The majority of readers of this journal have probably spent most of their professional lives in the Information Age. The Information Age started in 1975 and a major attribute is the near-instantaneous transmission of large quantities of information.\(^1\) We see this daily with the many uninvited email messages from sources that are selling or endorsing products and services ranging from apples to zoos.

Recently we have been presented with evidence,\(^2\) sometimes unsolicited evidence sent to us electronically by manufacturers,\(^3\) on the role of forced-air warmers in causing surgical site infections. Of particular concern are surgical site infections in patients undergoing total joint replacement.\(^4\) Deep infections in patients receiving a prosthetic implant can be particularly devastating.\(^5\) There has been at least 1 legal suit where the plaintiff who suffered a surgical site infection after a total joint replacement implicated the forced-air warmer as a cause of the infection.\(^6\)

### Inadvertent Perioperative Hypothermia

Inadvertent perioperative hypothermia (≤36°C or ≤96.8°F) is a common problem seen in surgical patients. Contributing factors include the cold ambient temperature in the operating room and anesthetics and adjuncts interfering with temperature regulation mechanisms. Other reasons include the use of cold intravenous and irrigation fluids.\(^7\)

The effects of hypothermia vary. Feeling cold is very uncomfortable for the patient pre- and post-operatively. Hypothermia can lead to increased myocardial oxygen demand due to shivering, coagulopathy, and prolonged hospitalization.\(^7\) The effects of inadvertent perioperative hypothermia have been studied in subjects undergoing laparotomy\(^8\) and clinicians have used these results in caring for other surgical patients.

Methods used to combat inadvertent perioperative hypothermia include the use of warm cotton blankets, reflective blankets, warmed intravenous and irrigation solutions, and circulating warm water mattresses.\(^9\) A reusable electric blanket has been also introduced that uses a resistive polymer blanket covered by a polypropylene sheet.\(^10\) For over 2 decades we have relied on using forced-air warmers to address this problem due to their efficacy.\(^11\)

Paradoxically, do forced-air warmers play a role in causing surgical site infections?

### Forced-air Warmers and Surgical Site Infections

We published an evidence-based review examining the role of forced-air warmers in causing surgical site infections in 2014.\(^12\) I urge you to take a look at the paper for yourself but will summarize the major points. Using a search strategy, 15 of 192 possible evidence sources fit our inclusion criteria. There were 3 trials examining surgical site infections in surgical subjects where forced-air warmers were used peripherally. Authors of the remaining sources used indirect methods to help determine the role of forced-air warmers in causing surgical site infections.
These indirect methods included looking at unwanted airflow disturbances, examining the forced-air warmer hoses and air emitted from the forced-air warmer for particles and pathogen and evaluating bacterial counts near on real or simulated patients. We included this indirect evidence in our review due to the small amount of direct evidence.

It is not surprising that there were no large multicenter, randomized controlled trials examining this problem. In 2 (n = 16 to 30) of the 3 trials, there were no surgical site infections. Authors of the remaining trial reported a reduction of surgical site infections in subjects undergoing total joint replacements when a reusable electric warming blanket (intervention, n = 371) was used rather than a forced-air warmer (control, n = 1066). The study was conducted over 2 years. In the first portion of the study a forced-air warmer was used. A carbon fiber warming blanket was used in the latter part of the study. The effect of history is not known due to the use of historical controls. Other factors not taken into consideration included the overall physical status of the subjects and incidence of patient incontinence and blood transfusions.

The indirect evidence suggested that while forced-air warmers can harbor pathogens, when maintained and used per the manufacturer’s directions there was little risk of forced-air warmers playing a role in causing surgical site infections. The authors of studies examining unwanted airflow disturbances in laminar flow operating rooms reported conflicting findings. Some reported the air currents produced by forced-air warmers could foster the flow of dust particles possibly containing bacteria towards the surgical site. Other authors did not observe this unwanted airflow.

We found no conclusive evidence that forced-air warmers increase the incidence of surgical site infections and suggested these devices should continue to be maintained and used according to the manufacturer’s directions. Due to the importance of this problem and the implications of these findings, the journal where our paper was published reviewed our paper twice before approving it for publication.

The results of a review by the ECRI Institute agreed with our findings. The ECRI Institute is an independent nonprofit organization with a long history of testing medical devices. Their review was based on 4 studies, all of which were included in our review. The ECRI group concluded there was insufficient evidence to suggest the use of forced-air warmers leads to surgical site infections. ECRI noted that the manufacturer of a device competing with forced-air warmers used findings in their review found in materials such as press releases. The editor of the ECRI publication where the review was published cautioned clinicians to read the article and not rely on reports of the article published by manufacturers. This is sage advice.

A third review published in 2014 also examined the role of forced-air warmers in causing surgical site infections in patients undergoing total joint replacement. Unfortunately, the authors did not describe their search strategy or appraisal methods. They examined the results reported in “10 important papers” regarding the use of forced-air warmers in the operating room. One of these was declared not applicable to the problem. The remaining 9 sources were included in our review. These authors concluded it was important to take steps to reduce surgical site infections. They also concluded that while forced-air warmers can produce unwanted airflow, its effect on surgical site infections in patients undergoing total joint surgery has yet to be established in rigorous studies. They suggested clinicians consider using alternative warming methods for patients undergoing total joint replacement until further definitive studies can be done. Notably, these authors recommended “some caution in condemning forced-air warmers should be observed.”

**Conclusion**

This question of the role of forced-air warmers in causing surgical site infections, especially in patients undergoing total joint replacement, is best addressed by a large randomized controlled trial with appropriate blinding. Since surgical site infections are rare events, this is a difficult study to conduct and will take substantial time and funding. A high quality observational study may be an alternative, however steps must be taken addressing potential confounding factors. Until then, what should we do?

First and foremost, we need to read and appraise the evidence published in peer-reviewed journals. As evidence-based practice practitioners, we owe this to our patients. However well meaning, the interpretation of the evidence by manufacturers may be biased.

We should work with our other nursing colleagues and surgeons to ensure we are taking other steps to reduce surgical site infections. These steps include limiting traffic in the operating room and proper antibiotic prophylaxis, skin preparation, and surgical technique. The incidence of surgical site infection should be continuously monitored and regularly reported to all of the stakeholders.

When used, forced-air warmers should always be meticulously maintained and used according to the manufacturer’s directions. This includes proper cleaning of the unit, changing the air filter per the manufacturer’s directions, and only using the forced-air warmer with the manufacture-approved coverlet. Manufacturers should investigate designs facilitating easier cleaning of these devices.
It is not unreasonable to consider using other methods to warm patients, including patients undergoing total joint replacements. The implications of using an alternative device must be considered especially when abandoning the use of forced-air warmers when the results of 3 reviews did not support ending the use of these devices. These implications go beyond the cost and efficacy of an alternative device. Is the device sufficiently easy to use and comfortable for the patient so its use is adopted? What is the evidence supporting claims that an alternative device is not a vector for pathogens?

While the current evidence on the benefits of forced-air warmers appears to outweigh the risk, we must keep an open mind. The gains made in the Information Age will help get new information about the use of forced-air warmers to us quickly and conveniently. However, we must use our skills as evidence-based clinicians to assess this evidence for ourselves.

REFERENCES


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