

Occurrence and factors associated with hypothermia during elective abdominal surgery

Ocorrência e fatores associados à hipotermia no intraoperatório de cirurgias abdominais eletivas

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Keywords

Hypothermia; Perioperative nursing; Intraoperative period; Operating room nursing; Digestive system surgical procedures

Descritores

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Abstract

Objective: To analyze the association between sociodemographic, clinical, surgical and environmental variables and the occurrence of hypothermia.

Methods: Cross-sectional and analytical study conducted with 105 adult patients of both genders. The Pearson's coefficient showed a correlation between the patients' temperature with the duration of the anesthetic-surgical period, the stay in the operating room, and the average temperature in the operating room.

Results: Of the 105 (100%) participants, 73 (69.5%) were female and 85 (81%) were adults. Hypothermia occurred in 98 (93.3%) patients. The average temperature was 36.1°C at the start of anesthetic procedure, with gradual decrease, reaching the average of 34°C. At the beginning of anesthetic induction, 29 (27.6%) patients had ear temperature <36 ° C and 60 minutes after induction, 78 (85.7%) patients were hypothermic, with an average temperature of 35.2 ° C. At the end of anesthesia, 93 (88.6%) patients had hypothermia with a minimum temperature of 31.4°C.

Conclusion: There was no significant correlation between the patient's average temperature and the average temperature of the operating room. The variables of female gender, combined anesthesia, duration of the procedure and the length of stay in the operating room were statistically significant to predict hypothermia.

Resumo

Objetivo: Analisar a associação entre variáveis sociodemográficas, clínicas, cirúrgicas e ambientais e ocorrência de hipotermia.

Métodos: Estudo transversal e analítico, realizado com 105 pacientes adultos de ambos os sexos. O coeficiente de *Pearson* verificou a correlação entre a temperatura dos pacientes com a duração do período anestésico-cirúrgico, a permanência na sala de operações e a média de temperatura na sala cirúrgica.

Resultados: A hipotermia ocorreu em 98 (93,3%) dos pacientes. No início do procedimento anestésico, a média de temperatura foi de 36,1°C, com diminuição gradativa atingindo 34°C de média. No início da indução anestésica, 29 (27,6%) pacientes apresentavam temperatura auricular <36°C e, 60 minutos após a indução, 78 (85,7%) pacientes encontravam-se hipotérmicos e com temperatura média de 35,2°C. Ao final do procedimento anestésico, 93 (88,6%) pacientes tiveram hipotermia com valor mínimo de 31,4°C.

Conclusão: Não houve correlação significativa entre a média de temperatura do paciente e as médias de temperatura da sala cirúrgica. As variáveis sexo feminino, anestesia combinada, duração do procedimento e o tempo de permanência na sala cirúrgica foram estatisticamente significantes para predizer hipotermia.

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Introduction

Hypothermia is defined as a core body temperature $<36^{\circ}\text{C}$ and one of the most frequent complications in patients in the perioperative period.⁽¹⁻³⁾ Studies show that between 60 and 90% of surgical patients have hypothermia in the intraoperative and postoperative periods.⁽²⁻⁴⁾

Perioperative nursing searches the quality of care and safety of surgical patients. Thus, knowledge on the clinical manifestations and complications of adverse events resultant from the anesthetic-surgical procedure is essential for developing effective intervention plans. The implementation of heating measures and the prevention of hypothermia in surgical patients are essential to avoid these complications and reduce the patients' hospital stay.^(4,5)

The association between hypothermia and changes of blood glucose with other predisposing factors in the intraoperative period may contribute to the quality of care to surgical patients. The objective of this study was to analyze the association between sociodemographic, clinical, surgical and environmental variables and the occurrence of hypothermia.

Methods

This is a cross-sectional analytical study conducted in the operating room of a large public teaching hospital with 292 beds. The surgical center consisted of 12 operating rooms and a post-anesthetic recovery room with ten beds. In 2014 were performed 1,815 abdominal surgeries (gynecological, gastrointestinal and general).

The participants were 105 patients who met the following inclusion criteria: undergoing elective conventional and/or minimally invasive abdominal surgery, aged 18 years or more, of both genders, and classified as ASA (American Society of Anesthesiologists) I and II. Exclusion criteria were: ear temperature $<36^{\circ}\text{C}$ or $\geq 38^{\circ}\text{C}$, patients with previous diseases (Parkinson, hypo and hyperthyroidism) or trauma affecting the regulation of body temperature, and patients classified as ASA III, IV, V and VI.

