G46: Does intraoperative normothermia influence the rate of subsequent Surgical Site Infection (SSI)/ Periprosthetic Joint Infection (PJI) in major orthopedic surgery?

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Response/Recommendation:
The available evidence was inconclusive for maintaining normothermia as a measure to reduce the risk of SSI/PJI, and fracture-related infection (FRI) in adult patients undergoing major orthopedic surgeries. However, we suggest maintaining normothermia primarily as a measure to reduce the risk of 30-day mortality in major orthopedic surgeries.

Strength of recommendation: Limited

Delegate Vote:

Rationale:

Inadvertent perioperative hypothermia has been associated with clinical complications such as surgical site infection, increased bleeding, and cardiovascular events [1-3]. Several well-designed studies have attributed a substantial decrease in SSI rates in colorectal and non-orthopaedic clean surgeries to normothermia [4,5]. Therefore, current guidelines [1-3] recommend maintaining perioperative normothermia to reduce the risk of SSIs and other complications associated with surgery. There is a paucity of published literature regarding normothermia in orthopaedic procedures, however.

We conducted a meta-analysis to clarify the efficacy of normothermia over hypothermia in reducing SSI in major orthopaedic surgery, including spine surgery, fracture surgery and joint arthroplasty. Following ICM guidance, we searched MEDLINE (via PubMed), CENTRAL, and EMBASE for all RCTs and observational studies including longitudinal/cohort studies, case-control studies, controlled before-and-after studies, and cross-sectional studies published through Nov 2024 that reported the outcome of the surgical patients. We included all adult patients with primarily closed surgical incisions after spine surgery, trauma/fracture surgery, and joint arthroplasty of any joint, both with or without implants. We also included fracture fixation for open fracture if the wound was primarily closed as well as outpatient, emergent, elective, and revision surgery.

Of the 1,353 articles that were subjected to title and abstract screening, we shortlisted 43 articles for full-text screening. We excluded 33 articles and added 1 article per a hand search. The remaining 11observational studies were included in our final analysis [6-16]. Meta-analysis was performed using R version 4.4.1. When both crude and adjusted ORs were reported in the original articles, adjusted ORs were used for the main synthesis. We used a random-effects model. Risk of bias was evaluated using the Quality In Prognosis Studies (QUIPS) tool [17] for observational studies. We used GRADE (Grading of Recommendations Assessment, Development and Evaluation) to evaluate the certainty of the evidence and created a summary of findings table to describe the results [18].

Eleven observational studies comparing normothermia vs. hypothermia with an outcome of SSI/PJI/FRI were evaluated. Evidence was available from various countries including Mexico, Japan, France, USA, China, Canada, UK, and Italy on various surgical procedures including

spinal procedures, total hip/knee/shoulder arthroplasty, osteotomies for deformity corrections, arthroscopy, fracture surgeries, bone tumor resections, and soft tissue surgeries. All studies were published between 1999 and 2024. The definition of normothermia varied among studies ranging from ≥35-36.5°C. Four studies used CDC's criteria for the definition of SSI/PJI [10-12,14] whereas 2 studies did not describe their definition [7,9]. The follow-up period varied among studies.

Based on our analysis, hypothermia failed to show an association with increased incidence of all SSI/PJI/FRI in patients undergoing major orthopedic surgeries with primarily closed surgical incisions as compared to normothermia (OR 1.22; 95% CI 0.78-1.92, very low certainty of the evidence). The evidence, however, was interpreted as inconclusive given the large heterogeneity (I^2 of 69%) and wide confidence intervals that included both clinically-relevant and non-relevant effects. The possible influence of publication bias was considered to be small given that the comparison-adjusted funnel plot did not show significant asymmetry (Egger's test: P=0.27). This finding was consistent with our sensitivity analyses including studies with ≥30 days follow up (OR 1.22; 95% CI 0.78-1.92), and when including studies with multivariate analysis only (OR 1.31; 95% CI 0.72-2.35). Similar results were seen in our subgroups focusing on clean surgery (OR 1.14; 95% CI 0.65-2.00), definition of normothermia of ≥36°C, high income country, middle income country, and elective surgery. Only trauma surgery showed a significant association with increased incidence of SSI/FRI with hypothermia (OR 2.41; 95% CI 1.49-3.91).

For the secondary outcomes, which were based on very low-certainty evidence, the results were inconclusive as to whether hypothermia was associated with an increased incidence of superficial SSI, deep & organ/space SSI, urinary tract infection, respiratory tract infection, cerebral cardiovascular events, and blood transfusion. Hypothermia was, however, significantly associated with all-cause death within 30 days after surgery with low certainty of the evidence (OR 4.55; 95% CI 2.26-9.18).

Although the results were inconclusive for the association between hypothermia and increased SSI incidence in the overall population, the results showed that maintaining normothermia was significantly associated with decreased risk of 30-day mortality in major orthopedic surgery. Therefore, despite the uncertainty regarding impact on SSI, we recommend following the general principle of maintaining normothermia recommended in various guidelines [1-3] for major orthopedic surgeries in adults.

There are several limitations to this meta-analysis. First, all of the studies evaluated were observational studies with various definitions for SSI and normothermia with various follow up periods. These heterogeneities and the nature of observational studies may have affected our results. Second, although there was a significant association with 30-day mortality, the number of observational studies evaluating mortality was very limited. Third, as we did not include a pediatric population, reproducibility and generalization of this population may be limited. Fourth, there are three important phases (pre-, intra-, and post-operative) for maintaining normothermia, but the association between these phases were not evaluated. Fifth, there are several active body surface warming systems considered useful for preventing inadvertent hypothermia, but the effect of these different systems was not evaluated.

