Intraoperative hypothermia and occurrence of surgical site infection in cancer patients: retrospective cohort

Hipotermia intraoperatória e ocorrência de infecção do sítio cirúrgico entre pacientes oncológicos: coorte retrospectiva

Hipotermia intraoperatoria y ocurrencia de infección del sitio quirúrgico entre pacientes con cáncer: cohorte retrospectiva

Carolina Tomanini Cazella[1], Camila Dalcól[1], Vanessa de Brito Poveda[1]*

ABSTRACT: Objectives: To analyze the correlation between intraoperative hypothermia and the occurrence of surgical site infection in patients with cancer. **Method:** Retrospective cohort study with data extracted from the electronic medical records of 79 patients between 2014 and 2015. All ethical precepts were complied with. **Results:** Of 79 patients, 18 (22.79%) developed surgical site infection, 12 (66.66%) during hospitalization and 6 (33.33%) after hospital discharge. Surgical site infection was significantly correlated with diabetes mellitus, intraoperative transfusion, type of surgery proposed, length of stay in an Inpatient or Intensive Care Unit, surgical re-approach and hospital readmission. Each episode of hypothermia lower than or equal to 35.5 °C increased the chance of surgical site infection by 6.2%. **Conclusion:** Intraoperative body temperature below 35.5 °C increases the chance of surgical site infection. The multidisciplinary team must maintain the patient's normothermia throughout the perioperative period.

Keywords: Hypothermia. Surgical wound infection. Intraoperative period. Surgical oncology. Cohort studies.

RESUMO: Objetivos: Analisar a correlação entre hipotermia intraoperatória e ocorrência de infecção de sítio cirúrgico em pacientes oncológicos. **Método:** Estudo de coorte retrospectiva com dados extraídos do prontuário eletrônico de 79 pacientes entre 2014 e 2015. Todos os preceitos éticos foram cumpridos. **Resultados:** De 79 pacientes, 18 (22,79%) desenvolveram infecção de sítio cirúrgico, sendo 12 (66,66%) durante a internação e 6 (33,33%) após a alta. A infecção do sítio cirúrgico apresentou correlação significativa com diabetes *mellitus*, transfusão intraoperatória, tipo de cirurgia proposta, tempo de permanência em Unidade de Internação ou de Terapia Intensiva, reabordagem cirúrgica e readmissão hospitalar. Verificou-se que cada episódio de hipotermia menor ou igual a 35,5°C aumentou a chance de infecção do sítio cirúrgico em 6,2%. **Conclusão:** A temperatura corporal intraoperatória abaixo de 35,5°C aumenta a chance de infecção de sítio cirúrgico. A equipe multiprofissional deve manter a normotermia do paciente durante todo o período perioperatório.

Palavras-chave: Hipotermia. Infecção da ferida operatória. Período intraoperatório. Oncologia cirúrgica. Estudos de coortes.

[1]Universidade de São Paulo – São Paulo (SP), Brazil.
Corresponding author: vbpoveda@usp.br
Received on: 08/23/2022 – Approved on: 09/28/2022
https://doi.org/10.5327/Z1414-4425202227835

RESUMEN: Objetivos: Analizar la correlación entre la hipotermia intraoperatoria y la ocurrencia de infección del sitio quirúrgico en pacientes oncológicos. **Método:** Estudio de cohorte retrospectivo con datos extraídos de la historia clínica electrónica de 79 pacientes entre 2014 y 2015. Se cumplieron todos los preceptos éticos. **Resultados:** De 79 pacientes, 18 (22,79%) desarrollaron infección del sitio quirúrgico, 12 (66,66%) durante la hospitalización y 6 (33,33%) después del alta. La infección del sitio quirúrgico se correlacionó significativamente con la diabetes mellitus, la transfusión intraoperatoria, el tipo de cirugía propuesta, la estancia hospitalaria o en la Unidad de Cuidados Intensivos, la reintervención quirúrgica y el reingreso hospitalario. Se encontró que cada episodio de hipotermia menor o igual a 35,5°C aumentó la probabilidad de infección del sitio quirúrgico en un 6,2%. **Conclusión:** La temperatura corporal intraoperatoria por debajo de 35,5°C aumenta la probabilidad de infección del sitio quirúrgico. El equipo multidisciplinario debe mantener la normotermia del paciente durante todo el perioperatorio.