The unsystematic, convenience, sequential, nonprobability sampling was adopted, and all patients undergoing elective abdominal surgery in July, August and September 2014 who met the inclusion criteria participated in the study.

Figure 1 shows the analysis for obtaining the sample.

For data collection, an instrument was developed and submitted to face and content validation by experts in the subject. The instrument included the following variables - Sociodemographic: age, gender, weight, height; Age range: adult and elderly; Clinical: BMI, blood glucose, ASA and temperature; Surgical: anesthetic procedure, surgical type and approach, length of stay in the room, anesthetic time, hypothermia preventive measures and surgical positioning; Environmental: temperature and relative air humidity.

The sociodemographic, clinical and surgical variables were collected by observation of patients in the operating room, and by consulting their medical records and anesthesia records.

The temperature of patients' ear and of the operating room, as well as the relative air humidity were measured at the time of admission to the room, at the beginning of anesthesia and at the start of surgery itself. Then, at every hour after anesthetic induction, until the time the patient left the operating room.

The temperature measurement was always taken in the same ear canal (outer ear) to minimize errors. An infrared tympanic thermometer G-TECH Premium® brand was used. To check the temperature and relative air humidity in the operating room, was used a calibrated thermo-hygrometer Inco-term® brand positioned beside the patient's head, always on the same side where the ear temperature was taken.

The qualitative variables were analyzed using descriptive statistics, and for quantitative variables were used descriptive measures of centrality and dispersion.

The chi square test was used to investigate the association between the variables of gender, age range, body mass index, blood glucose upon admission to the operating room, blood glucose after sur-

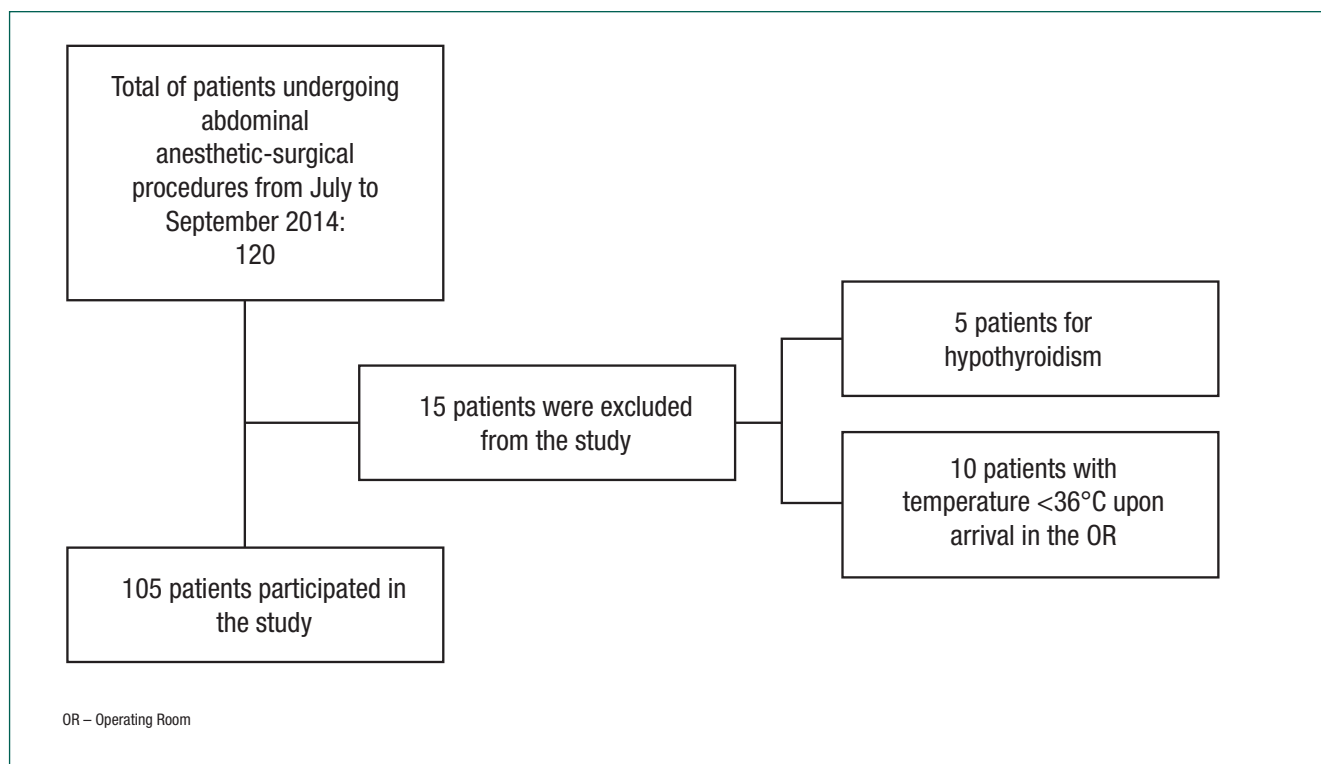


Figure 1. Analysis for obtaining the sample (n=105).

gery, ASA classification, surgical approach, use of preventive measures for hypothermia, and the occurrence of hypothermia. The Analysis of Variance (ANOVA) was used to check if there was correlation between the occurrence of hypothermia and the type of anesthesia.

