Original Article

Intraoperative hypothermia in patients undergoing elective surgery*

Hipotermia no período intra-operatório em pacientes submetidos a cirurgias eletivas

La hipotermia en el período intraoperatorio en pacientes sometidos a cirugías electivas

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ABSTRACT

Objective: To evaluate the body temperature of patients during the intraoperative period. **Methods:** The sample consisted of 70 patients undergoing elective surgery. An instrument with established face and content validity was used to collect the data. The variables consisted of operation room temperature and humidity and patient's body temperature at different time points during the intraoperative period. **Results:** The mean temperature of the operation room when the patients were transferred to the surgical table and at the fourth hour of the surgical procedure were 24.6º C and 22.4ºC, respectively. At the end of the surgery the patients' mean body temperature was 33.6º C. There were statistically significant positive correlations among the variables measured. **Conclusion:** The results indicated the need for implementation of effective interventions to prevent hypothermia during the intraoperative period. Nursing interventions are crucial to improve the delivery of quality care to surgical patients.

Keywords: Hypothermia/prevention & control; Perioperative nursing; Intraoperative period

RESUMO

Objetivo: Analisar a temperatura corporal do paciente submetido a cirurgia eletiva no período intra-operatório. **Métodos:** Para a coleta de dados elaborou-se um instrumento que foi submetido à validação aparente e de conteúdo e a amostra foi constituída de 70 pacientes. As variáveis mensuradas foram: temperatura e umidade da sala de cirurgia e temperatura corporal do paciente em diferentes momentos do período intra-operatório. **Resultados**: Em relação à temperatura corporal dos pacientes observou-se que no final do procedimento anestésico-cirúrgico a média foi de 33,6º C. A temperatura média da sala na chegada dos pacientes foi de 24,6º C e na quarta hora de procedimento anestésico-cirúrgico foi de 22,4ºC. Houve correlação estatisticamente significante e positiva entre as variáveis mensuradas. **Conclusão:** Os resultados apontaram a necessidade de implementação de intervenções efetivas para a prevenção da hipotermia e, neste cenário, a atuação do enfermeiro é crucial para a melhoria da assistência prestada ao paciente cirúrgico.

Descritores: Hipotermia/prevenção & controle; Enfermagem perioperatória; Período intra-operatório

RESUMEN

Objetivo: Analizar la temperatura corporal del paciente sometido a cirugía electiva en el período intra-operatorio. **Métodos:** Para la recolección de datos se elaboró un instrumento que fue sometido a la validación aparente y de contenido. La muestra estuvo constituida por 70 pacientes. Las variables mensuradas fueron: temperatura y humedad de la sala de cirugía y temperatura corporal del paciente en diferentes momentos del período intra-operatorio. **Resultados**: En relación a la temperatura corporal de los pacientes se observó que al final del procedimiento anestésico-quirúrgico el promedio fue de 33,6º C. La temperatura promedio de la sala a la llegada de los pacientes fue de 24,6º C y en la cuarta hora de procedimiento anestésico-quirúrgico fue de 22,4ºC. Hubo correlación estadísticamente significativa positiva entre las variables mensuradas. **Conclusión:** Los resultados apuntaron la necesidad de implementación de intervenciones efectivas para la prevención de la hipotermia y, en este escenario, la actuación del enfermero es crucial para la mejora de la asistencia prestada al paciente quirúrgico.

Descriptores: Hipotermia/prevención & control; Enfermería perioperatoria; Periodo intraoperatorio

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INTRODUCTION

Body temperature is regulated by the balance between heat production and loss. Most of the heat from human body is produced in deep organs than it is transferred to the skin and, later, lost in the environment. Thus, body heat production will depend on the body metabolism, and heat loss will depend specially on the speed at which heat can be transferred from its site of production to the skin and to how fast this heat is lost from the skin to the environment[1].