Palabras clave: Hipotermia. Infección de la herida quirúrgica. Periodo intraoperatorio. Oncología quirúrgica. Estudios de cohortes.

INTRODUCTION

Currently, the volume of total surgeries is estimated between 187 and 281 million operations per year, with 1 surgery for every 25 human beings, which represents a large volume of procedures with significant implications for public health. The rate of complications resulting from surgical procedures is 3 to 16%, while the mortality rate is 0.4 to 0.8% in developed countries. However, in developing countries, the mortality rate can reach 5 to 10% among surgical patients[1].

Surgical complications and infections are a worldwide concern, with almost 7 million occurrences per year and 1 million deaths during or after surgery, even though 50% of these events are preventable[1]. Among surgical complications, hypothermia occurs accidentally in many patients. Hypothermia is defined as core body temperature below 36°C, and can be subdivided into mild (32°C to 35.9°C), moderate (28.1°C to 31.9°C) or severe (<28°C) hypothermia[2].

The combination of general and local anesthesia, preoperative body temperature below 36°C, low body weight, type of surgical procedure, exposure to low environmental temperatures in the operating room, which vary from 18°C to 23°C, heat transfer mechanisms present in the operating room, use of cold solutions on the skin, cold intravenous fluids, inhalation of cold anesthetic gases, large area of skin exposure and opening of the abdominal or thoracic cavity[3].

General anesthesia causes a block in the autonomic response of vasoconstriction, with consequent redistribution of heat from the center to the periphery of the body, being responsible for 80% of the reduction in the patient's body temperature in the first hour after anesthesia from 0 .5 to 1.5°C. In addition, there is a 15 to 30% reduction in metabolic production and an increase in cutaneous heat loss. After some time, the autonomic response is reactivated and the body temperature reaches a plateau. Surgical patient heat loss is associated with anesthesia in 80% of cases. For this reason, it is essential to implement measures to prevent hypothermia and warming methods in the perioperative period[2].

Complications of unplanned hypothermia include postoperative pain, increased blood loss and need for blood transfusion, reversible coagulopathy, myocardial events, impaired renal function, reduced drug metabolism, postoperative protein catabolism, increased peripheral vascularity, pressure ulcers, altered mental status, poor healing of surgical wound, infections, increased length of stay in the Post-Anesthetic Recovery Room (PACU), prolonged hospitalization and even death[2]. To avoid these possible complications, national and international guidelines and recommendations are to maintain normothermia during the surgical procedure[2,3].

The Association of periOperative Registered Nurses recommends the following measures to prevent hypothermia in surgical patients: preoperative assessment and choice of the best heating method, which can be active, passive or combined; initiation of active warming as soon as possible, preferably in the preoperative period; intraoperative monitoring of the patient; control of core temperature and maintenance of normothermia in the postoperative period[2].

According to the Brazilian Society of Anesthetic Recovery, Surgical Center and Material and Sterilization Center Nurses, the patient's temperature should be monitored throughout the perioperative period, as well as the patient and the type of surgical procedure to identify risk factors, initiate hypothermia preventive measures or maintain normothermia, initiate and/or maintain active intraoperative and postoperative heating, administer intravenous infusion and irrigation solutions heated to approximately 37°C, control temperature

and oxygen saturation in the PACU, offer greater supply of postoperative oxygen and observe changes in heart rate, heart rhythm, skin color, peripheral perfusion and skin temperature[3].

It is worth emphasizing that, the 2015-2017 edition of the North American Nursing Diagnosis Association had the nursing diagnosis "risk of perioperative hypothermia" included and defined as "vulnerability to an inadvertent drop in core body temperature" to values below 36°C in the perioperative period, which may cause damage to the health of affected patients[4]. Thus, the perioperative nurse must be acquainted with the possible complications related to hypothermia and implement prevention and treatment measures based on the best scientific evidence.

