An-Najah National University

Faculty of Graduate Studies

EFFECT OF WARMED VERSUS ROOM TEMPERATURE FLUID ADMINISTRATION ON POSTOPERATIVE HYPOTHERMIA AND SHIVERING AMONG ELECTIVE ABDOMINAL SURGERY PATIENTS

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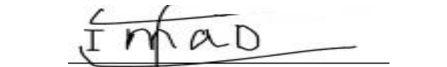

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Dedication

To my beloved family, whose unwavering support and encouragement have been my greatest source of strength and inspiration. Your love and belief in me have made this journey possible.

To my dear friends, for your constant cheer and understanding during both the challenging and triumphant moments of this endeavor. Your companionship has been invaluable.

To my esteemed colleagues, for your collaboration, guidance, and shared passion for learning. Together, we have navigated this path with dedication and determination.

Thank you all for being part of this journey with me.

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Thank you all for your unwavering support and belief in me.

Ahmad Abd Alkareem Hamad

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

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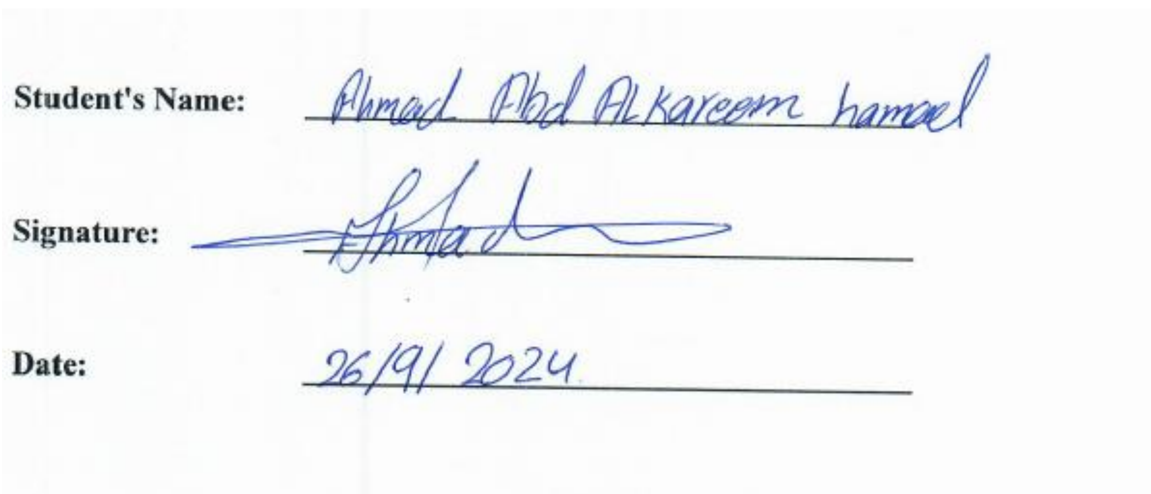
I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.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List of Contents

Dedication III
Acknowledgement IV
Ahmad Abd Alkareem Hamad IV
Declaration V
List of Contents VI
List of Tables VIII
List of Figures IX
List of Appendices X
Abstract XI
Chapter One: Introduction and Theoretical Background 1
1.1 Background 3
1.2 Physiology of shivering 5
1.3 Definitions of the key terms 9
1.4 Abdominal surgeries 12
1.5 Literature review 14
1.6 Problem statement 20
1.7 Aims and objectives 21
1.8 Research question 22
1.9 Hypotheses 22
1.10 Importance of the study 23
Chapter Two: Methods 24
2.1 Study design 24
2.2 Study setting 24
2.3 Population 24
2.3.1 Inclusion criteria 24
2.3.2 Exclusion criteria 26
2.4 Sample size and sampling method 26
2.5 Data collection and variables 28
2.5.1 The study tools 30
2.6 Statistical Analysis Methods 31
2.7 Ethical approval 31
Chapter Three: Results 32

3.1 Selection of the elective abdominal surgery patients 32
3.2 Characteristics of the elective abdominal surgery patients 33
3.3 Preoperative variables of the elective abdominal surgery patients 35
3.4 Intraoperative variables of the elective abdominal surgery patients 37
3.5 Postoperative variables of the elective abdominal surgery patients 39
3.6 Postoperative pain, hospital stay, and complications among the elective abdominal surgery patients in both groups 42
Chapter Four: Discussion and Conclusion 44
4.1 Summary of key findings 44
4.2 Discussion of the main findings 45
4.3 Strengths of the study 47
4.4 Limitations of the study 48
4.5 Implications for practice 48
4.6 Recommendations 49
4.7 Conclusion 49
List of Abbreviations 50
References 51
Appendices 59
الملخص .... ب

List of Tables

Table 1: Operative wound classification (48, 49) 13

Table 2: The American Society of Anesthesiologists (ASA) Physical Status Classification System (73) 25

Table 3: Demographic and surgical characteristics of the elective abdominal surgery patients in the two groups 34

Table 4: Preoperative variables of the elective abdominal surgery patients in both groups 36

Table 5: Intraoperative variables of the elective abdominal surgery patients 38

Table 6: Postoperative variables of the elective abdominal surgery patients in both groups 40

Table 7: Postoperative pain, hospital stay, and complications among the elective abdominal surgery patients in both groups 43

List of Figures

Figure 1: Hypothalamic thermoregulation (19) 4
Figure 2: The components of the physiology of shivering (24) 6
Figure 3: Mechanisms of hypothalamus to counterbalance the hypothermia (25) 7
Figure 4: Sample size calculation method 27
Figure 5: The patient selection process 32
Figure 6: Incidence of hypothermia among the elective abdominal surgery patients in both groups intraoperatively 39
Figure 7: Incidence of hypothermia among the elective abdominal surgery patients in both groups at admission to the PACU 41
Figure 8: Incidence of hypothermia among the elective abdominal surgery patients in both groups 30 min after admission to the PACU 42

List of Appendices

Appendix A: IRB Approval 59
Appendix B: Study approval 60

EFFECT OF WARMED VERSUS ROOM TEMPERATURE FLUID ADMINISTRATION ON POSTOPERATIVE HYPOTHERMIA AND SHIVERING AMONG ELECTIVE ABDOMINAL SURGERY PATIENTS

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Abstract

Background: Intraoperative hypothermia is one of the common complications associated with significant postsurgical complications and negative outcomes. The aim of this study to evaluate the effect of delivering warmed intravenous fluid to the patient undergoing elective abdominal surgery, on minimizing hypothermia and shivering.

Methods: Interventional research was done to assess the impact of administering warm intravenous fluids on reducing post-anesthesia shivering and hypothermia in patients undergoing elective abdominal surgery upon entering the operating room. The study was conducted in one of the main surgical hospitals in the West Bank, Palestine. In this study, a total of 118 elective abdominal surgery patients were assessed for eligibility. Of those, 90 were randomized into the intervention (n = 45) and control (n = 45) groups. Of those, half (50%) received warmed fluids (intervention group) and half (50%) received unwarmed fluids. The temperature of the elective abdominal surgery patients was assessed preoperatively, intraoperatively, upon admission, and 30 min after admission to the post anesthesia care unit. The Bedside Shivering Scale was used to evaluate elective abdominal surgery patients' shivering levels.