When the body increases its temperature, there are mechanisms working to reduce it, such as vasodilation, sweating and decrease in the production of heat. On the other hand, when exposed to extreme cold, the body reacts with vasoconstriction of the skin in the whole body, piloerection, and increase in heat production, through shivering, sympathetic excitation of the heat production and increase in thyroxin production (produced by the thyroid gland), a substance that determines the increase in cellular metabolism[1].

Hypothermia occurs in more than 70% of patients in the perioperative period, and it is a frequent adverse effect[2]. The main complications described in the literature are: increase in morbidity rate, increase in the rate of infection of the surgical site, increase in heart and oxygen demand in the presence of shivering, and impairment in platelet function[3].

Introduction of measures to prevent and treat hyperthermia in the perioperative period reduces patients' unpleasant sensorial experience, and is also an effective approach to control complication associated with this event[3].

The present study aims to contribute to the improvement in perioperative nursing care, searching data in the national reality on how hypothermia develops in the intra-operative period. Results will enable the understanding of this event making it possible to introduce efficient interventions in the routine of the clinical practice. Thus, the objective of the survey was to assess body temperature of patients undergoing elective surgery in the intra-operative period.

METHODS

This is a non-experimental, descriptive exploratory, correlational and prospective study, using a quantitative approach.

Place selected for the development of the study was a philanthropic hospital with 109 beds located in the interior of the state of São Paulo.

The research project has been approved by the Ethical Research Committee at Escola de Enfermagem de Ribeirão Preto, Universidade São Paulo, after approval by the selected hospital for this study, according to Resolution # 196/96 of the National Health Council, that regulates research with human beings[4]. All study participants gave their written consent.

Inclusion criteria were: to be 18 or over; to undergo elective surgery, with anesthesia lasting, at least, one hour. Exclusion criteria were: not agreeing to take part in the survey; presenting body temperature equal to or higher than 38ºC or below 36ºC when arriving at surgery room.

To reach the goal proposed in the present study, we have designed a document where apparent and content validation was performed by three judges. The instrument has data regarding patients, anesthesia and surgical procedure, environment, and patient's body temperature.

One of the researchers measured patients' body temperature at arrival in the surgical center, when arriving in the room, in the onset of anesthesia and every twenty minutes, from them on, until the end of the anesthetic-surgical procedure.

Patient's body temperature was verified using Canadian brand *ProCheck*® infrared ear thermometer, with ± 0.2ºC reading accuracy in laboratory. Ear temperature assessment is the non-invasive method of choice according to the guidelines to prevent hypothermia of the American Society of PeriAnesthesia Nurses (ASPAN)[5].

Temperature and the humidity of the operating room were measured when the patient entered the room, in the beginning of anesthesia induction and every 20 minutes until the end of the anesthetic-surgical procedure. To that end, we have used a domestic thermo hygrometer, brand Minipa®, with a ± 1ºC accuracy for internal temperature and ± 8% RH(relative humidity) accuracy for environment humidity, which was placed at approximately one meter away from patient's head and in the same side ear temperature was verified.

All measures were performed by one of the study researchers with the same instruments, from August 2006 to June 2007. Results were presented according to descriptive statistical measures, such as arithmetic mean, median, standard deviation, minimal and maximum level. Through Pearson's correlation coefficient, we have checked the correlation between patients' core body temperature measures and operating room mean temperature.

Double entry technique was used and data collected were assessed using Statistical Package Social Science software (SPSS 10.0). Significance level used was á= 0.05.

RESULTS

Among the 70 patients studied, mean age was 53.6 years, standard deviation was 15.4 years old. As for

gender, 46 (65.8%) patients were females and 24 (34.2%) were males. Regarding skin color 61(87%) were white, eight (11.5%) were pardos (mixed ancestry) and one (1.5%) was black.

Individuals' Body Mass Index (BMI) had a mean of 25.3 kg/m2 and median of 24.9 kg/m2. Blood hypertension was the most common chronic disease in our sample with 18 cases (25.7%). Regarding the American Society of Anesthesiologists (ASA) index, among the patients investigated, 49 (70%) were classified as ASA 2, 13 (18.5%) as ASA 1, and 7 (10%) as ASA 3, one individual has not been classified. These data have been collected in the patient's medical chart and recorded by the anesthetist.