In 2009, the World Health Organization published guidelines for surgery safety, including the maintenance of normothermia during surgery among its ten proposed measures, which is a simple method to limit the risk of developing surgical site infection (SSI)[1].

Considered to be one of the complications of hypothermia, SSI is the third leading cause of Healthcare-Related Infections (HAI), with rates ranging from 14 to 16%, and increasing patient hospital stay from 7 to 11 days, raising costs with health[5,6]. SSI can be classified according to the surgical plan: superficial incisional SSI develops only in the skin and subcutaneous tissue in the first 30 days after the surgical procedure; deep incisional SSI affects fascia and muscles, developing in the first 30 days, or up to 90 days in case of implantation of prostheses; organ/space infection develops within the first 30 days after manipulation of structures, or within 90 days in cases of prosthesis placement[7].

Several factors related to the procedure and the patient can be considered risky for the development of SSI, including the type of surgery, the surgeon's skill, the degree of tissue trauma, presence of diabetes, smoking, obesity, malnutrition, use of steroids or other immunosuppressive drugs, and also the occurrence of intraoperative hypothermia[8].

There is a scientific gap regarding the association of hypothermia with postoperative outcomes such as blood loss, wound complications, SSI, increased PACU time, increased hospital stay and death, and further research on the theme is needed[2].

Thus, considering the social and economic impact on global health that hypothermia and the occurrence of SSI cause, the need to implement guidelines and protocols with preventive measures for perioperative hypothermia, and the scientific gap on the subject, this study was guided by the following questioning: is there a correlation between intraoperative body temperature and the occurrence of SSI in patients undergoing gastrointestinal oncological surgeries?

OBJECTIVE

To analyze the correlation between intraoperative body temperature and occurrence of SSI in patients undergoing gastrointestinal oncological surgeries.

METHOD

This is a quantitative, retrospective cohort study, based on electronic medical records of patients undergoing oncological surgeries of the gastrointestinal tract at a hospital specializing in cancer diagnosis and treatment in the city of São Paulo (SP), with convenience sampling, including 79 adult patients of both sexes, who underwent elective oncological surgery of the digestive system, whether curative or palliative, with anesthesia time of at least one hour, performed in 2014 and 2015, and who participated in the previous prospective study in which the occurrence of intraoperative hypothermia was evaluated[9].

Data was collected from electronic medical records of patients from the day of surgery to 30 days after surgery, reporting signs or symptoms of SSI, according to the diagnostic criteria proposed by the Centers for Disease Control and Prevention (CDC)[7], or even the medical diagnosis of SSI. Data regarding the maintenance of core temperature during anesthesia procedure were measured using an esophageal thermometer, every 20 minutes, as in a previous investigation[9].

The project was approved by the Research Ethics Committee of the School of Nursing of Universidade de São Paulo, after authorized by the hospital selected for the investigation, under opinion 2,240,510 (Certificate of Presentation of Ethical Appreciation 68343917.6.0000.5392), and complied with guidelines and regulatory standards for research involving human beings, per Resolution No. 466 of 2012 of the National Health Council[10].

The data collected were analyzed in the Statistical Package Social Sciences software, version 20.0, in a descriptive and inferential way, using the Fisher test, chi-square test and logistic regression model including variables presenting $p \leq 0.25$. The level of significance was set at $\alpha \leq 0.05$.

RESULTS

Electronic medical records of 79 adult patients undergoing elective gastrointestinal oncologic surgeries, with mean age of 61.4 years (±11.9) and mean body mass index (BMI) of 25.07 kg/m² (±4.88), of which 18 (22.79%) had diabetes mellitus (DM). Regarding perioperative risk assessment, 53 (67.09%) patients were classified per the American Society of Anesthesiologists (ASA) as ASA 2, 19 (24.05%) as ASA 3, and 7 (8.86%) as ASA 1 (Table 1).

