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Optimizing Perioperative Temperature Management: The Case for Warm Irrigation in Orthopedics

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ABSTRACT

Background: Surgical procedures, particularly in orthopedics, carry the risk of intraoperative hypothermia, which is associated with increased complications such as infection, bleeding, and prolonged recovery. Maintaining normothermia using warmed irrigation solutions and intravenous fluids has demonstrated significant benefits, including reduced postoperative pain and infection rates and shorter hospital stays. This manuscript reviews the current evidence supporting the use of warm saline solutions to improve perioperative patient conditions.

Methods: A literature search was conducted using PubMed, Embase, and Google Scholar.

Results: Analysis of available studies suggests that warmed irrigation effectively reduces the incidence of hypothermia and may decrease surgical site infection rates and postoperative shivering in patients undergoing orthopedic surgery.

Conclusion: Warm irrigation is a simple, cost-effective strategy for improving temperature management and enhancing patient outcomes during orthopedic surgery.

Background

Perioperative hypothermia, defined as a core body temperature below 36.0°C, is a common and potentially serious complication in surgical patients, increasing the risk of adverse outcomes such as surgical site infections and prolonged recovery.[1,2]

Hypothermia is broadly defined as a body core temperature of less than 36.0°C, although normal core temperature is closer to 37°C.[2-4] It can be further classified as mild (34°C-36 °C), moderate (32°C-34 °C), and severe (<32°C).[5]

The incidence of perioperative hypothermia has been reported to range between 14 and 70% of patients having surgery;[1,2,6] and it is most commonly seen during anesthesia induction (redistribution period).[2] Perioperative hypothermia therefore results from a combination of impaired thermoregulation due to anesthetics and exposure to the cold environment of the operating room.[7-9]

Cellular functions, including enzyme activity, are temperature-dependent; therefore, hypothermia may lead to altered drug metabolism, leading to delayed emergence from anesthesia.[9] Important drugs affected by hypothermia are nondepolarizing muscle relaxants (results in prolonged duration of action), propofol and fentanyl (increase in plasma concentration due to reduced hepatic blood flow).[10-11]

Perioperative hypothermia affects the host defense mechanism against infection by vasoconstriction, which reduces tissue oxygen partial pressure and impairs tissue healing and protein metabolism.[2-9]

In orthopedic surgery, where procedures can involve large incisions and prolonged exposure of tissues to a cold temperature environment or cold irrigation solutions, the risk of hypothermia can be particularly pronounced. Traditional strategies for preventing perioperative hypothermia may not always be sufficient. Warmed irrigation solutions have emerged as a potential adjunct to these techniques, offering a means of directly delivering heat to the surgical sites. This literature review aims to synthesize the current evidence regarding the options for the management of perioperative hypothermia, focusing on the use of warmed irrigation solutions in orthopedic surgery, examining its role in perioperative temperature management and its impact on patient outcomes.

Methods

We conducted a literature review with a defined search strategy to identify articles relevant to the use of warmed irrigation and intravenous fluids during orthopedic surgery. This included a search of PubMed, Embase, and Google Scholar from January 1990 to July 2025. The search terms included warm[All Fields] AND ("therapeutic irrigation"[MeSH Terms] OR ("therapeutic"[All Fields] AND "irrigation"[All Fields]) OR "therapeutic irrigation"[All Fields] OR "irrigation"[All Fields]) AND ("solutions"[Supplementary Concept] OR "solutions"[All Fields] OR "solutions"[MeSH Terms]) AND ("orthopaedic"[All Fields] OR "orthopedics"[MeSH Terms] OR "orthopedics"[All Fields] OR "orthopedic"[All Fields]) AND ("hypothermia"[MeSH Terms] OR "hypothermia"[All Fields]).

The exclusion criteria encompassed letters, editorials, case reports, animal studies, and studies identified as having poor designs or low evidence levels. The references of the selected full-text articles were examined to include additional relevant articles. The authors critically appraised all selected articles.

