# L'IMPACT DE LA TEMPERATURE DES FLUIDES INTREVEINEUX SUR L'ETAT HEMODYNAMIQUE, LES FRISSONS POST-OPERATOIRES ET LA GUERISON SUIVANT UNE CHIRURGE ORTHOPEDIQUE

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**RESUME:**

L'hypothermie périopératoire produit du stress physiologique car elle fait monter la pression artérielle, le rythme cardiaque et la concentration de catécholamine du plasma sanguin, lesquels peuvent croître le risque de complications cardiaques, de saignement, d'infection de la plaie ainsi que la durée des soins post-anesthétiques. Cette étude a été conçue afin d'évaluer les effets du réchauffement des fluides intraveineux sur l'état hémodynamique, les frissons post-opératoires et la guérison des patients ayant subi une chirurgie orthopédique.

# THE EFFECTS OF INTRAVENOUS FLUIDS TEMPERATURE ON PERIOPERATIVE HEMODYNAMIC SITUATION, POST-OPERATIVE SHIVERING, AND RECOVERY IN ORTHOPAEDIC SURGERY

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**Background:** Perioperative hypothermia is physiologically stressful because it elevates blood pressure, heart rate and plasma catecholamine concentration that may increase the risk of cardiac complications, bleeding, wound infection, and post-anaesthesia care unit stay. This study was designed to evaluate the effects of warming intravenous fluids on perioperative hemodynamic situation, post-operative shivering and recovery in orthopaedic surgery patients.

**Methods:** Perioperative pulse rate, blood pressure, intraoperative esophageal and skin temperature were measured in sixty patients undergoing orthopaedic surgery that were randomly divided into two groups according to intraoperative IV fluids management. In 30 patients (hypothermia group) all IV fluids infused were at room temperature. In the other 30 patients (normothermia group) all IV fluids were warmed using a dry IV fluid warmer.

**Results:** The core and skin temperatures of the hypothermia and normothermia groups decreased significantly between the induction of anesthesia and the end of surgery, but the drop was greater in the hypothermia group ($P<0.005$). Postoperative mean arterial blood pressure (non-invasive) increased significantly more in the hypothermia group versus normothermia group ($p<0.005$). Shivering was observed in 21 of 30 in the hypothermia group and 11 of 30 in the normothermia group ($p<0.005$) and recovery time was significantly lower in the normothermia group ($36\pm5$ vs. $26\pm3$ min, $p< 0.005$).

**Conclusion:** Intraoperative IV fluid warming reduces perioperative changes to the hemodynamic situation, post-operative shivering, and recovery time.

**Key words:** Intravenous fluids temperature, hemodynamic situation, shivering, recovery, and orthopaedic surgery.

*Photo by/par J. Porteous*

*Positive pressure fluid warming system*

**Introduction:** Hypothermia may be mild (34-35.9°C, moderate (32-33.9°C) and severe (< 32°C).[1] Mild hypothermia is common after anaesthesia and surgery because of anaesthesia-induced inhibition of the patient's thermoregulatory system and exposure to a cold operative room environment.[2]

Perioperative hypothermia produces an undesirable manifestation of adrenergic responses, including increased norepinephrine release, peripheral vasoconstriction, hypertension, and myocardial ischemia.[3,4] Hypothermia also predisposes patients to shivering with associated increases in metabolic demand and cardiac output,[5] decreased drug metabolism,[6] impaired coagulation[7], and decreased immune response.[8] These adverse physiologic effects may result in morbid cardiac events;[4]; wound infections;[9] increased blood loss and blood transfusion requirements;[10] and delay discharge from the post anaesthesia care unit.[11] The administration of room temperature Intravenous (IV) fluids can cause hypothermia and it has been estimated that 1L of room temperature crystalloid solution decreases the mean body temperature by 0.25°C[6].

