body, and that they are not effective on the lower body either. He now uses thermal pads and a standalone unit from Kimberly-Clark Health Care and is pleased with the results.

Caregivers are looking for commonsense solutions that adapt to their needs and environment, Judson says.

"There are a number of independent factors that have an effect on a patient's temperature during surgery, so it is less about having an optimal device and more about having the right strategy," he says. "For simple procedures, a patient gown, a blanket and comfortable room temperature may be sufficient to prevent hypothermia. Continuing up the scale, if fluids are administered, such as for irrigation or transfusion, they need to be warmed. A patient should never be given cold fluids during surgery."

Other options are forced-air warming and IV fluid warming. A lot of work is being done to improve both methods, according to Boothe. He believes that better methods are needed for complex surgeries such as cardiovascular, colorectal and orthopedic.

"One solution is direct conduction, which uses water to transfer energy to the patient," Judson says. "Water is nearly 1,500 times more efficient at carrying energy than air at the same temperature, therefore it is a good choice for challenging warming needs."

Products

There is only one direct-conduction product on the market, Boothe says, and that is the Kimberly-Clark Patient Warming System (K-C PWS). The system uses three-layer thermal pads that adhere to the patient's skin. The inner layer is made of a medical-grade, biocompatible "hydrogel" that is 50 percent water. The product is computer-controlled and can automatically sense when a patient's temperature is escaping a healthy zone.

"With this system, only about 20 percent of the patient surface area is required for adequate treatment," Boothe says. "Think of it as providing patients with the same comfort and warmth as a whirlpool, only in the form of a soft flexible pad."

Another method is the use of radiant energy, such as the SunTouch Patient Warmers from Fisher & Paykel Healthcare. The SunTouch warmers are for intra-, pre- and post-operative use as well as use in burn units and emergency rooms. The warmers are used on the face, hands or feet, and send heat through the entire body via the blood.

"They can be used in combination with other patient warmers, especially in major operations such as ... off-pump cardiac, liver transplants etc.," product literature states. "No contact or airflow is required between the warmer and patient for heat transfer because the heat energy is carried by photons, or electromagnetic waves, and does not depend on the intervening air or contact. In this respect it differs from all other cutaneous warmers that must be positioned adjacent to the skin surface."

Radiant warmers are versatile enough to be used in many sections of a healthcare facility. The infrared wavelength that the warmers admit is mostly in the infrared B range. Only a little is in the Infrared A range (more than that could be dangerous). The warmers provide heat similar to what is felt on a sunny day, but do not emit UV energy, product representatives say.

The SunTouch warmers alert the user if inadequate temperatures are being reached, and can shut themselves off. The reflector can be cleaned of blood and other material.

"Under the reflector are two screws which when removed allow the lower part of the heater to hang down so that the surface of the reflector and element can be cleaned," product representatives say. "The reflector and element of course run at elevated temperatures that render them sterile."

Another product — warm air blankets — are also useful for certain conditions and procedures. The WarmAir® system from Cincinnati Sub-Zero Medical Division uses a low-velocity blower to gently move clean air through such blankets.

All air is filtered through a 0.2 micron HEPA filter to prevent airborne bacterial contamination in critical areas, product literature claims. The warmed air is then filtered again as it leaves the blanket.

The WarmAir® system is equipped with a safety monitor that alerts caregivers if the temperature falls or rises above safe levels. The product weights about 13 pounds. The WarmAir ® unit can attach to operating room tables, stretchers, bed ends, side rails, or IV poles. The technology uses filtered air warming as opposed to forced air warming.

Fluid products and blankets that can be stored in varied environments are beneficial, according to Lois R. Lane of Entermics Medical Systems.

One Entermics product, the EC1730bl, is a dual-chambered warming cabinet with independent touch keypad controls. The upper fluid compartment holds up to 30 liters and can be set to warm either irrigation or injection fluids. The lower blanket chamber temperature can be set as high as 200 degrees F, which is up to 50 degrees F hotter than most other warmers and can therefore keep blankets warm longer, Lane says.

The fluid chamber is unique because it is a metal basket that pulls out from both sides. Because of window doors on both sides of the unit, the warmer can be placed through a wall.

Precautions

Forced air warming devices are widely used, but some are far better than others according to Richard Cooke, author of the paper, "Maintaining perioperative normothermia: forced air warming devices require risk assessments before use."

Not many evaluations of forced air warming devices have been published, Cooke says.

"This is of concern since these devices have the potential for both harm and good ..." he says.

In one of the rare evaluations that has been released, two warming systems were found to be the home of pathogenic organisms.

"However, the risk of infection was low, provided microbial filters were changed as specified by the relevant manufacturer and detachable hoses were decontaminated regularly," Cooke says. "In a study of an ultra-clean ventilation systems (it was) noted that warm air convection heaters produced a small increase in the number of colony-forming units in ultra-clean air but levels were unlikely to be clinically significant."

Product purchasers should regardless assess the risks of any forced air warming device, even though the risks are low, Cooke says. "The potential for harm to the patient is low provided manufacturer's instructions are followed and staff are suitably trained," he adds.

"Their use in ultra-clean theatres however needs to be evaluated further. Improper use can have serious consequences ... Traumatic thermal injuries have been reported from failing to properly attach the blanket to the hose."

Patient warming devices have come a long way since the days of a patchwork quilt, a bowl of steaming soup, and a fire in the hearth, but there is still room for improvement. That will long be the case, according to Boothe.

"There will always be room for better technology and improved devices," he says. "Plus, there is a lot we still need to learn about SSIs and the role temperature plays in prevention. Using temperature as a treatment modality will continue to evolve as we improve the science and application to better devices."

In the meantime, surgery teams will continue to experiment with the best products and procedures that are available.

References

1. F.A. Davis Company. Taber's Cyclopedic Medical Dictionary, Edition 19. 2001.
2. Cooke R. Maintaining perioperative normothermia; forced air warming devices require risk assessments before use. BMJ Publishing Group Ltd. June, 2003.