Does the Magnitude of Intraoperative Hypothermia Affect Surgical Outcomes in Hip Fracture Fixation?

Henry O. Morar, BS[1], Alex Stratton, BS[1], Huaqing Zhao, PhD[1], Sharon S. Ashok, MD[2], Saqib Rehman, MD[2]
[1]Lewis Katz School of Medicine, Philadelphia, PA, USA
[2]Department of Orthopaedics and Sports Medicine, Temple University Hospital, Philadelphia, PA, USA
Henry.morar@temple.edu

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Introduction: Intraoperative hypothermia, defined as a patient's core body temperature <36°C during surgery, is a well-established contributor to adverse surgical outcomes, including impaired immune function, coagulopathy, and delayed wound healing.[1,2] Hip fractures among the elderly carry a high morbidity and mortality burden.[1-3] The presence of intraoperative hypothermia in surgery exacerbates these outcomes and carries with it unique risks, such as increased transfusion needs, surgical site infection rates, readmission rates, and length of stay.[2,3] Prior literature has investigated hypothermia as a binary variable, treating any reading of hypothermia at various time points (intraoperative, immediate pre-op, immediate post-op) as an indicator of hypothermia and utilizing various temperature monitoring methods to do so.[2-4] This leaves the question of whether the magnitude of intraoperative hypothermia is correlated to the severity of adverse outcomes in the elderly population.

Methods: Following IRB approval, we identified 1721 patients who underwent hip fracture fixation surgery by Temple University Hospital Orthopedics Department from January 1, 2018, to January 1, 2025, by relevant CPT and ICD-10 codes. After excluding patients who were not monitored via high precision temperature monitoring devices, those under the age of 55, and fractures due to high energy trauma, malignancy, infection, and prior device failures, we were left with 102 hypothermic patients aged 55-89 who experienced varying levels of hypothermia. We then calculated, for each patient, the magnitude of hypothermia (deficit × time) as the area under the curve <36°C (AUC <36°C) from induction to the end of surgery, using Python v3.13. Preoperative covariates such as age, BMI, sex, ASA status, preoperative hemoglobin, time till surgery, surgical duration, fracture type, antibiotic timing, the presence of intraoperative warming device and fixation method were recorded. Outcome variables included transfusion requirements, 30-day readmission, blood loss, length of stay, post-operative infection, 30-day mortality, and 1-year mortality. As a control, we collected 102 randomized patients who maintained intraoperative normothermia (>36°C) and examined outcomes for comparison. Continuous variables were compared using t-tests, and categorical variables with chi-square or Fisher's exact tests as appropriate. Multivariable logistic regression evaluated the independent effects of intraoperative hypothermia and AUC <36°C on binary outcomes, and linear regression was used for continuous outcomes.

Results: There were no significant differences in preoperative hemoglobin, age, BMI, sex, ASA status, fracture type, or fixation method between the hypothermic and normothermic cohorts. However, the time from hospital arrival to entry into the surgical suite was significantly longer among hypothermic patients, who waited an average of 49.03 hours compared to 35.03 hours in the non-hypothermic group ($p = 0.01$). Likewise, intraoperative warming device use ($p = 0.051$) and administration of antibiotics within one hour of surgery ($p = 0.058$) demonstrated a trend toward lower frequency in the hypothermic cohort. On univariate analysis, the presence of any magnitude of hypothermia was associated with a significant increase in the incidence of intraoperative blood transfusion ($p=0.017$). In multivariate analysis adjusting for time-to-surgery, warming device use, and antibiotic timing, hypothermia was independently associated with intraoperative transfusion (OR 3.60, 95% CI 1.28–10.08, $p = 0.015$). In sex-stratified models adjusting for wait time, antibiotic timing, and warming device use, greater AUC was associated with increased intraoperative transfusion needs in women (AOR 1.016, 95% CI 1.001–1.031; $p=0.031$). Effects in men were directionally similar but not statistically significant, likely reflecting limited power.

Discussion: Outcomes from this study demonstrated that in a balanced cohort of patients undergoing hip fracture fixation for low energy trauma, the presence of intraoperative hypothermia was associated with an increased need for intraoperative blood transfusion, corroborating findings from prior literature.[2-4] However, we did not find any difference in readmission rates, 72-hour post-operative transfusion rates, mortality rates, infection rates, blood loss, or length of stay, on univariate or multivariate analysis with the presence of hypothermia. Sex stratification revealed a significant association between increasing magnitude of hypothermia and need for intraoperative transfusion in women. Though our stringent methods limited our power and sample size, the results appear robust and generalizable to the broader population as hip fracture fixation for low energy "fall from seated" or "fall from standing" mechanisms carry a high morbidity and mortality and are prevalent and unique to the elderly demographic. As there is no standardized definition for the magnitude or clinical relevance of intraoperative hypothermia, research often categorizes hypothermia based on a single time point, such as the first, last, lowest, or average recorded temperature. These measures may fail to account for the duration, timing, or pattern of thermal fluctuation under anesthesia. The present study sought to establish a rigorous and replicable framework to minimize the effects of temperature variation.

Significance: As the population ages, it is important to understand mechanisms that exacerbate adverse surgical outcomes in an at-risk demographic and work to mitigate the variables within the operative team's control. This study provided insight into how the magnitude of intraoperative hypothermia affects surgical outcomes of the elderly during hip fracture fixation.

References:

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