The effects of perioperative IV fluid warming have been studied in different surgeries,


*Photo by/par J. Porteous*

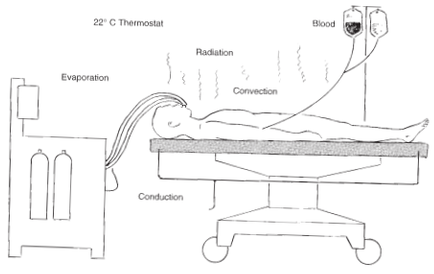
*Fluid line warming system*

especially in abdominal surgery, but rarely in orthopaedic surgery.[12,13] Thus the aim of this study was to evaluate the effects of warming intraoperative IV fluids, on the hemodynamic situation, post-operative shivering, and recovery time of patients undergoing orthopaedic surgery. The hemodynamic situation refers to blood circulation, resistance, pressure and hemoglobin concentration so it usually involves monitoring the level of consciousness, body temperature, blood pressure, heart rate, ECG, and urine output.[14] For the purpose of this study only body temperature, blood pressure and heart rate were measured).

**Materials and methods:** With approval of the Human Research Committee of the Tarbiat Modares University, School Of Medicine (Tehran, Iran) and written informed consent of the subjects, sixty adults undergoing elective orthopaedic surgery were studied. Prerequisites for selection included being ASA 1 (American Society of Anesthsiology physical status 1), and being scheduled for a procedure that would last at least 60 minutes.

Exclusion criteria were pre-operative use of calcium channel blockers, pre-operative sublingual temperature ≥ 38° C or < 35.5° C, history of endocrine disease, obesity, pregnancy, anemia and patients younger than 18 or older than 55 yr.

Patients taking calcium channel blockers were excluded because these agents cause a drug-induced modulation of vascular tone and a clinically important alteration in intraoperative core temperature.[11] All surgeries were done between 8 a.m and 12 p.m. IV fluids were infused through and 18-G cannula inserted into




*Heat Loss During Surgery*

Table 1

**SCORING FOR POSTANAESTHETIC SHIVERING**

| Grade | Clinical signs |
|---|---|
| 0 | No shivering |
| 1 | Fasciculation of face and lips |
| 2 | Fasciculation of face and neck |
| 3 | Visible tremor involving more than one muscle groups |
| 4 | Gross muscular activity involving the entire body |

antecubital vein. A randomized, controlled clinical trial was used, utilizing content-related validity and test-related reliability for instrumental validity and reliability. Patients were randomly assigned (by the toss of coin) to one of two groups as follows:

**Group One:** The normothermia group (n=30, "N-Group") received warm intraoperative IV fluids via a dry fluid warmer using a 130 cm extension tube and infusion set. Total tubing length between patient and warmer was 50 cm. Once suitable flow rates and temperature had been determined, IV fluids (Ringers solution) were infused via an infusion pump at different flow rates (400, 600, or 800cc/h) and the temperature was monitored by thermocoupler. The temperature of IV fluids were measured at three sites as follows:

1. IV solution bag ("T-Bag"),
2. just proximal to the IV fluid warmer ("T-Prox"), and
3. at end of the infusion set ("T-End"), and recorded when T-End fluctuated 0.1°C for 3 minutes 3 times every 2 minutes [15].

**Group two:** hypothermia group (n=30, "H-Group") received IV fluids at room temperature (24.4°C) at 800cc/h flow rate.

During surgery, all patients were covered by cotton blankets and surgical drapes. After surgery, all patients were covered with a cotton blanket by the OR nurse before being transported to the post anesthesia care unit.

The patients were premedicated with Atropine (0.2-0.4 mg). General anaesthesia was induced with Thiopental (5 mg/kg) and Fentanyl (3 ?g/kg). Intubation of the trachea was facilitated by administration of Succinylcholine (5 mg/kg). Inspired gases were not actively warmed. Anaesthesia was subsequently maintained with nitrous oxide (60%) in oxygen, Halothane, and Fentanyl.

Ambient room temperature was measured by a thermocoupler positioned at body level. Sublingual temperature was measured with an electronic thermometer preoperatively. Core body temperature (measured by esophageal probe) and chest skin temperature were measured at 15-minute intervals from the time of intubation until the end of surgery. A sphygmomanometer and finger pulse oximeter probe were used to measure arterial blood pressure and pulse rate preoperatively, intraoperatively, and postoperatively, at 10-minute intervals.