Anesthetic procedures lasted 158.2 minutes on average, median was 150 minutes and standard deviation was 53.7 minutes. The anesthetic procedure with shorter duration lasted 75 minutes and the one lasting longer had 280 minutes. Most patients underwent general anesthesia (54 patients, 77.1%), combined anesthesia was administered to nine patients (12.9%), and regional to seven (10%).

Mean duration of surgical procedures was 111 minutes, median was 100 and standard deviation was 48.1 minutes, with minimum duration of 40 minutes and maximum duration of 230 minutes.

Most patients investigated (72.8%) underwent medium-sized surgical procedures, with predominance of minimally invasive surgeries, cholecystectomy and laparoscopic hiatal hernia repair accounted for 35.7% of the procedures, followed by radical prostatectomy, radical mastectomy and abdominoperineal resection.

Table 1 presents the data on core patients' body temperature, operating room temperature and humidity in the intra-operative period. Overall, patients arrived normothermic in the operating room, that is, core and median body temperature was 36.4º C. When the anesthetic procedure started, core and median temperature decreased to 36.2º C and in the beginning of the surgical procedure, core temperature of patients was 35.6º C, and median was 35.6º C, therefore, hypothermia was present. In the end of the anesthetic-surgical procedure (fourth hour) patients' core body temperature was 33.6º C, median was 33.7º C and standard deviation was 0.2ºC.

Mean temperature in the operating room when patients arrived was 24.6º C, decreasing to 22.4º C after four hours of the anesthetic-surgical procedure. Mean air humidity at patients' arrival was 48.6%, decreasing during the anesthetic-surgical procedure and increasing in the fourth hour to 49.3%.

Mean temperature in the operating room presented positive, statistically significant correlation with patients' core body temperature ($r = 0.43$; p @0), that is, the greater the room temperature, the greater the patients' body temperature.

DISCUSSION

The majority of the sample from the present study was white and female, patients' mean age was 53.6 years old.

Presence of perioperative hypothermia in elderly patients is frequently longer and more prolonged than in younger patients, and elderly and neonates are at risk of developing hypothermia because their thermoregulatory system is either compromised or not developed[6-7]. In a recent study, age was pointed out as a risk factor for hypothermia, and being over 70 was a predictive factor for hypothermia during surgery[8].

In addition to age, gender can be a risk factor for hypothermia with stress to the female gender[9]. Women usually experience less loss of heat in the perioperative period than men because their body presents greater percentage of fat tissue which acts as a protective layer; on the other hand, women have a smaller amount of muscles and greater body surface index, and are more susceptible to lose heat to the environment[10].

According to studies found in the review of the literature, there are evidences of the association between hypothermia and age; however, as for gender, despite the apparent greater susceptibility of females, publications are lacking and new studies are necessary to strengthen this association. We also highlight that there

Table 1 – Patients' core temperature, operating room temperature and humidity in the intraoperative period. Jacareí -SP, 2006-2007

Period	Patients' temperature (ºC)			OP temperature (ºC)			OR humidity (%)		
	Mean ± SD	Median	Interval	Mean ± SD	Median	Interval	Mean ± SD	Median	Interval
Arrival at the room	36.4 ± 0.2	36.4	36.0 – 37.1	24.6 ± 1.9	24.6	17.8 – 28.7	48.6 ± 9.4	49.0	23 - 68
Anesthesia induction	36.2 ± 0.36	36.2	35.3 – 37.1	24.4 ± 1.6	24.5	18.8 – 27.8	47.7 ± 8.9	48.0	28 – 66
Beginning of surgery	35.6 ± 0.5	35.6	34.3 – 36.9	24.1 ± 1.5	24.1	18.6 – 27.5	45.7 ± 10	46.5	38 – 46
First hour	34.8 ± 0.7	34.9	32.5 – 36.2	23.5 ± 1.5	23.6	19.3 – 27.1	39.5 ± 10.7	38.0	20 - 65
Second hour	34.4 ± 0.8	34.7	31.8 – 35.6	23.5 ± 1.7	23.8	19.4 – 26.9	38.5 ± 10	37.0	20 – 70
Third hour	34.2 ± 0.9	34.3	31.6 – 35.4	23.3 ± 1.9	23.5	19.8 – 26.8	39.9 ± 14.9	39.0	20 – 66
Fourth hour	33.6 ± 0.2	33.7	33.4 – 33.7	22.4 ± 0.7	22.7	21.5 – 22.7	49.3 ± 10.6	55.0	37 – 56