The surgical procedures lasted more than one hour, with mean of 254.85 (±113.65) minutes, with emphasis to total and/or partial gastrectomy surgeries (31; 39.24%), rectosigmoidectomies (20; 25.32%) and pancreatoduodenectomy (12; 15.19%). General anesthesia combined with epidural anesthesia was the most frequent (57; 72.15%) form of anesthesia, and the anesthetic procedures lasted between 135 and 832 minutes, with mean of 360.86 minutes (±117.7) (Table 1).

The postoperative destination of 40 (50.63%) patients was the Post-Anesthetic Recovery Unit, and they were later referred to the Inpatient Unit, while the remaining 39 (49.37%) patients were taken directly to the Intensive Care Unit (ICU). The mean postoperative hospital stay was 11.39 days (±7.68). The mean ICU stay was 2.11 days (±4.22).

Surgical re-approach was required during hospitalization for eight (10.13%) patients, with three (3.79%) of them undergoing a third surgical procedure during their hospital stay.

Based on the medical criteria for SSI and following recommendations by the CDC (2018), 18 (22.79%) patients were diagnosed with SSI. Of these, 12 (66.66%) were diagnosed during hospitalization and 6 (33.33%) after hospital discharge.

Need for readmission occurred in 15 (18.98%) cases for different reasons within the 30-day postoperative period. Of the 15 (100%) individuals who were readmitted to hospital, 9 (60%) developed SSI, with 3 (20%) being diagnosed during hospitalization and 6 (40%) diagnosed at the time of readmission. The remaining cases of readmission (6; 40%) were due to pulmonary septic shock, various surgical complications, severe thrombocytosis, portal thrombosis, hepatic artery thrombosis or altered laboratory tests. Of 18 patients with SSI, 5 (27.8%) required surgical re-approach (Table 1).

The presence of SSI was correlated with DM (p=0.049), intraoperative transfusion (p=0.002), type of surgery (p=0.023), length of stay in the Inpatient Unit in the postoperative period (p=0.001), surgical re-approach (p=0.005) and readmissions (p=0.0001485) (Table 1). Each day in the ICU increases the chance of developing SSI by 28.3% and each day of hospitalization increases the chance of developing SSI by 17%.

The variables age (p=0.148), gender (p=0.0572), BMI (p=0.770), ASA (p=0.549), type of anesthesia (p=0.820), postoperative destination unit (p=0.952), preoperative (p=0.110) and postoperative blood transfusion (p=0.524), duration of anesthesia (p=0.238), and duration of surgery (p=0.066) (Table 1) were not related to SSI.

Intraoperative heating measures were adopted, namely the infusion of heated fluids in 100% of the cases and use of thermal blankets with a heating system in 98.7% of the patients. The patients' intraoperative body temperature was checked every 20 minutes, being below 36.0°C in 12.33 cases on average and below 35.5°C in 8.61 cases on average (Table 2). It was verified, through logistic regression, that each episode of intraoperative temperature lower than or equal to 35.5°C increases the chance of SSI by 6.2%.

Only nine patients (50%) with SSI had blood culture performed. The microorganisms identified were *Escherichia coli, Enterococcus faecium, Staphylococcus spp, Staphylococcus epidermidis* and *Candida parapsilosis*. However, in five (27.8%) situations in which the diagnosis of SSI was confirmed by the medical team, there was no request for blood collection for culture.

Culture of ascitic, peritoneal, biliary, pleural fluid, drain and collection of the abdominal wall were requested in six (33.4%) different situations, with identification of microorganisms, namely *Escherichia coli, Streptococcus viridans, Enterococcus faecium, Enterococcus faecalis, Klebsiella pneumoniae, Proteus mirabilis* and *Citrobacter farmer.*

The three most used classes of antimicrobials were nitromidazoles, mainly metronidazole (51; 64.5%), followed by the third-generation cephalosporins class, represented especially by ceftriaxone (49; 62%) and second-generation cephalosporins, by cefoxitin (27; 34.17%).

DISCUSSION

This study aimed to correlate intraoperative body temperature in cancer patients undergoing gastrointestinal surgeries with occurrence of SSI, since in Brazil SSIs are responsible for 14 to 16% of all Health Care-Related Infections among hospitalized patients[5].