Results: The elective abdominal surgery patients in the control group had significantly lower heart rate ($p = 0.044$), intraoperative body temperature ($p = 0.003$), and more moderate and severe Bedside Shivering Scale ratings ($p = 0.043$) compared to the patients who received warmed intravenous fluids. On the other hand, the elective abdominal surgery patients in the control group lost significantly more ($p = 0.020$) blood compared to the elective abdominal surgery patients in the intervention group. At admission to the post anesthesia care unit, the elective abdominal surgery patients in the

control group had significantly lower heart rate ($p = 0.046$), body temperature ($p = 0.018$), and more moderate and severe Bedside Shivering Scale ratings ($p = 0.036$) compared to the elective abdominal surgery patients who received warmed intravenous fluids. Similarly, 30 min after admission to the post anesthesia care unit, the elective abdominal surgery patients in the control group had significantly lower heart rate ($p = 0.048$), body temperature ($p = 0.031$), and more moderate and severe Bedside Shivering Scale ratings ($p = 0.018$) compared to the elective abdominal surgery patients who received warmed intravenous fluids.

Conclusions: Overall, the provision of heated intravenous fluids effectively decreases the occurrence of hypothermia and shivering in elective abdominal surgery patients who are having clean open abdominal surgery. This simple but impactful technique improves elective abdominal surgery patients outcomes, shortens recovery time, and lowers the occurrence of surgical site infections. Introducing the use of heated intravenous fluids in surgical procedures might enhance the quality of care during the perioperative period, emphasizing the significance of this intervention in improving elective abdominal surgery patients safety and comfort.

Keywords: Hypothermia, Abdominal surgery, Perioperative care, Complications, Patient outcomes.

Chapter One

Introduction and Theoretical Background

In surgical practice, occurrence of hypothermia and shivering is one of the most common emergencies encountered in operative and post anesthesia recovery rooms (1, 2). Perioperative hypothermia is often seen due to the suppression of thermoregulation caused by anesthesia and the patient's exposure to a cold environment (1, 3). In the mid-19th century, the standard for normal body temperature was established as 37°C (4). The normal range of temperature for adults is 36.1 ºC to 37.2 ºC, variations in the body temperature are associated with the location of verification, including oral, esophageal, axillary, rectal, and tympanic temperature (4, 5).

Meiman et al (2015) assert that hypothermia is an avoidable factor leading to mortality (6). Hypothermia is said to occur when the core body temperature drops below 35 °C (95 °F) (6-8). The earliest signs of hypothermia include shivering and chilly extremities (7). Furthermore, when hypothermia deteriorates, the symptoms advance to include cognitive disorientation, impaired dexterity, and memory loss. Furthermore, if proper re-warming is not provided, the ongoing loss of heat may lead to low blood pressure, compromised breathing, irregular heart rhythms, and ultimately, death (1, 9). It has been postulated that the incidence of hypothermia following surgery and use of anesthesia may be attributed to many factors. These include the inhibitory effects of anesthesia on thermoregulation, exposure to a chilly environment in the operating room, and the use of inhalation anesthetic, intravenous medicines, and fluids.

Core body temperature has become a fundamental parameter for monitoring patients who are having general anesthesia in recent years (1, 9). Starting with the mid-1990s, researchers noted that 60% of patients had hypothermia during surgery, and 30% of patients had a core body temperature below 35°C (10). Consequently, issues such as abnormal rapid heart rhythm, high blood pressure, and heightened susceptibility to infection linked to low body temperature during surgery and the immediate postoperative period (1, 9, 10).

General anesthesia eliminates the patient's capacity to control body temperature by voluntary actions, leaving only the autonomic defenses to react to temperature fluctuations. Shivering is a common occurrence throughout the postoperative phase. It is

a reflexive, rhythmic contraction of muscles that increases the generation of metabolic heat by up to 600% compared to the normal level (11). Post anesthesia shivering is characterized as a sudden, uncontrollable, and unexpected muscle activity (12). Post anesthesia shivering affects about 40% of patients who are in the process of recovering from general anesthesia (11, 12). This shivering is often preceded by cerebral hypothermia and peripheral vasoconstriction, suggesting that it is primarily a thermoregulatory response. Not all shivering is related to regulating body temperature, which complicates the treatment of post-anesthetic shivering. Furthermore, varying frequencies of shivering in the patients who were warmed and those who were not warmed were previously noted (13, 14). Shivering was seen in about 40% of patients who regained consciousness after general anesthesia without being warmed. Half of the patients whose core temperatures were 35.5 °C and 90% whose temperatures were 34.5 °C experienced this. Furthermore, postoperative shivering is a significant consequence of hypothermia that leads to a substantial increase in oxygen demand, ranging from 200 to 600%, in proportion to the amount of heat lost during the surgery, particularly in cases of hypothermia (13, 14).

Perioperative patient-warming devices have been in development since the 1980s. A study was conducted to examine the impacts of fluid warming in various countries. In their 1998 study, Smith, Gerdes, and Sweda discussed the phenomenon of warming during gynecological surgery (15). The study found that patients who were administered warmed fluid did not have hypothermia, in contrast to those who received fluid at room temperature. In a research conducted in 2007 by Smith, Sidhu, Lucas, Mehta, and Pinchak, they used the use of warming techniques in patients who were having ambulatory surgery (16). In a study conducted in China in 2011 by You, Xu, and Cao, the focus was on the use of warming devices in abdominal surgeries (17). This is because the abdomen is the largest area of skin exposed to heat loss and is also at risk of bleeding and other complications, as it contains major organs of the body.

When intravenous fluids are injected at room temperature, there is a possibility that hypothermia may occur (1, 2, 11, 13). It has been calculated that the infusion of 1 liter of crystalloid solution at ambient temperature reduces the average body temperature by 0.25˚C. Anesthesia leads to a decrease in temperature, which is directly related to the level of anesthesia achieved. This decrease is caused by a lowering of the

vasoconstriction threshold by 2-4 °C. Typically, the core temperature decreases by 0.5-1.5 °C within the first hour after the start of general anesthesia. This decrease is primarily due to heat loss caused by the vasodilating effects of anesthetics and heat redistribution within the body.