OR= Operating Room

were no studies in the literature investigating color as a predictive factor for hypothermia.

As already mentioned, in the present study, there was predominance of minimally invasive surgeries, which account for 35.7% of the procedures.

Hypothermia is frequent in abdominal surgeries because organs are exposed to the environment, it is also frequent in laparoscopic surgery due to the exposure of the cavity to a great amount of carbon dioxide insufflations. Thus, a study tried to prove this statement by comparing the changes in body temperature of patients undergoing laparoscopic surgeries and open gastric bypass, in which heated cotton sheets and moistening of airways were performed as measures to prevent heat loss during the intra-operative period. One hundred and one patients with morbid obesity presenting BMI between 40-60 kg/m2 took part, they were randomly selected to the group undergoing open surgery (n=50) or laparoscopy (n=51)[11].

After anesthesia, the temperatures measured were similar between the groups; there was no statistically significant difference in the data found from the induction to anesthesia to patients' recovery after surgery. Authors concluded that there is no significant difference in patients' body temperature in the intra-operative period and that prolonged carbon dioxide insufflation in laparoscopic surgery does not increase hypothermia indexes when measures to minimize heat loss are adopted[11].

In another study to compare the incidence of hypothermia during colorectal laparoscopy and open surgery, authors assessed 60 patients, 33 undergoing laparoscopic surgery and 27 undergoing open surgery. Results corroborate data from the previously mentioned study, that is, there was no statistically significant difference between the groups investigated. Despite these results, the authors pointed out the need for new studies to explain if there is difference in the incidence of hypothermia between open surgery and laparoscopic surgery[12].

Literature indicates that patients usually develop hypothermia in surgeries lasting longer, because the sharp decrease in body temperature actually occurs in the first 40 to 60 minutes after anesthesia induction[3].

Most subjects from this study (77.1%) received general anesthesia. Developing hypothermia during general anesthesia may be briefly explained in the following three phases: after anesthetic induction there is a quick fall in central temperature due to the phenomena of internal distribution of heat, from then on, there is a linear decrease in temperature, ranging from 0.5°C to 1°C, explained by the maintenance of the differences between the production and loss of heat to the environment; finally, when the body reaches a certain temperature, there is restriction in the heat flow, triggered by vasoconstriction, leading to a reduced internal redistribution of heat with lower loses of this heat to the environment, then a new thermal balance would be reached, with reduced values[13].

Regional anesthesia may extensively affect thermoregulation during surgery, both due to the effect of internal redistribution of heat and to the decrease in the temperature threshold needed to activate thermoregulatory responses[14].

Thermoregulatory responses are neurally mediated and thus, nerve blockage hinders normal activation of regional thermoregulatory responses such as sweating, vasoconstriction and shivering. Spinal and epidural anesthesia interrupt conduction in more than half of the body, this peripheral inhibition of the thermoregulatory responses is the greatest cause of hypothermia during regional anesthesia[15].

In the present study, patients' core body temperature, from the beginning of the anesthetic procedure (36.2ºC) presented constant decrease and reached 33.4ºC in the fourth hour of the surgical anesthetic procedure.