In patients undergoing anesthetic-surgical procedures, hypothermia is known to be a frequent diagnosis caused by the suppression of the thermoregulation system by anesthetic agents that reduce vasoconstrictor responses[2], combined with

low temperature in the operating room, exposure of abdominal and thoracic cavities at room temperature below body temperature, infusion of liquids and blood products without prior heating, among other elements[3].

Occurrence of SSI was related to DM, intraoperative transfusion, type of surgery, length of hospital stay in the postoperative period, surgical re-approach and readmissions. In another study, authors reported hypothermia significantly correlated with length of hospital stay, pain, nausea, absence

Table 2. Relation between temperature during anesthetic-surgical procedure and occurrence of SSI. Sao Paulo (SP), 2018.

Temperature	Number of temperature measurements Mean±SD (minimum–maximum)	p-value
Occurrences <36.0°C	12.33±7.11 (0–40)	0.131
Occurrences ≤35.5°C	8.61±7.74 (0–40)	0.079
Occurrences ≤35.0°C	4.80±6.83 (0–35)	0.173

Table 1. Clinical-surgical variables, according to their relationship with the occurrence of surgical site infection (n=79). São Paulo (SP), 2022.

Variables	SSI (n=18)	NSSI (n=61)	p
Age; mean (±SD) years	64.94 (±10.21)	60.31 (±12.25)	0.148
Sex, n (%)			
Female	4 (12.12)	29 (87.88)	0.057
Male	14 (30.43)	32 (69.57)	
BMI; mean (±SD) kg/m²	25.41 (±4.96)	24.97 (±4.89)	0.770
Diabetes mellitus; n (%)	1 (5.56%)	17 (94.44%)	0.049
ASA, n (%)			
I	1 (14.29)	6 (85.71)	0.549
II	14 (26.42)	39 (73.58)	
III	3 (15.79)	16 (84.21)	
Surgery, n (%)			
Total and/or partial gastrectomy	8 (25.81)	23 (74.19)	0.023
Rectosigmoidectomies	2 (10.0)	18 (90.0)	
Pancreatoduodenectomy	2 (16.67)	10 (83.33)	
Type of anesthesia, n (%)			
General anesthesia	2 (16.67)	10 (83.33)	0.820
General anesthesia + epidural	14 (24.56)	43 (75.44)	
General anesthesia + spinal anesthesia	2 (20.0)	8 (80.0)	
Blood transfusion in preoperative period; n (%)	0 (0.0)	9 (100.0)	0.110
Intraoperative blood transfusion; n (%)	4 (100.0)	0 (0.0)	0.002
Blood transfusion in postoperative period; n (%)	2 (33.33)	4 (66.67)	0.524
Anesthesia duration; mean (±SD), minutes	402.33 (±136.34)	348.62 (±109.86)	0.238
Surgery duration; mean (±SD), minutes	301.39 (±132.17)	241.12 (±104.88)	0.066
P.O. Destination — MC; n (%)	9 (22.50)	31 (77.50)	0.952
P.O. Destination — ICU; n (%)	9 (23.08)	30 (76.92)	0.952
MC stay; (mean±SD), days	18.11 (±11.15)	9.41 (±4.89)	0.001
ICU stay (mean±SD), days	5.06 (±7.77)	1.25 (±1.63)	0.078
Surgical re-approach; n (%)	5 (62.50)	3 (37.50)	0.005
Readmission; n (%)	9 (60)	6 (40)	0.0001

SSI: surgical site infection; NSSI: no surgical site infection; SD: standard deviation; BMI: body mass index; ASA: American Society of Anesthesiologists; P.O.: postoperative period; MC: Medical Clinic; ICU: Intensive Care Unit.

of evacuation and conditions of surgical wound. Hypothermic patients are more likely to have a surgical wound with secretion or dirt covering[11].

The scientific literature indicates that hypothermia is related to cases of SSI[8], and although most were diagnosed during hospitalization, 50% of patients who developed infectious complications required readmission, and almost 30% of them required surgical re-approach, that is, the deleterious effects related of the infectious process lead to longer hospital stays, permanence in ICU and use of a greater amount of human and financial resources, further burdening the health system[7,12].

