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ORIGINAL RESEARCH **GENERAL ANESTHESIA**

Efficacy of intravenous fluid warmer on prevention of hypothermia in laparoscopic gastrointestinal cancer surgeries during general anesthesia

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ABSTRACT

Background & objective: Perioperative hypothermia, if not managed adequately, might lead to increased risk of surgical site infection, decreased drug metabolism, a higher requirement for blood transfusions, and an increased chance of cardiac arrhythmias. Various active and passive methods to prevent hypothermia have been used. This study compared the incidence of hypothermia and shivering between patients receiving warmed intravenous fluids using fluid warmer and room temperature intravenous fluids in patients undergoing gastrointestinal cancer surgeries under general anesthesia.

Methodology: This prospective study was conducted in Shaukat Khanum Memorial Cancer Hospital and Research Centre's Department of Anesthesia and Pain Management, Lahore from January to June 2025. Patients aged 18 to 60 years who were undergoing elective laparoscopic gastrointestinal cancer surgery of duration of more than 2 hours were included. Laparoscopic surgery leading to exploratory laparotomy, severe endocrine, pulmonary, and cardiovascular disorders, and a pre-operative core temperature higher than 37.2 degrees Celsius were excluded. The lottery approach was used to randomly assign patients to either Group A or Group B. Fluid warmers were used to administer intravenous fluids to patients in Group A, whereas intravenous fluids at room temperature were administered to patients in Group B based on their body weight and hydration status (control group). The core body temperature was measured at the end of procedure using a temperature probe and the shivering score was recorded.

Results: In our study, the intravenous fluids using a fluid warmer led to a lower incidence of peri-operative hypothermia (2.38%) compared to the control group (28.57%), and the intravenous fluids using a fluid warmer group experienced significantly less shivering during the peri-operative period (19.05%) than the control group (42.86%).

Conclusion: In conclusion, patients undergoing gastrointestinal cancer surgery can benefit from continuous active warming as it can enhance the quality of postoperative rehabilitation and successfully prevent intraoperative hypothermia and shivering.

Abbreviations: HME: heat and moisture exchanger, PACU: post-anesthesia care unit,

Keywords: Gastrointestinal Cancer Surgeries, intravenous fluid warmer, hypothermia.

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1. INTRODUCTION

Perioperative hypothermia is defined as a core body temperature of less than 36.0 C. It is a common anesthetic side effect that increases the risk of illness and mortality. Increased risk of surgical site infection, decreased drug metabolism, a higher requirement for blood transfusions, and an increased chance of cardiac arrhythmias are all negative consequences of hypothermia. Numerous guidelines[1] that compile best practices for the prevention and management of hypothermia in adults following surgery have addressed perioperative hypothermia. Through the compensatory mechanisms of vasodilation, sweating, and shivering, the posterior hypothalamus regulates body temperature within a narrow range of changes in core body temperature.[2]

Perioperative hypothermia arises from the interaction of anesthesia-induced impairment of the thermoregulatory mechanism, surgical variables, and operating room ambient factors.[3] The primary cause of general or neuraxial anesthesia is heat redistribution from the core to the periphery as a result of vasodilation.[4] The temperature differential between the core and peripheral compartments determines how much heat is redistributed. Prewarming, or actively warming the skin prior to surgery, might decrease this gradient by raising the peripheral thermal compartment's heat content.[5] However, using a brief prewarming time by itself does not alter the intraoperative temperature fall and has a negligible impact on the perioperative core temperature. Although heat redistribution is the most likely cause of peri-operative hypothermia, surgical factors also play a role in systemic heat loss during the intraoperative phase.[3] The choice of laparoscopic vs open surgery, duration and site of surgery are major determinants of peri operative hypothermia.[6] Prevention strategies employed include use of pre-operative forced air warming devices, warm intravenous fluids, cotton blankets and HME filters but no technique is superior to other.

As far as we are aware, no research has been done in Pakistan to far that assesses the effectiveness of fluid warmers in preventing post-operative hypothermia and shivering, especially in cancer patients.

2. METHODOLOGY

The Shaukat Khanum Memorial Cancer Hospital and Research Centre's Department of Anesthesia and Pain Management in Lahore conducted this randomized controlled study from January to June 2025. Ethical approval was given by the IRB. Sample size was calculated by taking the proportion of shivering in active warming group versus passive warming group as 22% and 52%, respectively.[7] At 80 % power, 95 % confidence interval, assuming 10 percent dropout rate, a total of 84 patients will be included in this study divided into 42 in each group. Patients aged 18 to 60 years who were undergoing elective laparoscopic gastrointestinal cancer surgery of duration of more than 2 hours were included. Pre-operative core temperature greater than 37.2 degree centigrade, severe endocrine, respiratory, and cardiovascular disease and laparoscopic surgery proceeding to exploratory laparotomy were excluded.