The Pearson's correlation coefficient was used to see if there was correlation between the variable of patients' mean temperature in the period with the variables of duration of anesthetic-surgical period, length of stay in the operating room, and average temperature in the operating room. The significance level in this study was $p < 0.05$.

The study development met national and international standards of ethics in research involving human subjects.

Results

From July to September 2014 were performed 120 elective abdominal anesthetic-surgical procedures.

Of these, ten patients were excluded due to hypothermia upon admission to the operating room, and five for having a previous disease (hypothyroidism). Thus, the study sample consisted of 105 patients.

According to table 1, of the 105 (100%) patients who participated in the study, the average age was 43.9 years, ranging between 18 and 78 years.

Glycemic alterations at the time of admission to the operating room occurred in 56 (53.3%) patients. Of these, two (1.9%) had hypoglycemia and 54 (51.4%) hyperglycemia. At the end of surgical procedure, among the 76 (80.8%) patients with abnormal glucose, capillary hyperglycemia was identified in 75 (98.7%).

Regarding the occurrence of hypothermia, 98 (93.3%) patients had hypothermia at some point during the time in the operating room. Among the 105 patients, two (1.9%) received hypothermia preventive measures.

At the beginning of anesthetic induction, 29 (27.6%) patients had ear temperature $< 36^{\circ}\text{C}$ and 60 minutes after induction, 78 (85.7%) patients were hypothermic, with average temperature of

Table 1. Variables related to patients and the anesthetic-surgical procedure (n=105)

Variables	n(%)
Gender	
Female	73.0(69.5)
Male	32.0(30.5)
Age range	
Adult	85(81.0)
Elderly	20(19.0)
BMI classification	
Low weight	8(7.6)
Normal	43(41.0)
Overweight	54(51.4)
ASA	
ASA I	51(48.6)
ASA II	54(51.4)
Type of anesthesia	
General	61(58.1)
Local	27(25.7)
Combined	17(16.2)
Surgical approach	
Conventional	49(46.7)
Minimally invasive	56(53.3)
Surgical positioning	
Supine position	49(46.7)
Trendelenburg	29(27.6)
Reverse Trendelenburg	27(25.7)

BMI - body mass index; ASA - American Society of Anesthesiologists

35.2°C. At the end of anesthesia, 93 (88.6%) patients had hypothermia with minimum temperature of 31.4°C (Table 2).

At the beginning of anesthetic procedure, the average temperature was 36.1°C, gradually decreasing with increasing duration of anesthesia, reaching the average temperature of 34°C in the fourth hour of anesthesia.

Table 3. Distribution of the average body temperature of patients, the room temperature and relative air humidity of the operating room during the intraoperative period (n=105)

Period evaluated	Patient temperature		OR temperature		Relative air humidity of OR	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
When entering the OR	36.5±0.35	36.0-37.5	25.4±1.53	21.7-28.9	52.3±7.83	31.0-84.0
Onset of anesthesia	36.1±0.67	34.5-37.3	25.3±1.66	19.5-28.2	52.4±6.95	37.0-78.0
Beginning of surgery	35.9±0.73	34.0-37.3	25.1±1.65	19.7-28.2	52.7±6.85	38.0-78.0
1 st hour	35.2±0.77	33.0-36.4	22.5±1.99	17.3-27.7	52.4±7.71	38.0-80.0
2 nd hour	34.7±0.84	32.7-36.2	22.5±2.43	19.0-29.0	51.7±6.42	39.0-72.0
3 rd hour	34.6±0.74	33.2-35.9	23.4±2.46	19.9-28.7	54.0±7.63	42.0-78.0
4 th hour	34.0±0.84	31.7-35.3	22.8±2.93	18.9-28.9	51.4±4.06	43.0-60.0
End of surgery	34.7±0.95	31.4-36.5	23.4±2.30	19.7-28.8	53.2±7.82	39.0-81.0
End of anesthesia	34.8±0.94	31.4-36.5	23.7±2.15	20.1-28.8	53.3±7.68	39.0-81.0
When leaving the OR	34.8±0.95	31.4-36.7	24.1±1.95	20.3-28.8	53.3±7.91	39.0-82.0