1.1 Background

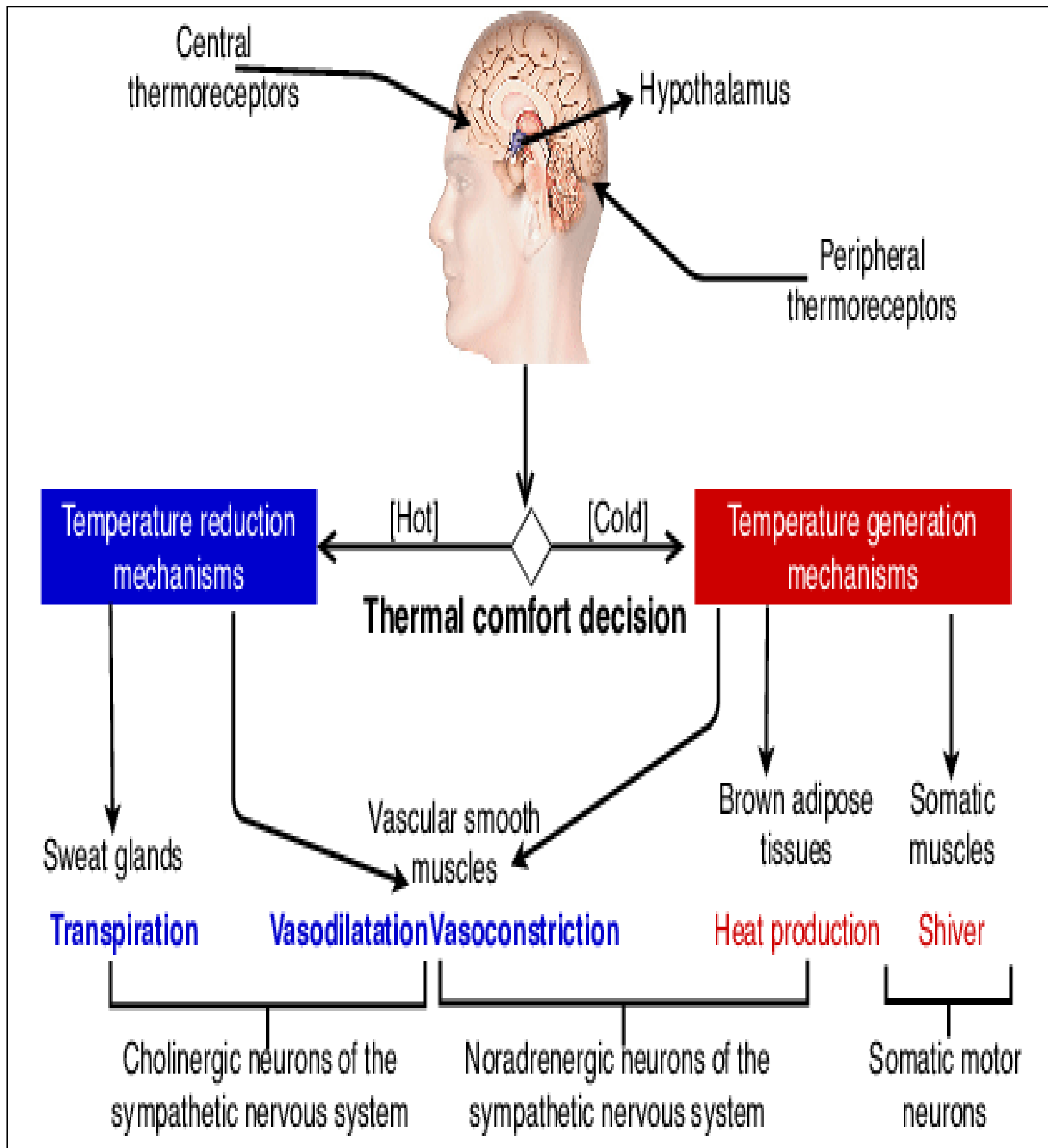
Hypothermia is a condition characterized by a core temperature that falls below 36 °C (1, 7). Furthermore, the core temperature may be accurately assessed in the tympanic membrane, pulmonary artery, nasopharynx, or distal esophagus. For clinical reasons, the core temperature may be accurately calculated using measurements of the oral, rectal, axillary, or bladder temperature. Hypothermia is classified into four degrees based on its severity: mild (32–35 °C), moderate (28–32 °C), severe (20–28 °C), and profound (less than 20 °C).

In response to a drop in temperature, our bodies constrict the blood vessels close to the skin, redistributing the body's warm blood to its core. After then, heat is able to leave the body via the skin while the inside remains warm. Shivering, which involves the contraction of muscles to generate heat, is used in cases when this is insufficient to maintain the body's temperature (1, 18).

What makes up physiologic thermoregulation is a network of afferent thermal sensors, central regulation, and efferent reactions. In hypothermia, cold-sensitive cells in the brain, spinal cord, deep abdomen, thoracic, and skin surfaces cause afferent thermal sensing. (Figure 1). Control of core body temperature is mostly vested in the hypothalamus, with some influence from the spinal cord. Vasoconstriction and shivering are adult manifestations of the efferent response to hypothermia, but behavioral change is the most common.

Figure 1

Hypothalamic thermoregulation (19)



The hypothalamus receives temperature signals, which are then combined and compared with threshold temperatures that activate appropriate thermoregulatory responses (20, 21). Typically, these reactions are triggered when the temperature is just slightly above or below the average body temperature of 37 °C (98.6 °F), by as little as 0.1 °C. Hence, the temperature discrepancy that triggers perspiration compared to that which triggers vasoconstriction is about 0.2 °C. The interthreshold range is the specific region in which the body does not activate thermoregulatory mechanisms. General anesthetics decrease the activity of the hypothalamus, which leads to an increase in the

range of temperatures that may be tolerated by the body, up to 4 °C. Consequently, patients have a reduced capacity to adapt to temperature fluctuations that arise during therapy.

The regulation of body temperature is achieved by the equilibrium between thermogenesis and thermolysis (20, 21). They said that heat generation is facilitated by mechanisms that regulate the body's metabolic rate, including the baseline metabolism of body cells and additional metabolism resulting from muscular activity, hormone actions, and other factors. Heat loss is a result of two processes: the transmission of heat from deep tissue to the skin by conduction, and the transfer of heat from the skin to the surrounding environment. Furthermore, they elucidated the mechanisms by which warmth is transferred, namely via four phenomena: radiation, when the patient emits heat into the surrounding environment (22). Radiation is the primary form of heat loss during surgery, although conduction plays a secondary role due to the patient's direct contact with the foam insulating mattress on the operating room table. In non-operating room hospital settings, the air in the room is usually replaced four times each hour. However, in typical operating rooms, the air exchange rate is higher, occurring 15 times per hour. The limited airflow in the operating area creates a subjective sensation of coldness. Surgical drapes function as thermal insulators in order to reduce convective heat loss. Although draping helps to reduce heat loss, convective heat loss is still regarded the second most major cause of heat loss in the operating room. Additionally, evaporation is another common kind of heat loss that happens when sterile preparation solutions are used. Evaporative losses from surgical wounds may also be a contributing factor.

1.2 Physiology of shivering

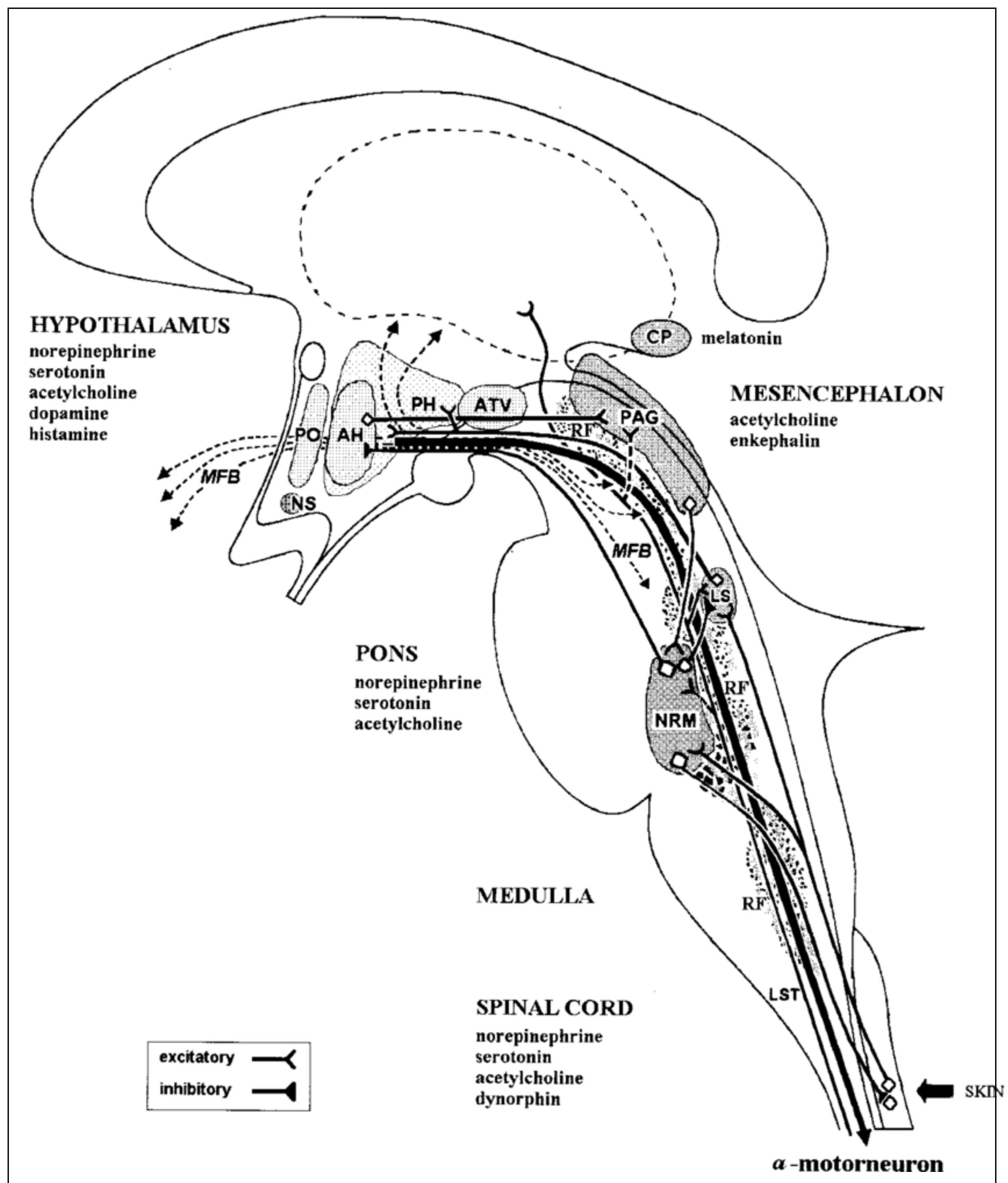
The physiological process of shivering is regulated by three main factors:

- Central control,
- The efferent response route,
- The afferent neural pathway

By integrating and regulating thermal information among these components, we have an efficient system that keeps our core body temperature within a narrow range, between 36.5 and 37.5 °C, by means of behavioral and autonomic responses that safeguard against fluctuations in core temperature, guaranteeing that our bodies function at their best. Older people have less control over their thermoregulatory response (23).

Figure 2

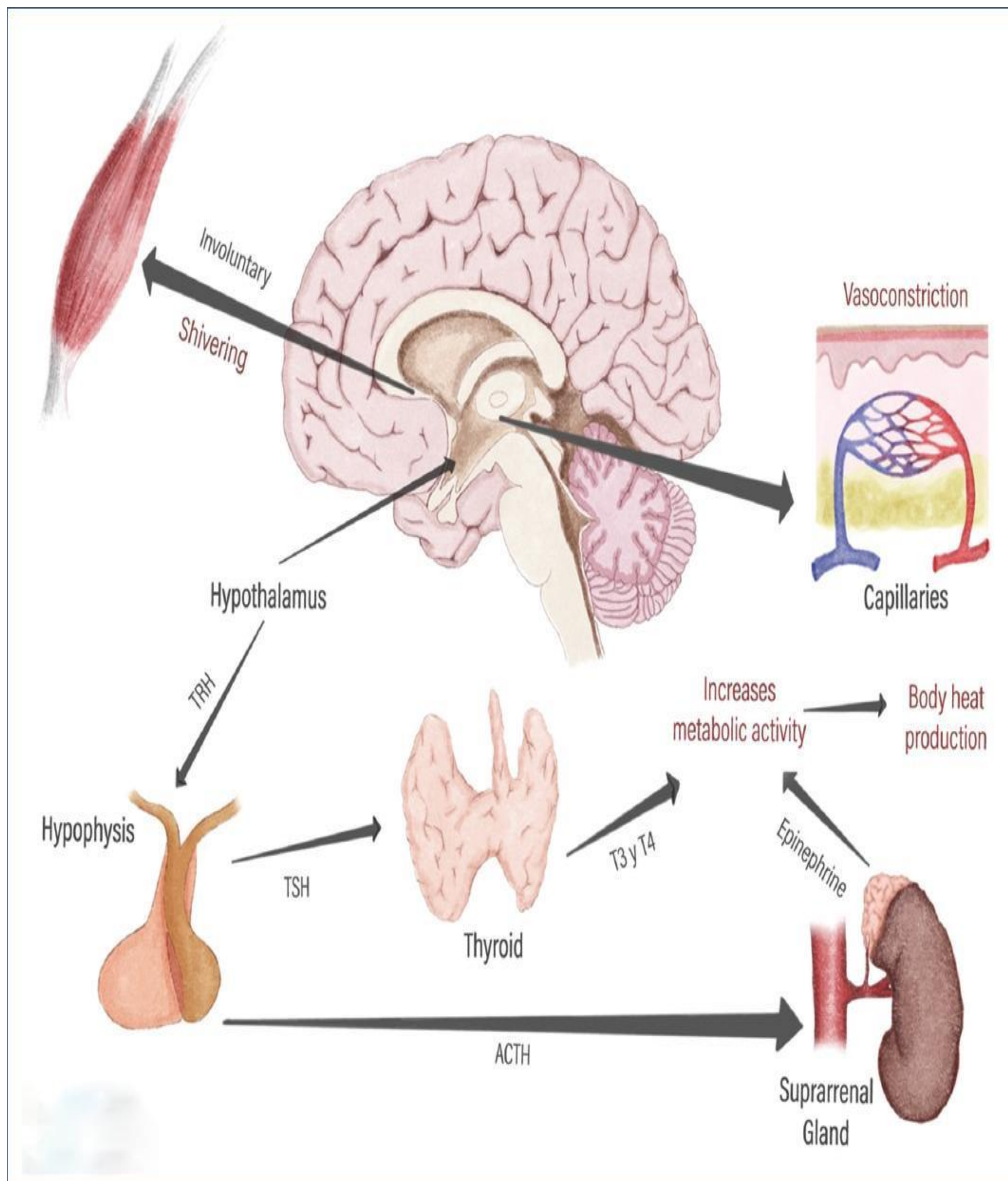
The components of the physiology of shivering (24)



In addition, other organs and organ systems are also involved in the pathophysiology of intraoperative hypothermia as shown in Figure 3.

Figure 3

Mechanisms of hypothalamus to counterbalance the hypothermia (25)



The process of shivering involves the cooling of the preoptic area of the anterior hypothalamus, which in turn activates the motor center of shivering situated in the posterior hypothalamus (20, 26). Consequently, the pathway that causes shivering is triggered, leading to an increase in muscular tone in the spinal cord. This is brought about by the activation of certain areas of the brainstem, including the mesencephalon, dorsolateral pontine, and medullary reticular formation, due to changes in temperature. The activation of alpha motor neurons is the ultimate shared route, and the simultaneous firing is achieved by the suppression of Renshaw cells (inhibitory interneurons).

The commonly accepted definition of anesthesia, which describes it as the loss of "awareness," is imprecise. A more practical definition of anesthesia is the administration of a combination of amnesia, analgesia (pain control), and muscle relaxation to enable surgical procedures or interventions (27). Anesthesia is the deliberate reduction of awareness. This should not be mistaken with lack of recollection. A patient who lacks the ability to remember events following general anesthesia may yet have been cognizant during the treatment. The claim that anesthetic-induced drowsiness and forgetfulness are causally linked to a reduced concentration of acetylcholine in the brain lacks experimental proof.

The American Society of Anesthesiologists described the process of inducing consciousness and amnesia in six distinct phases (27). During stages 1 and 2, the suppression of the brainstem reticular activation system leads to a reduction in the presence of acetylcholine, which in turn causes a decrease in the responsiveness of the limbic system and prevents the preservation of memories. During stages 3 and 4, if the reticular activation system is further depressed, it will cause the thalamic gates to close, preventing reverberations in the thalamocortical system. Ultimately, during stages 5 and 6, the parietal-frontal transactions are obstructed, resulting in the depression of the prefrontal cortex and subsequent unconsciousness.