It is noteworthy that the most recent recommendations regarding prevention of SSI include prevention of hypothermia and maintenance of perioperative normothermia as objectives to avoid and reduce the number of cases of infectious complications[5-7,13,14].

In the present study, in addition to conditions intrinsic to participants, they were subject to different extrinsic risk factors leading to intraoperative hypothermia, and, although heating measures were adopted in most cases, the sample was subject to 12.33 episodes on average in which intraoperative body temperature was lower than 36.0°C and 8.61 episodes on average in which intraoperative body temperature was lower than 35.5°C. It is important to note that, for each episode of body temperature below 35.5°C, the chance of developing an SSI increased by 6.2%.

Another study that analyzed the occurrence of hypothermia in patients undergoing abdominal surgery showed that 93.3% of the patients had hypothermia at some point during the surgery, but only 1.9% were exposed to some measure to prevent hypothermia. At the time of anesthetic induction, 27.6% of patients had a temperature below 36°C; after one hour, 85.7% were hypothermic, with a mean temperature of 35.2°C; at the end of the procedure, 88.6% had hypothermia[15].

A prospective cohort study that assessed 484 patients who underwent abdominal surgery in a hospital that does not use active skin warming methods identified that patients who faced five or more episodes of temperature below 36°C were more likely to develop SSI, or those submitted to 75 minutes of temperatures below 36°C were more likely to develop SSI[16].

In contrast, another cohort study with 1,015 patients undergoing colorectal oncologic surgery in a hospital that uses temperature management as standard treatment, reported low rates of intraoperative hypothermia and SSI, with mean temperature of 36.3°C and a rate of 10% SSI at 30 days post-surgery, concluding that adherence to normothermia seems to be an effective strategy to reduce SSI[17]. In addition, maintenance of perioperative normothermia is associated with reduced mortality within 30 days after surgery[18].

Some of the limitations of the study are the sample size, the choice of only one surgical specialty (gastrointestinal oncologic surgery), and the choice of only one health institution. However, it may contribute to the development of future investigations with larger samples, other surgical specialties, and investigating other hypothermia-related outcomes.

CONCLUSION

The results show that each occurrence of temperature lower than or equal to 35.5 °C increases the chance of SSI by up to 6.2%. Most cases of SSI were diagnosed during hospitalization, and even so readmissions and surgical re-approaches were needed.

SSI cases identified were related to DM, intraoperative transfusion, type of surgery proposed, length of stay in Inpatient Unit and ICU in the postoperative period, surgical re-approach and readmission.

It is the responsibility of the multiprofessional team to adopt preventive measures for aggravation of body temperature variation and to detect intraoperative hypothermia early, aiming at normothermia and to reduce the occurrence of SSI in patients undergoing surgical procedures.

FUNDING SOURCE

The present work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel (CAPES) – Financing Code 001.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

CTC: Conceptualization, Data Curation, Research, Methodology, Writing — Original Draft, Visualization. **CD:**

Formal analysis, Conceptualization, Data curation, Research, Methodology, Writing — review and editing, Validation, Visualization. **VBP:** Project administration, Formal Analysis, Conceptualization, Data Curation, Investigation, Methodology, Resources, Writing — original draft, Writing — review and editing, Supervision, Validation, Visualization.

REFERENCES

1. World Health Organization. WHO guidelines for safe surgery 2009. Safe surgery saves lifes [Internet]. 2009 [cited on Nov 16, 2021]. Available from: https://apps.who.int/iris/handle/10665/44185

2. Association of periOperative Registered Nurses. Updates for more effective hypothermia prevention [Internet], 2019 [cited on Nov 16, 2021]. Available from: https://www.aorn.org/about-aorn/aorn-newsroom/periop-today-newsletter/2019/2019-articles/hypothermia-prevention

3. Associação Brasileira de Enfermeiros de Centro Cirúrgico, Recuperação Anestésica e Centro de Material e Esterilização. Diretrizes de prática em enfermagem perioperatória e processamento de produtos para saúde. 8ª ed. São Paulo: SOBECC; 2021.

