Editorial Commentary: Just Getting Warmed Up: Risks, Benefits, and Economics of Active Warming Devices

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Abstract: Efforts to maintain normothermia should be a part of every patient's perioperative care. Risks, benefits, and economic implications should be considered when deciding how to use active warming devices for orthopaedic surgery. The Centers for Medicare & Medicaid Services has implemented economic incentives and penalties driving hospitals to invest in active warming devices, including forced-air warmers and resistive heating devices. Even though forced-air warmers and resistive heating blankets are likely to statistically improve patient temperatures, they may not be worth the additional cost for shorter, less invasive, elective arthroscopic surgeries. In addition, recent research demonstrates minimal clinically significant differences between these 2 types of devices. Concern regarding possible increased risk of surgical-site contamination with forced-air warmers warrants further study but, again, is unlikely clinically relevant to arthroscopic cases, and proper staff training and warming equipment routine maintenance could minimize patient risk.

See related article on page 347

Perioperative hypothermia (<36°C) has been shown in numerous studies to increase surgical wound infection, increase blood loss and need for transfusion, increase perioperative cardiac events, and decrease anesthesia drug metabolism, leading to prolonged recovery.[1-5] Although hypothermia has clear adverse effects on physiology, the importance of maintaining normothermia with active warming devices in all orthopaedic cases is less clear. Specifically, patients undergoing relatively short, elective, arthroscopic procedures, with small incisions, and minimal blood loss may not benefit nearly as much from maintenance of normothermia as patients undergoing longer, open surgeries with greater blood loss.

Given the known adverse effects of hypothermia, the Centers for Medicare & Medicaid Services currently includes "Perioperative Temperature Management" as one of its core anesthesia measures of its 2019 Merit-Based Incentive Payment System. All surgeries greater than 60 minutes qualify, and the goal is to measure one body temperature greater than or equal to 35.5°C within the 30 minutes immediately before or the 15 minutes immediately after anesthesia end time. Exceptional performance can lead to an additional 0.5% in payments; poor performance can lead to negative payment adjustment of −4%. These economic incentives and penalties are driving hospitals to invest in active warming devices, including forced-air warmers and resistive heating devices, despite the additional cost.

Active warming devices, including forced-air warmers and resistive heating devices, although known to improve the ability to maintain normothermia, do not eliminate the incidence of hypothermia. Also, use of these devices carries some risk to patients, including burns and pressure sores.[6] More importantly, several articles have raised concerns surrounding possible increased risk of deep surgical-site infection with forced-air warming devices (Bair Hugger).[7-13] Some studies suggest these devices can create convection currents, disrupting laminar flow, and mobilizing floor air into the surgical site.[9-13] Other studies have shown that potentially pathogenic organisms grow in the hoses and filters of forced-air warming devices.[7,8] Conclusions, however, regarding the independent effect of warming devices on surgical-site contamination are uncertain because a number of these studies were funded by manufacturers of competing devices, underpowered, and poorly controlled.[14] Nonetheless, to reduce the risk of burns and the potential increased risk of infection, routine maintenance is recommend for forced-air warmers, including thorough temperature

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calibration and filter changes every 500 hours or 6 months.[14] With proper training, education, and maintenance, risk can be minimized with active warmers, and further study is warranted on the potential relationship between forced-air warmers and surgical-site contamination and infection.

In their article, "Prevention of Perioperative Hypothermia: A Prospective Randomized Control Trial of Bair Hugger Versus Inditherm in Patients Undergoing Elective Arthroscopic Shoulder Surgery," Ralte, Mateu-Torres, Winton, Bardsley, Smith, Kent, Sethuraman, and Guisasola[15] report the Bair Hugger (forced-air warming) was statistically better at preventing hypothermia than the Inditherm mattress (resistive heating device), although no clinically significant difference was observed. Looking closer at the results, at 60 minutes, the Bair Hugger group mean temperature was 35.9 $\pm$ 0.5°C and the Inditherm group mean temperature was 35.7 $\pm$ 0.5°C , and at 90 minutes, the Bair Hugger group mean temperature was 36.1 $\pm$ 0.5°C and the Inditherm group mean temperature was 35.6 $\pm$ 0.5°C. Although statistically significantly different at 90 minutes, the 0.5°C difference was quite small. The authors' conclusion, "The Bair Hugger was statistically significantly better at preventing hypothermia than the Inditherm mattress," although an accurate statement, may not reflect the entirety of their results. Both devices appear to help maintain normothermia.

Given the known adverse effects associated with hypothermia, efforts to maintain normothermia should be a part of every patient's perioperative care. Risks, benefits, and economic implications should be considered when deciding how to use active warming devices for orthopaedic surgery. Even though forced-air warmers and resistive heating blankets are likely to statistically improve patient temperatures, they may not be worth the additional cost for shorter, less invasive, elective arthroscopic surgeries. Concern regarding the possible increased risk of surgical-site contamination with forced-air warmers warrants further study but is unlikely clinically relevant to arthroscopic cases. Proper operating room staff training and active warming equipment routine maintenance is critical to minimize patient risk.

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