The primary objectives of anesthesia are to provide pain relief and induce a state of relaxation during surgical procedures, while also ensuring that the patient does not retain any memory of the events that occurred during the operation (28, 29). An anesthesiologist may accomplish these objectives by using general, regional, or local anesthetic. The selection of an anesthetic method is often based on surgical

requirements, such as patient position or the need for relaxation, as well as the patient's overall condition.

1.3 Definitions of the key terms

- **Abdominal surgery:** An operation in which the surgeon opens the abdominal cavity to remove or mend abnormal, superfluous, or cancerous tissue (30). Abdominal surgery includes surgical procedures performed on many organs inside the abdominal cavity, such as the small intestine, esophagus, pancreas, gallbladder, liver, stomach, large intestine, spleen, and appendix. The operations may be conducted for many purposes, including as addressing infection, blockage, tumors, or inflammatory bowel disease. The categorization of previous abdominal surgery prior abdominal surgery refers to any prior surgical procedure performed on the abdomen, either by laparoscopy or laparotomy. Prior abdominal surgery may be further categorized as major or minor (30).

- **Open wounds**: Fissured skin, exposing the underlying tissue to the external environment (31).

- **Core temperature:** It refers to the temperature in internal tissues including the chest, abdomen, and central nervous system (8). The temperature is carefully regulated, often maintained at a level that is 2-4 °C (3.6-7.2 °F) higher than the temperature of the skin. Core temperatures are assessed using several methods, including measuring temperatures at specific locations such as the distal esophagus, bladder (when urine flow is high), nasopharynx, and pulmonary artery (8).

- **Preoperative fasting:** Preoperative fasting refers to a certain length of time before a medical treatment during which patients are prohibited from consuming any liquids or solid foods orally (32).

- **Warming cabinet:** A warming cabinet, often referred to as a solution warming cabinet, lotion warming cabinet, or heated lotion cabinet, is specifically built for use in hospital operating theatres (33). Its purpose is to warm bottles or bags of fluid to body temperature or higher (33).

- **Post anesthesia shivering:** Post anesthesia shivering refers to a sudden, uncontrollable, and uncontrolled muscle activity (34).

- **Shivering:** Shivering is an involuntary and oscillatory muscle activity that increases metabolic heat generation by up to 600% over the baseline level (35).

- **Normothermia**: Normothermia refers to a state in which the body temperature falls between the range of 36º C to 38 ºC (36).

- **Hypothermia:** It is defined as having a core body temperature ≤ 35 °C (95 °F) (7).

- **General anesthesia:** Various surgical procedures are performed under general anesthesia, such as abdomen, knee and hip replacement, ears, nose, and throat, among other surgeries (37). General anesthesia is induced by administering drugs that cause amnesia, analgesia, muscular paralysis, and sleepiness to the patient. An anesthetized patient might be considered to be in a regulated and reversible condition of unconsciousness. General anesthesia is induced when a patient is given drugs that induce amnesia, analgesia, muscular paralysis, and sleepiness. An anesthetized patient might be considered to be in a regulated and reversible condition of unconsciousness. Anesthesia allows patients to endure surgical operations that might otherwise cause excruciating pain, intensify physiological distress, and lead to unpleasant recollections. General anesthesia and unconsciousness are often achieved by intravenously administering medicines such as barbiturates, opiates, and more recently, propofol, a novel sedative-hypnotic agent. After inducing unconsciousness, anesthesia is sustained by administering a mixture of substances such as inhaled anesthetics, opiates, propofol, and neuromuscular blocking medications. The inhaled anesthetics may be delivered by a face mask or a laryngeal mask airway (37).

- **Midazolam:** Midazolam is a water soluble and does not require a lipoidal vehicle (such as propylene glycol) for parenteral use (38). Each milliliter of preparation contains 1 or 5 mg of midazolam. The half-life of midazolam 1.7-2.6 hr.

- **Atracurium:** Atracurium is rapidly distributed throughout the extra cellular space after IV injection (39). Doses of 0.3 to 0.6 mg/kg. The duration of atracurium

increases as its dose increases. On average, as an intermediate relaxant, the duration of action is 30 to 60 min.

- **Neostigmine:** Neostigmine is administered at a dosage of 25-75 mcg/kg (39). It takes 5-15 min for the drug to take effect, and its effects last for 45-90 min. It is mostly used as a reversal medication and may potentially enhance the occurrence of postoperative nausea and vomiting.

- **Atropine:** Atropine is administered at a dosage of 15 micrograms per kilogram (40). It takes 1-2 min to take effect and its effects last for 1-2 hours. Edrophonium should be added due to its faster onset.

- **Regional anesthesia:** Regional anesthesia encompasses several types, with spinal anesthesia and epidural anesthesia being the most prevalent (41).

- **Spinal and epidural anesthesia:** Spinal and epidural blocks are collectively referred to as central neuraxial blockade because they include the administration of local anesthetic solution onto or near the spinal cord (41). Spinal and epidural blocks have similar morphology and physiology, yet they differ from one other because of their unique anatomic, physiologic, and clinical characteristics. The first clinical use of the Spinal method was purportedly conducted in the late 1890s. Nevertheless, the predominance of spinal anesthetic was brief. After the patient is properly positioned, the lumbar area of the back is identified using anatomic surface cues. This region will be utilized for dural puncture, specifically a spot below the termination of the spinal cord known as L2. The intercristal line, also known as Tuffier's line, extends horizontally across the vertebral column, ranging from the L3 to L4 disk to the L5 to S1 disk (41).

- **Epidural anesthesia:** Epidural anesthesia is a kind of central neuraxial block that is applicable for a diverse range of medical operations (42). Contrary to spinal anesthesia, which produces a complete block, epidural anesthesia may be adjusted to provide either pain relief or complete anesthesia for a broad range of surgical and pain management operations. Anatomical spread occurs when local anesthetics or other analgesic treatments are administered into the epidural space. Medication distributes horizontally to the areas around the dural cuffs, allowing it to diffuse into

the cerebrospinal fluid and seep into the intra vertebral foramen and Para vertebral spaces, resulting in analgesia/anesthesia (42).

- **Local anesthesia:** Local anesthesia is the injection of an anesthetic substance directly into the tissue, specifically targeting the area of the body that requires minor surgery or a treatment, in order to numb it (43).

- **Body mass index (BMI):** A person's body mass index (BMI) is determined by squaring their height in meters and dividing their weight in kilograms (44).

1.4 Abdominal surgeries

Abdominal surgery may be conducted using two techniques: open surgery and laparoscopy (45). Open abdominal surgery involves making large incisions to directly see the region being operated on. This approach yields positive results, but it also results in prolonged recuperation periods, substantial job and daily routine absences, and noticeable aesthetic imperfections. The technique was first used in the field of general surgery in 1988 for the purpose of extracting a gallbladder (46).

Typically, wounds may be categorized as either closed (when the skin remains unbroken) or open. Open wounds occur when the skin is split, exposing the underlying tissue to the external environment. This increases the risk of bleeding and infections. All wounds resulting from surgical procedures are categorized as acute wounds. Accidental wounds include a range of injuries caused by various forms of physical harm, such as abrasions, punctures, penetrating wounds, gunshot wounds, and incisions. These are most frequently the outcome of a surgical intervention or a skin incision made with a sharp instrument, such as scalpels, knives, or scissors. The incisions often have a linear form and have crisp, clean edges (47).

Acute wounds are categorized based on particular criteria related to the cause, kind of tissue damage, and accompanying pollution. Operative wounds have been classified into four distinct categories. Each class exhibits a progressive rise in bacterial contamination and the existence of nonviable tissue. The classification of operative wounds is shown in Table 1.