Post-operative data was recorded every 10 minutes beginning with the arrival of the patients in the post anesthesia care unit. The recording nurse was unaware of which patients were in which group. Data consisted of arterial blood pressure, pulse rate, presence or absence of shivering and the intensity of it, and the length of recovery time. Shivering details were determined by visual observation, and were graded on a five-point scale (Table 1).[16]

Post-anaesthesia recovery scores were used to determine PACU stay.[17] Patients were discharged when they were awake and oriented, able to breathe deeply and cough freely with an oxygen saturation>92 % on room air, able to move extremities, stable blood pressure and pulse rate. Data are presented as mean ± SD throughout the article. Comparisons between the demographic, clinical characteristics and clinical out come of two groups were analyzed using student's t-test and chi-square analysis as appropriate.

Repeated-measures analysis of variance (ANOVA) was used to compare means of multiple observations over time. Repeated-measures ANOVA by simple contrast was applied for comparison of arterial blood pressure, pulse rate, and temperature measurements between and within patient groups with respect to time or group.

Multiple regression analysis was used to determine appropriate flow rate and the temperature set-point of the fluid warmer used. Tests of the assumption of normality were applied to standardized residuals of ANOVA models; no models violated the assumption.[18] A P-value of <0.05 was considered significant. (The P-value is the probability of wrongly rejecting the null hypothesis if it is in fact true.)

**Results:** There were no significance differences in patients' demographic data, pre-operative arterial blood pressure, pulse rate, and sublingual temperature (table 2). All 17 female patients were older than 45 years of age. (This is important because pregnancy and female hormones can affect core body temperature.) Operating room temperature did not differ significantly between and within groups. The temperature set-point of

Table 2

**DEMOGRAPHIC CHARACTERISTICS AND CLINICAL DATA OF PATIENTS STUDIED**

| | P | N.group (n = 30) | H.group (n=30) |
|---|---|---|---|
| Awake PR (beats/min) | 0.104 | 74 ± 4 | 77± 7 |
| Awake sub lingual T(°C) | 0.47 | 37 ± 0.3 | 37 ± 0.7 |
| OR T(°C) | 0.68 | 24.2 ± 0.8 | 24 ± 0.6 |
| Final core T(°C) | 0.004 | 36.4 ± 0.5 | 35.9 ± 0.5 |
| Final skin T(°C) | 0.002 | 33.8 ± 0.5 | 33.2 ± 0.4 |
| Shivering (0:1:2:3:4) | 0.001 | 19:9:2:0:0 | 9:5:9:7:0 |
| Recovery(min) | 0.004 | 28 ± 6 | 36 ± 9 |
| Age ( yr) | P | 38 ± 10.2 | 35 ± 10.6 |
| Sex (M/F) | 0.245 | 18/12 | 21/9 |
| Weight (kg) | 0.94 | 70 ± 9.2 | 71 ± 8.2 |
| Height (cm) | 0.79 | 170 ± 5.2 | 171 ± 6.4 |
| Duration of Surgery (min) | 0.81 | 70 ± 4 | 73 ± 6 |
| Infused fluids (ml) | 0.303 | 918 ± 118 | 984 ±173 |
| Awake MAP (mm.Hg) | 0.136 | 96 ± 8.7 | 96 ± 8.1 |

**Means ± SD ,* p < 0.05 between groups**

# Effects of Warming IV Fluids (cont.)

the fluid warmer used during this study was 39.5°C at a flow rate of 800cc/h. (Figure 1, 2). Five patients were excluded from the study after randomization for the following reasons:

- decision by anesthesiologist to use epidural anaesthesia instead of general anaesthesia (n=3) and
- use of Midazolam as the premedication (n=2).

Some of the value differences were:

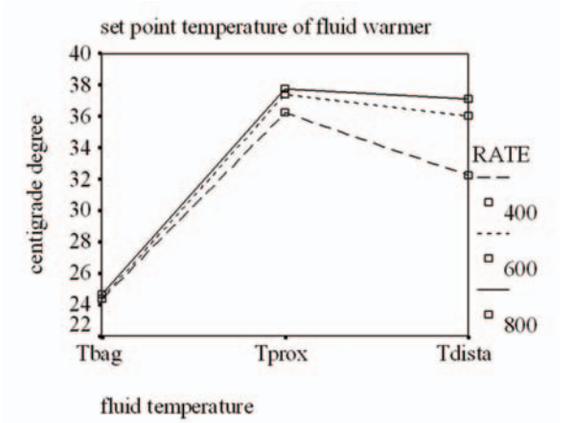
- The intraoperative mean arterial blood pressure and pulse rate values in the two groups decreased significantly compared with the awake values, and they increased significantly in PACU.
- The mean arterial blood pressure of the hypothermia group was significantly higher in PACU than that of the normothermia group
- There were no significant differences in pulse rate between the two groups.
- The recovery time was significantly shorter in normothermia group.
- Post-operative shivering occurred significantly more in the hypothermia group (Table 1).
- Core and skin temperature was lower in hypothermia group.