When central temperature falls below 36ºC reaching up to 34ºC, considered as mild hypothermia, it can be presented as confusion, shivering, amnesia, normal pulse and blood pressure and peripheral vasoconstriction, these signs are many times difficult to see, stressing the importance of constant monitoring of body temperature in the perioperative period[16].

With the progression of temperature reduction, that is, core temperature between 30ºC and 33ºC, hypothermia is called moderate and the symptoms include pupil dilation, atrial fibrillation, post-ventricular contractions, and presence of J waves on ECG. If the decrease in temperature persists, and it is below 30ºC, therefore severe, symptoms include ventricular fibrillation, hypotension, asystole, and it may lead to death[16].

According to ASPAN's recommendation, the temperature in the operating room must be between 20ºC and 24ºC[5]. In the present study, the mean temperature of the operating room presented small variations, remaining between 22.4 and 24.1ºC. This variable presented statistically significant and positive correlation with patients' core body temperature.

Human body exposed to the environment loses heat through physical mechanisms known as: radiation, the body loses heat to the colder environment through electromagnetic waves, corresponding to 60% of its total thermal elimination; conduction corresponds to the minimal calorie loss (3%) resulting from the transference of thermal energy by direct contact with surfaces; convection occurs when body heat is transferred by the air, corresponding to approximately 12% of the total

loss; and evaporation is when water is lost, evaporating from the body surface[1].

Patients, when exposed to a surgical environment, lose heat to the environment through the skin by radiation, convection, and evaporation. These mechanisms are responsible for 90% of the metabolic heat loss by the cutaneous surface[17].

The Association of periOperative Registered Nurses[18] indicates that the operating room temperature will determine patients' heat loss through the skin due to radiation and convection and to evaporation due to the use of antiseptic solution for skin preparation.

Researchers assessed 40 patients undergoing lower extremity orthopedic surgical procedures to determine the incidence and magnitude of core hypothermia. Authors tested the assumption that hypothermia would be less frequent if operating room temperature was kept at 26ºC, regardless of patients' age; results indicate that maintaining operating room temperature in the investigated parameter is effective in preventing hypothermia and it is well tolerated by the surgical team, becoming thus, a cost-effective tool, especially in places with no warming devices available[19].

In a study, anesthetic technical variables, operating room temperature, and age have been investigated on the multifactor causes for perioperative hypothermia; authors investigated 97 patients undergoing lower extremity vascular surgery receiving either general (GA) or epidural (EA) anesthesia, with different room temperature. In two groups, patients remained in the room with temperature around 24.5ºC (GA=30; EA= 33) and in two groups (GA=21; EA= 13) patients remained in a room with a 21.3ºC temperature[20].

Results showed statistically significant association between room temperature and the type of anesthesia, and the greatest decrease in body temperature occurred in patients receiving general anesthesia, when compared to epidural anesthesia, the decrease in temperature was similar in general anesthesia, regardless of room temperature. Data also suggest association between the type of anesthesia and patients' age, with greater decrease in young patients undergoing general anesthesia and similar in elderly patients, regardless of the type of anesthesia[20].

Maintaining a patient normothermic during the perioperative period may lead to decrease in hospital costs; decrease in intraoperative bleeding, in the infection of the surgical site, and in the permanence in postanesthesia care unit; greater thermal comfort and, consequently, greater patient's satisfaction; however, this is a challenge nurses must face[10].

Nurses in the perioperative period have an important role in the prevention and treatment of hypothermia and introducing efficient interventions is crucial to make this complication a thing of the past. To that end, scientific knowledge to base clinical practice is a *sine qua non* condition, restricting the improvement of care in perioperative nursing.

CONCLUSION

When data from the 70 patients investigated was assessed, the main results found were:

- there was constant decrease in patients' core body temperature ranging from 36.4ºC (when arriving at the operating room) to 33.6ºC (end of anesthesia induction);
- mean temperature in the operating room presented mild variations; it was 24.6ºC when patients arrived and 22.4ºC in the end of anesthesia induction;
- there was statistically significant and positive correlation between patients' core body temperature and mean operating room temperature.

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