SD - standard deviation; OR - operating room

Table 2. Analysis of body temperature (n=105)

Time of measurement	Mean ± SD	n	n(%)	Range
When being anesthetized	36.1±0.67	105	29(27.6)	34.5-37.3
When starting surgery	35.9±0.73	105	47(44.8)	34.0-37.3
60 minutes after anesthesia	35.2±0.77	91	78(85.7)	33.0-36.4
120 minutes after anesthesia	34.7±0.84	50	46(92)	32.7-36.2
180 minutes after anesthesia	34.6±0.74	26	26(100)	33.2-35.9
240 minutes after anesthesia	34.0±0.84	16	16(100)	31.7-35.3
At the end of anesthesia	34.7±0.95	105	93(88.6)	31.4-36.5
At the end of surgical procedure	34.8±0.94	105	93(88.6)	31.4-36.5
When leaving the operating room	34.8±0.95	105	93(88.6)	31.4-36.7

SD - standard deviation

The average temperature of the operating room fell since the admission of patients, with fluctuations until their departure from the room. The relative air humidity ranged between 31 to 84% (Table 3).

Among the predictive variables analyzed, there was a statistically significant correlation (p = 0.026) between the occurrence of hypothermia and the variable of gender. Although the relative risk was not significant, the odds ratio was 6.57, with confidence interval between 1.20 and 35.94.

By analyzing the occurrence of intraoperative hypothermia as the cause of hyperglycemia at the end of surgical procedure, no statistically significant result was found (p = 0.21).

The association between the type of anesthesia and the occurrence of hypothermia was statistically significant (p <0.001), and although all patients had hypothermia, the averages of temperature were lower in those that received combined anesthesia.

In the bivariate analysis, when correlating the average temperature of patients with the anesthetic-surgical time and the length of stay in the operating room, was found a statistically significant ($p < 0.001$ and $p = 0.02$, respectively), moderate and negative correlation (-0.34 and -0.31, respectively). In other words, the greater the duration of the anesthetic-surgical procedure and the length of stay in the operating room, the lower the averages of body temperature.

Discussion

The study limitations were related to the un-systematic convenience sampling and the sample size, which limit generalizations to other populations. However, the methodological rigor and statistical analysis ensured the reliability of results.

The results contributed to reveal the prevalence and identify the risk factors associated with hypothermia during the intraoperative period in patients undergoing abdominal surgery. These data should support the planning of nursing actions to detect and prevent unintended hypothermia in the operating room, reduce the occurrence of complications related to this adverse event, promote the safety of surgical patients and quality of care.

The Pearson's correlation coefficient showed that gender was statistically significant to predict hypothermia. Studies report that women have a thicker subcutaneous layer than men, leading to less heat loss, however, as women's body surface is bigger and their muscle mass is smaller, the female gender becomes more susceptible to heat loss and, consequently, to hypothermia.^(1,6)

The present study corroborated the results of a study with adults in the immediate postoperative period conducted in 2012 at a university hospital in Cartagena (Murcia, Spain) that identified the variable of female gender as a predictive factor ($p = 0.02$) for the occurrence hypothermia.⁽⁶⁾ Despite the apparent vulnerability of the female gender to occurrence of hypothermia, only a few studies

found a statistically significant relationship for this variable.

Although the variables of age and age range were not considered statistically significant in this study, several others have pointed that older people were more susceptible to present hypothermia in the perioperative period.⁽⁶⁻⁸⁾

The metabolic activity and the thermoregulatory system have their activities reduced in the elderly population. Concomitant to this, there is a significant reduction in muscle mass and the amount of subcutaneous tissue, which acts as a thermal insulator and affects negatively the body heat production and retention, respectively.^(7,9)

Although in this study the body mass index has not shown a statistically significant relationship with hypothermia in the intraoperative period, this index is known to have a positive correlation with the body temperature of patients. Thus, the higher the body mass index, the higher the temperature.^(6,8)

Much of the heat produced by the body stems from the reactions involved in the conversion of molecules (including glucose) into energy for the cells. Therefore, malnourished patients with reduction of blood glucose levels produce less heat and tend to reduce the body temperature. However, no statistically significant results were found when comparing the occurrence of hypothermia and blood glucose values.^(9,10)

Hyperglycemia was the most frequent change in blood collections at the end of the surgical procedure. However, when correlating the occurrence of hyperglycemia at the end of surgery with hypothermia in the intraoperative period, the results found were not statistically significant.