Results

Mild hypothermia during surgical procedures is associated with several adverse outcomes, including an increased risk of requiring blood transfusions. A meta-analysis by Rajagopalan et al. demonstrated that hypothermic patients had an approximately 22% higher likelihood of requiring transfusions than normothermic patients.[12] This increased transfusion requirement can be attributed to the physiological effects of hypothermia on blood coagulation and platelet function. Additionally, hypothermia often leads to shivering, an autonomic thermoregulatory response aimed at generating body heat. Shivering not only increases oxygen consumption but also causes significant discomfort to patients in the postoperative period.[13-15]

The occurrence of perioperative hypothermia is largely preventable, and its management has become a focus of perioperative care.[2,16-19] Beyond the immediate effects of increased transfusion risk and shivering, hypothermia is associated with an elevated risk of surgical site infections. Some studies, such as that by Kurtz et al., have reported up to a three-fold increase in the infection risk among hypothermic patients.[20] However, it is important to note that the relationship between hypothermia and surgical site infections remains a subject of debate, with some researchers, such as Liedl et al., finding no significant association.[21] These conflicting findings underscore the need for further research to elucidate the complex relationship between perioperative temperature management and the postoperative outcomes.

Accurate measurement of the core body temperature is crucial for monitoring and managing perioperative hypothermia. The most reliable methods include the use of a Swan catheter in the pulmonary artery or probes placed in the distal esophagus, nasopharynx, or tympanic membrane.[2,9,22] Prewarming patients before anesthesia induction mitigates the redistribution effect of anesthetic drugs, thereby reducing the risk of redistribution hypothermia.[22] This approach helps to maintain a more stable core temperature throughout the surgical procedure.

Perioperative warming strategies can be categorized into passive insulation and active warming methods.[2] Passive insulation, such as blankets or reflective coverings, aims to reduce heat loss but does not actively increase the patient's core temperature.[22] In contrast, active warming systems, particularly forced air warming, have been shown to reduce surgical site infections and

cardiovascular complications.[23] Interestingly, studies have not found significant differences in the hypothermia prevention efficacy among various types of active warming systems.[23-24] This suggests that the implementation of any active warming method may be beneficial, allowing healthcare providers to choose based on availability, cost-effectiveness, and comfort.

The use of warm irrigation solutions in arthroscopic procedures has been the subject of ongoing research, with mixed results owing to the diverse methodologies employed across studies. Our research, published in 2014 and 2012,[25-26] demonstrated that the use of irrigation solutions warmed to 32°C, in conjunction with a forced-air warming device during hip arthroscopy, effectively prevented hypothermia and reduced the incidence of postoperative shivering. These findings align with those of other studies that have explored the benefits of warm irrigation solutions in knee and shoulder arthroscopy,[27-28] suggesting a potential trend in the efficacy of this approach across different joint procedures.

Some studies have not found a statistical difference with the use of heated irrigation, such as Ahmet Fırat et al., who compared the use of a heated irrigation solution 36°C-38°C vs a room temperature irrigation solution for hip arthroscopy and found no difference in the incidence of hypothermia (53.3% in the heated irrigation group vs 42.9% in the room temperature irrigation group, p=0.425).[29]

The positive outcomes observed in our study and others focusing on warm irrigation solutions are comparable to the benefits of using warm intravenous fluids in various orthopedic procedures.[19] This similarity in results across different warming methods and surgical contexts indicates that maintaining patient temperature through various means may be crucial for improving surgical outcomes and patient comfort.

Another potential advantage of using warmed irrigation solutions is their possible beneficial impact on articular cartilage and chondrocytes, as indicated by a systematic review conducted by Sardana et al.[19]

However, the heterogeneity in study designs and specific methodologies used across the field necessitates further standardized research to definitively establish the optimal temperature and application methods for warm irrigation solutions in arthroscopic procedures.

Future research should focus on quantifying the cost-effectiveness of warmed irrigation solutions, identifying optimal temperature ranges for different surgical procedures, and evaluating their impacts on long-term outcomes, such as joint function and patient-reported quality of life. Additionally, multicenter studies could provide further evidence to support the widespread adoption of this practice and refine the guideline.

Conclusion

In conclusion, our experience and the current literature advocate the routine use of warmed irrigation solutions during orthopedic surgeries as a safe, effective, and economically sound approach to enhance perioperative care. By integrating this simple yet impactful strategy into standard surgical protocols, healthcare providers can optimize patient outcomes and contribute to a more efficient and patient-centered healthcare system.

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