Table 1

Operative wound classification (48, 49)

Class	Description	Surgical examples	Wound infection risk (%)
I	Clean	Operative wounds that are not infected and for which gastrointestinal, respiratory and urinary tracts are not entered	1-2
II	Clean-contaminated	Operative wounds where the gastrointestinal respiratory and urinary tracts are entered with minimal contamination	Up to 30% (Organ-dependent)
II	Contaminated	Wounds where there has been a major break in sterile technique. Wounds made through or near contaminated skin. Wounds where there is inflammation without purulence.	Up to 60%
IV	Infected	Wounds where there is purulent infection.	Up to or >60%

The preoperative use of antibiotics as a preventive measure has become a crucial component in the management of surgical patients (50). Prophylactic antibiotics are administered to patients prior to the occurrence of contamination or infection. In surgical patients, these antibiotics are given just before or during the procedure. The administration of antibiotics has been proven to result in a one-week increase in hospitalization and a 20-30% increase in hospital costs due to surgical wound infections. Conversely, the inappropriate and indiscriminate use of prophylactic antibiotics can lead to increased costs, unnecessary drug use, and the growth of resistant organisms (50).

Hernia repair is classified as a 'clean' surgical procedure. The prevalence of wound infection after clean surgeries, such as hernia, varicose vein, and breast surgeries, is often underestimated. Ceftriaxone, cefazoline, and cefuroxime are some of the prophylactic antibiotics that are often used in different hospitals (51).

1.5 Literature review

Several international research have been conducted worldwide on the warming of intravenous fluid after abdominal surgery and its impact on reducing postoperative hypothermia and shivering. However, no study has been conducted on this issue in Palestine. The research used the databases MedLine, Science Direct, Google Scholar, and Pub Med. Data was retrieved from many countries' databases. The literature review was constrained by just looking for items produced in the English language.

A recent study was conducted to assess the impact of a 10-minute prewarming procedure, together with the delivery of warmed intravenous fluid during surgery after transurethral surgery while under general anesthesia, on patients' core temperatures (52). This research involved a total of fifty patients who were having prostate resection or transurethral bladder under general anesthesia. The patients were randomly assigned to either the control group or the pre-warming group. Patients in the pre-warming group had a 10-minute warming procedure before to anesthesia induction using a forced-air warming equipment. Additionally, they received IV fluid that had been warmed throughout the surgical procedures. The control group patients did not undergo preoperative forced-air warming and were given room-temperature liquids. Participants' core body temperature was assessed upon arrival at the preoperative holding area (T0), upon entering the operating room, immediately after anesthesia induction, and at 10-minute intervals thereafter until the end of the operation (Tend). Temperature measurements were also taken upon entering the post anesthesia care unit and at 10-minute intervals during the stay in the post anesthesia care unit. A comparison was made between the groups in terms of the occurrence of intraoperative hypothermia, the difference in core temperature (T0 - Tend), and the level of thermal comfort after the surgery. The occurrence of hypothermia was 64% in the control group and 29% in the prewarming group, with a statistically significant difference ($P = 0.015$). The control group saw a change in core temperature of 0.93 ± 0.3 °C, whereas the prewarming group experienced a change of 0.55 ± 0.4 °C ($P = 0.0001$). A statistically significant improvement in thermal comfort was seen in the prewarming group in comparison to the other group ($P = 0.004$). After conducting the research, the researchers came to the conclusion that a ten-minute prewarming phase, in conjunction with the administration of warmed intravenous fluid, significantly decreased the incidence of intraoperative

hypothermia and significantly enhanced the thermal comfort of patients who had transurethral urologic surgery while under general anesthesia (52).

A recent randomized controlled single-blind trial focused on patients undergoing elective open abdominal surgery. The study aimed to investigate the impact of a forced-air warming blanket on core temperature in various body regions (53). Following open abdominal surgery, a total of 537 patients were randomly assigned to one of three groups and given distinct forced-air warming blankets. Each of the three groups received a distinct kind of blanket: an underbody blanket, a lower body blanket, and an upper body blanket. This study conducted a comparison between three groups in terms of many factors associated with intraoperative hypothermia, including the duration of hypothermia, the speed of body warming, the rate of rewarming, and the occurrence of related problems. Group B showed a prevalence of 51.4% instances of intraoperative hypothermia, whereas group A had 37.6% and group C had 34.1% ($P = 0.002$). Before the onset of hypothermia, the duration for groups A and C to maintain their core temperatures over 36 °C was substantially longer (log-rank $P = 0.006$). Groups A and C exhibited shorter durations of hypothermia, quicker rates of rewarming, reduced occurrences of shivering, and fewer instances of postoperative nausea and vomiting in comparison to group B. The study's results indicate that patients who had planned open abdominal surgery had a reduced risk of hypothermia when they were provided with a forced-air warming blanket. The duration for the core temperature to drop below 36 °C was prolonged, and once it reached that point, it exhibited enhanced resistance to further decreases in temperature. Within the postoperative care unit, it has shown remarkable efficacy in reducing postoperative nausea, vomiting, and shivering (53).

A recent systematic study with meta-analysis was performed to assess the efficacy of using carbon-fiber polymer-fabric resistive heating combined with forced-air warming in reducing unintentional intraoperative hypothermia in patients undergoing elective abdominal surgeries (54). The study analyzed several randomized controlled trials to provide a comprehensive evaluation of the two methods. The quantitative synthesis includes a total of five randomized controlled studies including 282 participants who were having elective operations. Four investigations have established that forced-air warming is as effective to carbon-fiber polymer-fabric resistive heating in the prevention of hypothermia. Nevertheless, research produced contrasting results,

indicating that the effectiveness of forced-air warming was greater to that of carbon-fiber polymer-fabric resistive heating, with a low occurrence of hypothermia. A meta-analysis revealed that forced-air warming was superior than carbon-fiber polymer-fabric resistive heating in its efficacy for avoiding hypothermia. The study concluded that carbon-fiber polymer-fabric resistive heating was shown to be less efficient than forced-air warming (forced-air warming) in preventing hypothermia during elective abdominal surgery. Nevertheless, hypothermia persisted in the forced-air warming group. Additional research is advised to assess the efficacy of warming technology by taking into account both the incidence of hypothermia and the core body temperature, since this methodology is more unbiased (54).

Another systematic review was conducted to validate the most effective technique for using forced air warming intervention to avoid peri-operative hypothermia in abdominal surgery (55). A systematic review and meta-analysis were performed to provide a consolidated and evaluative assessment of the included research. We conducted a systematic search for randomized controlled trials published to March 2020 using PubMed, EMBASE, CINAHL, and Cochrane Library CENTRAL. A comprehensive review was conducted on twelve studies on forced air warming intervention. The forced air warming strategy successfully averted peri-operative hypothermia in patients having open abdominal and laparoscopic surgery. A statistically significant impact size could not be demonstrated when the intervention was given solely before or during the operation. The upper body was the main center of focus, as opposed to the lower or whole body. These results might provide precise standards and criteria that can be efficiently used in the clinical setting for conducting abdominal surgery.

A separate research investigated the influence of warming intravenous fluids on the central body temperature after elective orthopedic procedures (56). An intravenous (IV) fluid warmer was used either alone or in conjunction with forced warm air to evaluate the individual or combined effects of IV fluid warming. The study investigated the outcomes of dogs that received no heat assistance compared to those who received just forced warmed air in a randomized prospective trial design. The study's results suggested that the heating of intravenous fluids did not affect the dogs' ability to maintain or preserve their core body temperature. In line with previous studies, the use of pushed warmed air has been shown to decrease the rate of heat dissipation during

anesthetic procedures. The relative location of the fluid warmer in relation to the patient might be a logical explanation for the lack of benefit. This study represents the first exploration of the effects of warming intravenous fluids on the central body temperature of dogs that are having a planned orthopedic surgery (56).