Conclusion:

Based on our results, we suggest maintaining normothermia primarily as a measure to reduce the risk of 30-day mortality in adult patients undergoing major orthopedic surgeries. The evidence for maintaining normothermia to prevent SSI/PJI/FRI was inconclusive. Therefore,

more robust, well-designed trials with larger sample sizes and standardized surgical protocols (eg. same definition for normothermia/SSI and adequate follow-up period) are needed to further evaluate the effectiveness of SSI prevention.

References

1. National Institute for Health and Care Excellence (NICE). Surgical site infections: prevention and treatment. Published: 11 April 2019, Last updated: 19 August 2020. Available from: https://www.nice.org.uk/guidance/ng125/resources/surgical-site-infections-prevention-and-treatment-pdf-66141660564421

2. World Health Organization. Preventing surgical site infections: imple mentation approaches for evidence-based recommendations. Geneva: World Health Organization; 2018. Available from: https://www.who.int/ publications/i/item/9789241514385.

3. Berrios-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for disease control and prevention guideline for the pre vention of surgical site infection, 2017. JAMA Surg. 2017;152(8):784–91

4. Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical–wound infection and shorten hospitalization. Study of Wound Infection and Temperature Group. N Engl J Med. 1996;334:1209-1215.

5.Melling AC, Ali B, Scott EM, Leaper DJ. Eff ects of preoperative warming on the incidence of wound infection after clean surgery: a randomised controlled trial. Lancet. 2001;358:876–880.

6. Frisch, Nicholas B. and Pepper, Andrew M. and Jildeh, Toufic R. and Shaw, Jonathan and Guthrie, Trent and Silverton, Craig Intraoperative hypothermia during surgical fixation of hip fractures. Orthopedics. 2016 Nov 1;39(6):e1170-e1177.

7. Reina, N. and Fennema, P. and Hourlier, H. The impact of mild peri-operative hypothermia on the effectiveness of tranexamic acid in total hip arthroplasty. Int Orthop. 2017 Jan;41(1):55-60.

8. Jildeh, Toufic R. and Okoroha, Kelechi R. and Marshall, Nathan E. and Amato, Chad and Trafton, Hunter and Muh, Stephanie J. and Kolowich, Patricia The effect of intraoperative hypothermia on shoulder arthroplasty. Orthopedics. 2018 Jul 1;41(4):e523-e528.

9. Williams, M. and El-Houdiri, Y. Inadvertent hypothermia in hip and knee total joint arthroplasty. J Orthop. 2018 Jan 20;15(1):151-158.

10. Dyck, Myrna and Embil, John M. and Trepman, Elly and Bohm, Eric Surgical site infection surveillance for elective primary total hip and knee arthroplasty in Winnipeg, Manitoba, Canada Am J Infect Control. 2019 Feb;47(2):157-163.

11. Yamada, K. and Nakajima, K. and Nakamoto, H. and Kohata, K. and Shinozaki, T. and Oka, H. and Yamakawa, K. and Matsumoto, T. and Tokimura, F. and Kanai, H. and Takeshita, Y. and Karita, T. and Tajiri, Y. and Okazaki, H. and Tanaka, S. Association Between Normothermia at the End of Surgery and Postoperative Complications Following Orthopedic Surgery. Clin Infect Dis. 2020 Jan 16;70(3):474-482.

12. Hu, Q. and Zhao, Y. and Sun, B. and Qi, W. and Shi, P. Surgical site infection following operative treatment of open fracture: Incidence and prognostic risk factors. Int Wound J. 2020 Jun;17(3):708-715.

13. Vicentini, Costanza and Corradi, Alessio and Scacchi, Alessandro and Elhadidy, Heba Safwat Mhmoued Abdo and Furmenti, Maria Francesca and Quattrocolo, Francesca and Zotti, Carla Maria. Impact of a bundle on surgical site infections after hip arthroplasty: A cohort study in Italy (2012–2019). Int J Surg. 2020 Oct;82:8-13.

14. Charles-Lozoya, S. and Cobos-Aguilar, H. and Manilla-Muñoz, E. and De La Parra-Márquez, M. L. and García-Hernández, A. and Rangel-Valenzuela, J. M. Survival at 30 days in elderly patients with hip fracture surgery who were exposed to hypothermia: Survival study. Medicine (Baltimore). 2021 Oct 1;100(39):e27339.

15. Abugri BO, Matsusaki T. Ren W, Morimatsu H. Intraoperative hypothermia is not associated with surgical site infections after total hip or knee arthroplasty. Acta Med Okayama. 2022 Dec;76(6):651-660.

16. Liedl, H. J. C. and Lazenby, K. A. and Arimoto, R. S. and Singh, A. and Strelzow, J. A. Normothermia to Decrease Surgical Site Infection Risk: Silver Bullet or Fool's Gold? A Retrospective Cohort Study J Am Acad Orthop Surg Glob Res Rev. 2024 Jun 14;8(6):e23.00227.

17. Hayden JA, van der Windt DA, Cartwright JL, et al. Assessing bias in studies of prognostic factors. Annals of internal medicine 2013;158(4):280-86.

18. Guyatt G, Oxman AD, Akl EA, Kunz R, Vist G, Brozek J, et al. GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. J Clin Epidemiol. 2011;64(4):383–94.