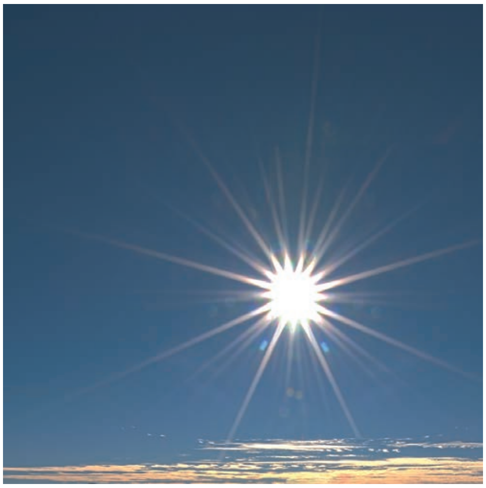
# The Heat Is On

## *Clinical Implications of Intraoperative Thermoregulation Research*

David A. Story, M.D., F.A.N.Z.C.A.



**"...surgical demands for both a cool operating room AND no forced-air warming appear inconsistent with good practice."**

"WILL somebody turn the temperature down!!!"

Every anesthesiologist has heard this request from surgical colleagues as we endeavor to give patients the likely clinical benefits[1–3] of active perioperative thermal management. While superficially these surgical demands appear to be only about the surgeon's personal comfort, the literature raises further points about the potential risks of warmer operating rooms, including decreased quality of surgical performance and sweat contaminating the surgical site.[4] The other principal warming strategy used in combination with, or as an alternative to, a warmer operating room is active warming; with forced-air warmers being the dominant current technology.[1] Surgical and infection control colleagues have, however, raised concerns that forced-air warmers may change operating room airflow patterns, which may in turn increase the risk of surgical site infection.[5] An important part of constructive engagement on the benefits and risks of thermal management is to better quantitively understand thermal interactions between warming modalities.

In this edition of Anesthesiology, Pei *et al.*[6] report on a randomized trial examining the interactive effects of operating room temperature (19, 21, or 23°C) and forced-air warming, in a 3 × 2 factorial design. Pei *et al.*[6] provide new quantitative insights into this interaction. Patients were undergoing predominantly open thoracic or abdominal surgery in a leading Chinese hospital. The generalizability of the results may be tempered because intravenous fluids were not actively warmed (perhaps of limited importance[7]), and few patients were obese. Further, patients assigned to passive insulation were covered with a cotton gown and single layer of cloth surgical draping which may vary from passive insulation practice elsewhere.[8] The primary outcome was the relationship between ambient temperature level change and intraoperative core temperature rate of change (°C/h) per hour expressed as $°C_{core}/(h/°C_{ambient})$ during the second and third hours of surgery. This is the period where heat gain and heat loss, rather than redistribution of heat, are the predominant factors governing patient temperature changes. The metric $°C_{core}/(h/°C_{ambient})$ is more clearly stated as an increase in patient core temperature in degrees Celsius, per hour, per degree Celsius increase in operating room temperature. Another way to look at the question is: as the operating room temperature becomes colder, how much greater is the rate of decrease in patient core temperature, with or without active warming?

Pei *et al.*[6] randomized 292 patients into six groups of approximately 48 patients each. They measured patients' core temperature using sublingual thermometers. The authors found that there was minimal interaction between patient temperature and operating room temperature in the actively warmed groups. In contrast, the insulation-only groups had greater rate of temperature decrease in the colder operating rooms with a significant CI: mean increase in rate of decrease of $0.03°C_{core}/(h/°C_{ambient})$. Of note, this change in the rate of change was less than the authors anticipated. I suspect the quantitative importance of this primary result is unlikely to be intuitively obvious to most anesthesiologists, and therefore, application to clinical practice is unclear. Of greater quantitative use is figure 4 in the Pei article, which shows that during this linear phase, an insulated patient will have a decrease of about 0.18°C/h if the operating room is 19°C compared to only 0.05°C at 23°C, and that patients who are actively warmed may have a slight increase in temperature of about 0.05°C/h.

Of further clinical interest is the actual temperature of patients in the study. Figure 3 in the Pei article is striking

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for the different trends among the six groups. Of note is the degree of temperature drop in the redistribution phase in the different insulated only groups, particularly the 19°C group. Unfortunately, one point that is hard to discern from the article by Pei *et al.*[6] is how many patients had a final temperature greater than or equal to 36°C. This core temperature level is widely touted as a lower limit of perioperative normothermia[9] associated with the likely benefits of active thermal management. In the United States, the Surgical Care Improvement Project for Body Temperature Management (SCIP Inf-10)[2] and the National Institute of Clinical Excellence (NICE) in the United Kingdom[10] base clinical actions and assessing quality of care around a temperature of 36°C. However, while 36°C is suggested as a clear line in the sand, it is also a rather arbitrary cut off for perioperative normothermia that has been derived from clinical trials of warming strategies.[3,9] Further, while $°C_{core}/(h/°C_{ambient})$ may be a bit esoteric for some, there is increasing evidence that severity and duration of hypothermia throughout surgery may be clinically important.[9] Therefore, some sort of time weighted average temperature or duration and extent of hypothermia (possibly less than 36°C) may become important in assessing risk (notably infection) and quality of clinical care. In the current study,[6] a line drawn across the 36.0°C mark in figure 3, a graph of temperature *versus* time, gives insight into how these results would look. Passive insulation at 19°C may not pass muster.

Further information about the 36°C threshold can be derived[6]: the three warmed groups tracked closely with a final mean temperature of 36.3°C (SD 0.5°C). However, in the passively insulated 19°C group, the mean final temperature was 35.6°C (SD 0.6°C), while the 23°C group had a mean core temperature of 36.1°C (SD 0.5°C), half a degree higher. Therefore, using normal distribution curves for warmed patients, irrespective of operating room temperature, fewer than 15% of actively warmed patients had a final temperature less than 35.8°C. However, in the 19°C insulated group, about 85% of patients had a final temperature less than 35.9°C, while in the 23°C group, only 30% of patients had a temperature less than 35.7°C.

So how to apply this study to practice? What are the implications of the interactions on decreases in patient temperature? The effectiveness of forced-air warming largely eliminated interaction with operating room temperature and was associated with small increases in patient temperature. However, a 19°C operating room with passive cotton insulation and no forced-air warming was associated with many patients having hypothermia throughout surgery. Further, at 19°C the anticipated cooling may be about 0.2°C/h. Therefore, given this pattern of interaction, surgical demands for both a cool operating room AND no forced-air warming appear inconsistent with good practice. The randomized results of Pei *et al.*[6] reinforce the apparent effectiveness of forced-air warming in maintaining temperature and support practical advice from NICE in the United Kingdom, who advise that in addition to warming patients preinduction: 1) the ambient (operating room) temperature should be at least 21°C while the patient is exposed; 2) once active warming is established, the ambient temperature may be reduced to allow better working conditions; and 3) using equipment to cool the surgical team should also be considered. All in all, ensure the heat is on.

## Competing Interests

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## Correspondence

Address correspondence to Dr. Story: dastory@unimelb.edu.au

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