Hyperglycemia is a complication of hypothermia. The low use of glucose by the body, the decreased renal loss of glucose, decreased insulin release and increased peripheral insulin resistance may lead to increased blood glucose levels. Furthermore, increased circulating catecholamines culminate in glycogenolysis, augmenting hyperglycemia.^(10,11)

The high frequency of hypothermia found in this study can be explained by not using hypothermia preventive measures in the pre- and intra-

operative periods. All patients were covered with sterile drapes, leaving only the upper limbs, head and neck exposed. However, this measure was not considered a hypothermia preventive intervention, because the use of these operative fields was intended only to maintain the surgical area free of contamination and not to maintain the temperature of patients.

The perioperative warming measures can be divided in active and passive. Active measures are more efficient for treating hypothermia and warming hypothermic patients than passive measures. By adopting warming measures in the perioperative period, there is a significant reduction in the occurrence of hypothermia during intraoperative and immediate postoperative periods. The most common measures in these studies were the use of cotton blankets in the preoperative period, heated forced air system, thermal blanket, infusion of heated intravenous and/or intracavitary fluids, heated waterbed, among others.^(2,12,13)

In contrast, anesthesia has a direct effect on the central thermoregulatory system and on hypothalamic responses for body temperature control. The main effect of anesthetics is peripheral vasodilation, which causes an increase in heat loss to the environment, inhibits muscle tremor and peripheral vasoconstriction, accentuating the temperature reduction.^(9,14,15)

In the present study, when correlating the average temperature of patients during the intraoperative period and the type of anesthetic used, statistically significant results were found for those who received combined anesthesia. Thus, combined anesthesia was a risk factor for the occurrence of hypothermia during surgery.

Combined anesthesia increases the chances of patients having hypothermia, because deficiencies in thermoregulatory mechanisms of general anesthesia add to the impaired ability to maintain compensating mechanisms such as tremors, peripheral vasoconstriction and thermal sensation, common in local anesthesia, contributing to lower mean temperatures.^(14,15)

Hypothermia was also related to the duration of anesthesia, surgery, and the length of stay in the operating room. In this study, we correlated the aver-

age temperature of patients with the time duration of the anesthetic-surgical procedure and the length of stay in the operating room. The correlation of these variables with the average temperature of patients during this period was significant, similar to data found in other studies.^(1,8,15)

The prolonged time in the operating room, the duration of anesthesia and duration of surgery are factors that interfere with the body temperature of patients; the longer this duration time, the lower is the patients' body temperature.^(15,16) A study conducted in the city of Porto (Portugal) with 340 patients in the immediate postoperative period showed that the duration of anesthesia was considered an independent predictor for the occurrence of hypothermia and for the increased time spent in the post-anesthetic recovery room.⁽⁸⁾

The duration of anesthetic-surgical procedure and the prolonged length of stay in the operating room were risk factors for hypothermia, and a reason may be related to prolonged exposure to the low temperatures of the operating room.

In this study, there were temperature variations in the operating room between 22.5 and 25.4°C, and a linear decline since admission to the operating room until the second hour of anesthesia. After this period, the average temperature rose again and the average relative air humidity remained between 51.4 and 54%. This result corroborates the American Society Perianesthesia Nurses (ASPAN) recommendations to maintain the temperature of the operating room between 20 and 25°C.⁽¹⁾

The average temperature and average relative air humidity in the operating room were not statistically significant when compared to the average temperature of patients in the intraoperative period.

Conclusion

The variables of age range, ASA classification, BMI, surgical positioning, type of surgical approach and glycemic alterations upon patients' admission to the

OR were not predictive for the occurrence of hypothermia.

The occurrence of hypothermia was not a statistically significant factor to predict the incidence of hyperglycemia at the end of the anesthetic-surgical procedure, but it favored the occurrence of complications during surgery.

There was no significant correlation between the patient's average temperature and the average temperature of the operating room. The variable of female gender was statistically significant to predict hypothermia, as well as combined anesthesia, the duration of the anesthetic-surgical procedure, and the length of stay in the operating room.

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Collaborations

Prado CBC participated in the project design, analysis and interpretation of data, article writing and critical and relevant review of intellectual content. Haas VJ contributed to the analysis and interpretation of data. Pires PS and Barichello E contributed to the critical and relevant review of intellectual content. Barbosa MH participated in the project design, analysis and interpretation of data, article writing and critical and relevant review of intellectual content, and final approval of the version to be published.

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