**Discussion:** Because maintenance of perioperative normothermia may prevent adverse outcomes, many techniques for minimizing hypothermia have been prescribed (e.g. air heating and humidification, cutaneous warming, and fluid warming).[24]

Inadvertent hypothermia during anaesthesia is by far the most common perioperative thermal disturbance.[19] Heat can be transferred from a patient to the environment four ways:
**1. Radiation; 2. Conduction**
**3. Convective; 4. Evaporation.**

Conductive heat loss is proportional to the temperature difference between two adjacent surfaces. Warming IV fluids decreases conductive heat loss by minimizing the temperature difference between the patent and the fluids. Post-operative thermal discomfort is physiologically stressful, because it elevates blood pressure, heart rate, and plasma catecholamine concentrations.[3,19] When human volunteers are cooled to a core temperature

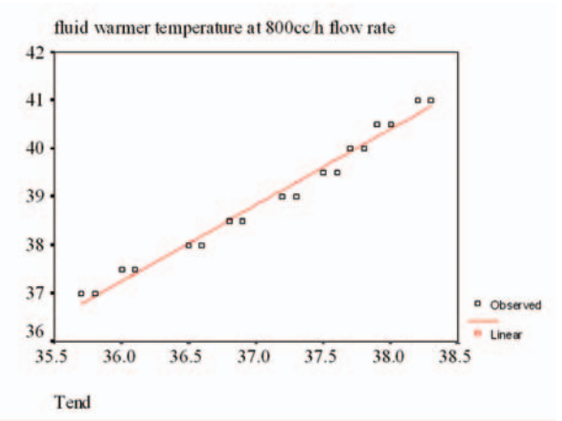
Figure 1




of 35.5 °C, there is a 700% increase in norepinephrine along with increased arterial blood pressure and vasoconstriction.[20] Catecholamine concentrations in plasma decrease significantly after epidural block, and although concentration of epinephrine increases sharply from the baseline in the hypothermic group at the end of surgery, it decreases in the normothermic group.[21]

Steven M. Frank's study of seventy-four elderly patients undergoing abdominal, thoracic, or lower extremity vascular surgical procedures compared patients in the forced-air warming group with patients receiving routine thermal care. The patients receiving the routine care had lower core temperatures, a greater degree of peripheral vasoconstriction, higher norepinephrine concentrations, and higher arterial blood pressures during the early postoperative period.[21] The baroreflex sensivity decreased more in the

Figure 2



hypothermia group compared with the normothermia group and returned to the base-line values faster in the normothermia group after general anaesthesia.[23]

IV fluid warming is an important method of heat conservation.[23] The present study demonstrated that warming IV fluids during orthopaedic surgery resulted in final core and skin temperatures that were 0.5˚C and 0.6˚C greater than those of the patients receiving room temperature fluids. (Table 1). The mean arterial blood pressure increased significantly more in the hypothermia group than in the normothermia group after induction of general anesthesia, but pulse rate changes were not significantly different between groups. It should be noted that preoperative anxiety of patients was not assessed, and that it might have affected the results of this study.

A previous study demonstrated that hypothermia after major abdominal surgery was associated with delayed post-anaesthetic recovery time when compared with normothermia.[10] In the present study, recovery time was significantly lower in the normothermia group. It is probable that it was lower due to the fact that in the present study, ambulation prior to discharge from PACU was not required. Postoperative shivering (a serious complication of hypothermia that increases oxygen consumption 200 to 600 percent proportional to intraoperative heat loss) occurred more in the hypothermia group during this present study.

In conclusion our study showed that the hemodynamic situation (core and skin temperature, and mean arterial pressure), shivering, and recovery time was less in the group receiving warm IV fluids versus the group receiving fluids at room temperature.

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