A comprehensive systematic review with network meta-analysis of randomized controlled trials was conducted to examine the impact of various warming methods on hypothermia in individuals who have had abdominal surgery (57). The main result measured was the central body temperature at 60 and 120 minutes following the start of anesthesia for abdominal surgery. The secondary measure was the occurrence of postoperative shivering. This study consisted of a total of 24 randomized controlled trials including 1119 people. At 60 and 120 minutes after anesthesia induction, a forced-air warming system applied to the upper body (with a temperature increase of 0.3 °C and a 95% confidence interval of [0.3 to 0.4]), lower body (with a temperature increase of 0.4 °C and a confidence interval of [0.3 to 0.5]), and underbody (with a temperature increase of 0.5 °C and a confidence interval of [0.5 to 0.6]) was more effective than passive insulation in regulating core body temperature. The use of forced-air warming system on the lower body (odds ratio = 0.06) or underbody (0.44), as well as the electric heating blanket on the lower body (0.02) or the entire body (0.07), considerably decreased the likelihood of experiencing shivering when compared to passive insulation. The findings of this network meta-analysis demonstrate that the use of forced-air warming with an underbody blanket successfully raises core body temperatures between 60 and 120 minutes after the administration of anesthesia. Additionally, it effectively reduces shivering in patients throughout the recovery phase after abdominal surgery (57).

A randomized clinical trial was conducted to examine the impact of two therapies, compared to the regular use of pethidine, on shivering in patients who are having abdominal surgery under general anesthesia (58). A total of eighty-seven patients who were scheduled for abdominal surgery under general anesthesia were randomly divided into three groups, with two groups receiving different interventions while the third group followed the normal procedure including the use of pethidine. Patients in the warmed intravenous fluids group were administered pre-warmed Ringer serum at a temperature of 38°C. In addition, patients in the combined warming group received pre-

warmed Ringer serum at a temperature of 38°C, coupled with humid-warm oxygen. Patients in the pethidine group received intravenous pethidine on a regular basis. The length of shivering and specific hemodynamic signs of the participants were assessed during a 20-minute period after surgery in the recovery room. The mean duration in the group administered warmed intravenous serum, the group administered combination warming, and the group administered pethidine was 7 (1.5) minutes, 6 (1.5) minutes, and 2.8 (0.7) minutes, respectively. The observed difference was statistically significant at a significance level of $P < 0.05$. Both the groups who received combination heat and pethidine saw a significant increase in body temperatures ($P < 0.05$). The research found that simultaneous warming may successfully control postoperative shivering and avoid an increase in body temperature (58).

Another study was conducted to assess the impact of continually administering warmed (at a temperature of 37.0° C [98.6° F]) intravenous fluids on two groups of middle-aged female patients who were having laparoscopic cholecystectomy operations (59, 60). The researchers postulated that increasing the temperature of intravenous fluids administered during surgery would reduce the likelihood of patients experiencing hypothermia. A cohort of patients was administered prewarmed intravenous fluids that gradually cooled to the ambient temperature throughout the surgical procedure. The second group was administered intravenous fluids that were consistently heated by a fluid warmer during the surgical procedures. Analyses of covariance, using the initial intraoperative temperature measurement as the covariate, showed no significant results at the $P <.05$ level. The findings indicate that the continuous administration of warmed intravenous fluids during laparoscopic surgical operations of short duration does not have a major impact on the maintenance of patients' body temperatures (59, 60).

An experiment was carried out to examine the hypothesis that combining the warming of intravenous (IV) fluids with convective warming leads to a lower occurrence of intraoperative hypothermia (core temperature below 36.0°C) compared to using convective warming alone (61, 62). 61 patients with ASA physical status I, II, and III who are having major surgery and receiving general anesthesia with isoflurane were included. Convective warming was administered to all patients. Patients in Group 1 were given warmed fluids at a temperature of 42°C. Group 2 patients were given fluids at a temperature of around 21°C. The lowest and final temperatures measured in the

distal esophagus during surgery were significantly higher in Group 1 (mean ± SEM: 35.8 ± 0.1°C and 36.6 ± 0.1°C) compared to Group 2 (35.4 ± 0.1°C and 36.1 ± 0.1°C, respectively), with a p-value of less than 0.05. A higher proportion of patients in Group 2 (10 out of 26, or 38.5%) were hypothermic at the conclusion of anesthesia compared to Group 1 (4 out of 30, or 13%; $p < 0.05$). Following a 30-minute period in the recovery room, there were no discernible variations in temperature between the two groups. The temperature measurements for Group 1 and Group 2 were recorded as 36.7 ± 0.1°C and 36.5 ± 0.1°C, respectively. In 33% of patients in Group 1, convective warming during surgery had to be stopped because their core temperature was higher than 37°C. This was compared to just 11.5% of patients in Group 2. The difference between the two groups was not statistically significant ($p = 0.052$). The use of both convective and fluid warming techniques was linked to a reduced probability of patients exiting the operation theater with hypothermia. Nevertheless, the average end temperatures exceeded 36°C in both groups, with little variations across the groups. It is important to be cautious in order to prevent the patient from overheating while using both warming techniques simultaneously (61, 62).

Another study was conducted to assess the impact of administering warmed intravenous (IV) fluid to patients in order to avoid intraoperative hypothermia (63, 64). During extended abdominal surgery, the core and mean skin temperatures of 18 patients were recorded. The patients were randomly assigned to two groups based on their intraoperative IV fluid management. All intravenous fluids administered to the control group consisted of fluids at room temperature in 9 individuals. In the remaining 9 patients (in the group that received warmed fluids), all intravenous (IV) fluids were heated using an active IV fluid tube-warming device. All 18 patients had a warming blanket placed on their skin surface to provide cutaneous warmth. The calculation of changes in total body heat content (kJ) during surgery was based on the measurements of core and mean skin temperatures. After the operation, the core temperature of the group that received warmed fluids was 36.7±0.2°C, whereas the control group had a core temperature of 35.8±0.2°C ($P<0.05$). The warming of IV fluid resulted in an estimated decrease in heat loss of 217 kJ, which closely aligns with the predicted theoretical value calculated via thermodynamics. During the recovery period, a single patient had shivering in the group that received warmed fluids, whereas seven patients in the control group experienced shivering ($P<0.05$). To summarize, the administration

of heated fluids, together with warming the skin's surface, aids in the prevention of hypothermia and decreases the occurrence of postoperative shivering (63, 64).

1.6 Problem statement

Hypothermia and shivering pose significant challenges in several hospitals worldwide, particularly in the operating room. Over the last 20 years, many nations have developed several interventional studies to minimize hypothermia (1).

Patient pain is caused by hypothermia and shivering during the recovery from general anesthesia. Intraoperative hypothermia is primarily caused by the redistribution of heat within the body, which is facilitated by the vasodilation induced by anesthesia. This condition can lead to various complications, including a 20% increase in the duration of hospitalization, postoperative wound infections, myocardial ischemia, and a decrease in cardiac output due to hypothermia-induced bradycardia. Post anesthesia shivering may lead to problems such as coagulopathy, wound infection, reduced immunity, and increased oxygen use (2, 65).

The total number of hypothermia-related fatalities in the United States for a ten-year period (2003-2013) was 13,419. The yearly rates of these deaths, when not corrected, ranged from 0.3 to 0.5 per 100,000 individuals (6, 66). Between 26 and 90 percent of elective surgery patients in Germany have hypothermia in the postoperative period (67-69). The occurrence of impaired wound healing is linked to a 3.25 (95% CI 1.35 to 7.84) relative risk when compared to normothermia. A relative risk of 4.49 (95% CI 1.00 to 20.16) for cardiac problems and a related risk of 1.33 (95% CI 1.06 to 1.66) for increased bleeding after blood transfusions was identified.