Using the lottery approach, patients were assigned at random to either Group A or Group B. While patients in Group B received intravenous fluids at room temperature based on their needs, such as body weight and hydration status (control group), patients in Group A received intravenous fluids using a fluid warmer. The patients in both groups were put under general anesthesia. Induction was accomplished with intravenous propofol 2 mg/kg and atracurium 0.5 mg/kg, while anesthesia was maintained with sevoflurane. A blanket heated by forced air was given to both patient groups. During surgery, the patient's core body temperature was taken using a temperature probe that was placed into the nasopharynx. Using a temperature probe that had already been positioned, the core body temperature was collected at the conclusion of the procedure and recorded on Performa (connected at the end). Following extubation, the patient was moved to the post-anesthesia care unit (PACU), where the shivering score was registered on Performa five minutes after arrival.

The analysis was done on a computer. The version of SPSS 27.0 was utilized. For every patient group, the mean ± SD of the shivering score in the PACU and the core temperature at the conclusion of the procedure were determined. The frequency and proportion of shivering, hypothermia, and gender were computed. The degree of hypothermia and shivering in the two groups was compared using the chi square test, and a p-value of less than or equal to 0.05 was deemed significant. After the data had been categorized by age, gender, and BMI, the chi square test was employed; a p value of less than or equal to 0.05 was deemed significant.

3. RESULTS

Demographic data of the study participants is given in Table1. Mean age was 43.87 ± 12.68 years. Patients in Groups A and B had mean ages of 44.12 ± 12.24 and 43.62 ± 12.88 years, respectively. Group B mean BMI was 26.05 ± 3.21 kg/m^2, while Group A mean BMI was 25.69 ± 2.98 kg/m^2. Table I displays the ASA status of the patients.

Table 1: Comparative demographic data (n = 84).

Variables		Group A (n = 42)	Group B (n = 42)	P-value
Age (years)	**18-40**	16 (38.10)	19 (45.24)	0.5632
	41-60	26 (61.90)	23 (74.76)	
Gender	**Male**	24 (57.14)	26 (61.90)	0.6711
	Female	18 (42.86)	16 (38.10)	
BMI (kg/m²)	**≤25**	20 (47.62)	21 (50.0)	0.7098
	>25	22 (52.38)	21 (50.0)	
ASA status	**1**	16 (3810)	13 (30.95)	0.4935
	2	26 (61.90)	29 (69.05)	

Data given as n (%); Chi-square or t-test were used to show significance. P < 0.05 is significant
BMI: Body mass index; ASA: American Society of Anesthesiologists physical status.

Table 2: Comparison of hypothermia and shivering between groups

Outcome	Group A (n = 42)	Group B (n = 42)	Chi-square	P-value
Hypothermia	1 (2.4)	12 (28.6)	11.01	0.0091
Shivering	8 (19.1)	18 (42.9)	5.57	0.0183

Data given as n (%); Chi-square or t-test were used to show significance. P < 0.05 is significant

Table 3: Stratification of hypothermia by age, gender, BMI, and ASA

Variable	Category	Group A	Group B	P-value
Age (years)	18–30	00 (0.0)	06 (31.58)	0.0132
	31–45	01 (3.85)	06 (26.09)	0.0264
Gender	Male	00 (0.0)	08 (30.77)	0.0032
	Female	01 (5.56)	04 (25.0)	0.1104
BMI (kg/m²)	≤25	01 (5.0)	05 (23.81)	0.0891
	>25	00 (0.0)	07 (33.33)	0.0035
ASA	I	00 (0.0)	02 (15.38)	0.1044
	II	01 (3.85)	10 (34.48)	0.0051

Data given as n (%); Chi-square or t-test were used to show significance. P < 0.05 is significant

In our study, the intravenous fluids using a fluid warmer led to a lower incidence of peri-operative hypothermia (2.38%) compared to the control group (28.57%), and the intravenous fluids using a fluid warmer group experienced significantly less shivering during the peri-operative period (19.05%) compared to the control group (42.86%). (Table 2). Stratification of hypothermia and shivering with respect to age, gender, BMI and ASA is shown in Table 3 & 4 respectively.

4. DISCUSSION

The high incidence of intraoperative hypothermia in many cancer surgery procedures is a significant cause of morbidity and a separate risk factor for cancer patients' overall survival.[8] In fact, there is still a significant rate of

Table 4: Stratification of shivering by age, gender, BMI, and ASA

Variable	Category	Group A	Group B	p-value
Age (years)	18–30	05 (31.25)	08 (42.11)	0.5084
	31–45	03 (11.54)	10 (43.48)	0.0121
Gender	Male	05 (20.83)	12 (46.15)	0.0592
	Female	03 (16.67)	06 (37.50)	0.1691
BMI (kg/m²)	*≤25*	*04 (20.0)*	*08 (38.10)*	*0.2034*
	>25	04 (18.18)	10 (47.62)	0.0402
ASA	I	04 (25.0)	03 (23.08)	0.9042
	II	04 (15.38)	15 (51.72)	0.0053

Data given as n (%); Chi-square or t-test were used to show significance. P < 0.05 is significant

intraoperative hypothermia following radical tumor excision; this may be because operators spend more time dissecting lymph nodes while adhering to the no-touch and block resection principles to prevent tumor spread.[8]

The usefulness of intravenous fluids using a fluid warmer during laparoscopic gastrointestinal cancer surgery and its relationship to postoperative rehabilitation, however, have not been thoroughly studied.