4. North American Nursing Diagnosis Association. Diagnósticos de enfermagem da NANDA: definições e classificação 2018-2020. 10ª ed. Porto Alegre: Artmed; 2018.

5. Agência Nacional de Vigilância Sanitária. Critérios diagnósticos de infecções relacionadas à assistência à saúde. 2ª ed. Brasília: ANVISA; 2017.

6. World Health Organization. Global guidelines for the prevention of surgical site infection [Internet]. 2016 [cited on Nov 16, 2021]. Available from: https://www.who.int/publications/i/item/global-guidelines-for-the-prevention-of-surgical-site-infection-2nd-ed

7. Centers for Disease Control and Prevention. Procedure-associated module: surgical site infection. Atlanta: CDC; 2018.

8. Carvalho RLR, Campos CC, Franco LMC, Rocha AM, Ercole FF. Incidência e fatores de risco para infecção de sítio cirúrgico em cirurgias gerais. Rev Latino-Am Enfermagem 2017; 25: e2848. https://doi.org/10.1590/1518-8345.1502.2848

9. Poveda VB, Nascimento AS. The effect of intraoperative hypothermia upon blood transfusion needs and length of stay among gastrointestinal system cancer surgery. Eur J Cancer Care (Engl) 2017; 26(6). https://doi.org/10.1111/ecc.12688

10. Brasil. Ministério da Saúde. Conselho Nacional de Saúde. Resolução nº 466 de 12 de dezembro de 2012 [Internet]. 2012 [cited on Nov 16, 2021]. Available from: https://conselho.saude.gov.br/ultimas_noticias/2013/06_jun_14_publicada_resolucao.html

11. Pereira NHC, Mattia AL. Complicações pós-operatórias relacionadas à hipotermia intraoperatória. Enferm Glob 2019; 18(55): 270-313. https://dx.doi.org/10.6018/eglobal.18.3.328791

12. Berríos-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg 2017; 152(8): 784-91. https://doi.org/10.1001/jamasurg.2017.0904

13. Association for Professionals in Infection Control and Epidemiology. Implementation guide. Infection preventionist's guide to the OR [Internet]. Arlington: APIC; 2018. [cited on Nov 16, 2021]. Available from: https://jnjinstitute.com/sites/default/files/2018-12/093691-180619-APIC-Implementation-Prevention-Guide.pdf

14. Eng OS, Raoof M, O'Leary MP, Lew MW, Wakabayashi MT, Paz IB, et al. Hypothermia is associated with surgical site infection in cytoreductive surgery with hyperthermic intra-peritoneal chemotherapy. Surg Infect (Larchmt) 2018;19(6):618-21. https://doi.org/10.1089/sur.2018.063

15. Prado CBC, Barichello E, Pires PS, Haas VJ, Barbosa MH. Ocorrência e fatores associados à hipotermia no intraoperatório de cirurgias abdominais eletivas. Acta Paul Enferm 2015; 28(5): 475-81. https://dx.doi.org/10.1590/1982-0194201500079

16. Ribeiro JC. Efeito da hipotermia sobre a incidência de infecção do sítio cirúrgico em cirurgias abdominais: estudo de coorte. [doctoral thesis]. Ribeirão Preto: Universidade de São Paulo, Escola de Enfermagem de Ribeirão Preto; 2017.

17. Fahim M, Dijksman LM, Biesma DH, Noordzij PG, Smits AB. Effect of intra-operative hypothermia on post-operative morbidity in patients with colorectal cancer. Surg Infect (Larchmt) 2021; 22(8): 803-9. https://doi.org/10.1089/sur.2020.229

18. Yamada K, Nakajima K, Nakamoto H, Kohata K, Shinozaki T, Oka H, et al. Association between normothermia at the end of surgery and postoperative complications following orthopedic surgery. Clin Infect Dis 2020; 70(3): 474-82. https://doi.org/10.1093/cid/ciz213