Based on the results of the study, the intravenous fluids using a fluid warmer group had a significantly lower incidence of perioperative shivering (19.05%) compared to the controlled group (42.86%), and the intravenous fluids using a fluid warmer group resulted in a lower incidence of perioperative hypothermia (2.38%) compared to the controlled group (28.57%). A study by Jun et al. (2020) found that the active warming group went through the perioperative period with much less shivering (22%) than the controlled group (52%), and that the intravenous fluids using a fluid warmer group resulted in a lower incidence of perioperative hypothermia (0%) than the controlled group (48%).[7]

According to Dan et al (2024), at least 34.1% of patients having elective open abdominal surgery experienced intraoperative hypothermia.[9] However, their study did not concentrate on patients with stomach cancer; rather, it covered individuals undergoing all types of abdominal surgery. Consequently, compared to our study, the incidence of hypothermia was greater. Ninht et al.'s study (2010) demonstrated that the prevalence of perioperative hypothermia was as high as 41%.[10] Additionally, the study participants had open abdominal surgery, which exposed vast skin surfaces for an extended period of time.

Intraoperative hypothermia was linked in the current study to higher immediate postoperative pain scores, longer times from the completion of surgery to tracheal extubation and the onset of the first postoperative flatus, and more instances of postoperative shivering and agitation. The study's findings were in line with earlier research; Madrid et al. (2016) found that approximately one-third of surgical patients receiving active warming had a higher incidence of postoperative shivering than those who were not receiving forced air warming.[11] By decreasing the shivering threshold and affecting the body's capacity to regulate temperature, the majority of narcotic medicines decrease sensitivity to hypothermia in a dose-dependent manner. According to the findings, up to 65% of patients under general anesthesia experienced postoperative shivering. Shivering raises the body's need for oxygen, which raises the risk of problems.[12,13,14] In the earlier trial, extended postoperative extubation time and agitation after anesthesia were frequent side effects.[12,15] Enzyme activity and the majority of biological processes are temperature-dependent. Thus, it should come as no surprise that even mild hypothermia prolongs the effects of several medications. Perioperative hypothermia is linked to delayed awakening from anesthesia by altering medication metabolism.[16]

The findings of Luke Reynolds et al. (2008), in contrast to the current investigation, showed that a simple 1.9 °C core hypothermia increases hospital stays by 20%.[17] As a result, patients experienced fewer unpleasant responses. Future studies with ethical permission are needed to determine whether a core body temperature below 36 °C raises the probability of negative effects.

Consistent with our research, Rongjuan et al. (2019) demonstrated that a forced-air warmer could significantly reduce the time until the patient

experienced their first flatus and that intraoperative normothermia could enhance the recovery of intestinal motility.[18] Yeh et al. (2008) shown that in patients having laparoscopic colorectal surgery, the passage of flatus was more delayed when heated and humidified CO_2 was used.[19] However, a number of additional risk variables, including the use of an enema and perioperative care that adheres to the improved recovery after surgery (ERAS) standards, were linked to the day to first flatus. Moreover, the research was restricted to colorectal surgery. Intraoperative hypothermia in our investigation led to a clinically significant increase in the immediate postoperative pain score.

The study's findings indicated that intraoperative hypothermia in a clinical environment did not appear to have an impact on opioid requirements. The fact that every patient in this study had laparoscopic surgery may be the cause of this. Furthermore, a variety of factors, such as non-pharmacological management techniques, preoperative pain education, and the standard of pain management, affect postoperative pain.[20,21,22]

5. LIMITATIONS

We are aware of the study's various shortcomings. First off, this study was limited to patients undergoing laparoscopic gastrointestinal cancer surgery; additional research is required to confirm its generalizability to other populations. Then, bladder temperature appears to be reliable and not less reliable than the other evaluation site that is currently in use.[23] However, the pulmonary artery catheter is still the gold standard for measuring core temperature[24], thus future temperature measurement techniques will need to confirm the quality. Furthermore, we must recognize that the patient population included in this study spans a wide age range (18–60 years). Future research has to be more subdivided because body temperature regulation is a component of homeostatic control and differs greatly between age groups. The fact that the study included patients who had the same surgical procedure, surgeon, and treatment plan is significant.

6. CONCLUSION

In conclusion, patients undergoing gastrointestinal cancer surgery can benefit from continuous active warming as it can enhance the quality of postoperative rehabilitation and successfully prevent intraoperative hypothermia and shivering. Anesthesiologists and operating room nurses should take specific preventive action and pay closer attention to fluctuations in perioperative core body temperature.

7. Data availability

The numerical data generated during this research are available from the authors.

8. Conflict of interest

All authors declare that there was no conflict of interest.

9. Funding

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

HE: designed study protocol, collected data, wrote manuscript, responsible for IRB and SRC review,

ADA: Concept, supervised the conduct of study, data analysis, reviewed manuscript.

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