Various techniques are used to address the issue of hypothermia and shivering both before and after surgery, including the use of skin coverings such as surgical drapes, blankets, or plastic bags (70). Applying a single layer of insulation lowers heat loss by about 30 percent. However, in most situations, some type of active warming is necessary to avoid hypothermia during surgery. Forced-air warming is often the most efficient approach currently available. It may be used on its own or in combination with fluid warming. Warming fluids to around 37 °C is effective in preventing hypothermia and is suitable for administering large amounts (70).

By warming the intravenous fluid, the outcome was a reduction in hypothermia and shivering. Furthermore, research was conducted to evaluate the efficacy of several warming techniques in avoiding a reduction in core temperature during anesthesia and post-anesthesia shivering. Forced air warming coupled with a surgical access blanket, forced air warming paired with an upper body blanket, and a circulating water mattress were the modalities that were used. Using a surgical access blanket to warm the patient was shown to be more successful than the other ways of warming, according to the findings of the research. A total of 39.9% of patients had hypothermia during the operation. All of the patients were given passive warming measures, such as surgical sheets or cotton blankets; however, only 10.7% of the patients received active warming via the use of space heaters or electric blankets. The intravenous administration of pre-warmed fluid was administered to 16.9% of patients, whereas the irrigation of wounds with pre-warmed fluid was administered to 34.6% of patients. It is estimated that around forty percent of individuals who have not been warmed after receiving general anesthesia are affected by shivering. This is a considerably higher prevalence. Furthermore, it is seen in around fifty percent of patients who have a core temperature of thirty-five degrees Celsius, and in ninety percent of patients who have a core temperature of thirty-four and a half degrees Celsius (70).

No studies have been undertaken yet to determine the incidence of hypothermia and shivering after surgery in Palestine and the Arab world. Furthermore, there is a lack of research conducted in Palestine about the use of warming intravenous fluids during clean abdominal procedures and its impact on hypothermia and shivering (70).

1.7 Aims and objectives

The aim of this study was to evaluate the effect of delivering warmed intravenous (IV) fluid to the patient undergoing elective abdominal surgery, on minimizing hypothermia and shivering.

The specific objectives of the study were:

- To determine the rate of elective abdominal surgery patients who developed hypothermia during/post operation among patient who were given warmed fluid (at 37˚C) versus those who were given fluid at the room temperature (25˚C).

- To estimate the percentage of elective abdominal surgery patients who developed shivering post operation who were given warmed fluid (at 37˚C) versus those who were given fluid at the room temperature (25˚C).

- To compare the rate of elective abdominal surgery patients who would develop shivering post operation that given warmed fluid, versus the rate of those who would be given fluid at the same room temperature.

1.8 Research question

The study questions were:

- What was the incidence of hypothermia and shivering in patients who have elective abdominal surgery, independent of the fluid temperature (either 25˚C or 37˚C)?

- What was the percentage of elective abdominal surgery patients who developed shivering post operation who were given warmed fluid (at 37˚C) versus those who were given fluid at the room temperature (25˚C)?

1.9 Hypotheses

The main hypotheses in this study were:

- The incidence of hypothermia in elective abdominal surgery patients receiving warmed fluid at 37˚C during and after surgery was expected to be significantly lower compared to those receiving fluid at room temperature (25˚C).

- The incidence of postoperative shivering was expected to be significantly lower among elective abdominal surgery patients who get warmed fluid at 37˚C compared to those who receive fluid at room temperature (25˚C).

- Administering warmed intravenous fluid (at a temperature of 37 ˚C) to elective abdominal surgery patients may significantly reduce the likelihood of developing hypothermia and experiencing shivering.

1.10 Importance of the study

The study's findings might have positive effects on four categories: society, patients, medical team, and hospital (71). No studies have been conducted in Palestine about the warming of intravenous fluids. Additionally, there is a lack of important information regarding the occurrence of complications related to hypothermia and shivering in Palestine. Although such instances have occurred in operation rooms, there is a notable absence of clear evidence and documentation regarding these cases.

Additionally, this research would serve as a comprehensive assessment for the medical team. This investigation might be helpful in enhancing knowledge regarding hypothermia and shivering. It would likely enhance the medical team and the country's knowledge of potential complications associated with shivering and hypothermia.

For future researchers, this study may provide fundamental data on the current state of warming intravenous fluid in sterile abdominal surgery and its potential to reduce the impact of shivering and hypothermia. Crucially, this study will inform the decision-making process on whether it is really fulfilling its commitment to the community.

Chapter Two

Methods

2.1 Study design

Interventional research was done to assess the impact of administering warm intravenous fluids on reducing post-anesthesia shivering and hypothermia in patients undergoing elective abdominal surgery upon entering the operating room (72). This research design was selected based on its suitability for achieving the goals, since it involves implementing an intervention and then measuring the result of the intervention.

2.2 Study setting

The study was conducted in one of the main surgical hospitals in the West Bank that is located in Jerusalem area, Palestine. had the cabinet warmer that was used during the study.

2.3 Population

The target group consisted of patients who were scheduled to have elective abdominal surgery at the hospital. The length of the operation was estimated to range from 30 to 120 minutes. A thorough history was conducted to eliminate any patients who did not meet the specified criteria.

2.3.1 Inclusion criteria

The inclusion criteria were:

- Patients in the age group 18-70 years old.
- Patients who were scheduled for an elective abdominal surgery.
- American Society of Anesthesiologists (ASA) physical status I-III (Table 2).

Table 2

The American Society of Anesthesiologists (ASA) Physical Status Classification System (73)

ASA Classification	Definition	Examples
ASA1	Physiologically sound individual	The individual does not have any biological, physiological, or psychological abnormalities. This assessment does not include those who are very young or very elderly. The individual is in excellent health and has a high level of exercise tolerance.
ASA2	Individuals with minor systemic illness	The individual does not have any impairments that affect their ability to perform. They have a well-managed condition in one body system. They have controlled hypertension or diabetes without any impact on the whole body. They smoke cigarettes without having chronic obstructive pulmonary disease. They have a modest case of obesity and are now pregnant.
ASA3	Individuals suffering from a serious systemic illness	The individual has several functional limitations and is managing a chronic disease that affects multiple body systems or a major system. There is no immediate risk of death. The controlled conditions include congestive heart failure, stable angina, a previous heart attack, poorly controlled hypertension, morbid obesity, and chronic renal failure. Additionally, the individual experiences intermittent symptoms of bronchospastic disease.
ASA4	Patients suffering from a serious systemic condition that poses a continuous risk to their lives	Exhibits at least one serious condition that is inadequately managed or in its last stage; potential risk of mortality; unstable angina, symptomatic chronic obstructive pulmonary disease, symptomatic congestive heart failure, hepatorenal failure
ASA5	Terminally ill individuals who are unlikely to live without the surgical procedure	The patient is not anticipated to live for more than 24 hours without undergoing surgery. There is an immediate danger of mortality due to multiple organ failure, sepsis syndrome with unstable blood flow, low body temperature, and poorly regulated blood clotting.
ASA6	A patient who has been certified brain-dead and whose organs are being extracted for the purpose of donation.	

2.3.2 Exclusion criteria

Elective abdominal surgery patients who had anemia, which may be attributed to potential blood transfusion and increased fluid administration during surgery. Elective abdominal surgery patients who were on calcium channel blockers were not included in the study due to the fact that these medications may produce changes in blood vessel constriction and significant changes in core body temperature during surgery. Elderly elective abdominal surgery patients who were older than 70 years old were excluded because their thermoregulatory thresholds are lowered than those in younger elective abdominal surgery patients. The elective abdominal surgery patients who had thyroid disorders, neurological disorder, or shock manifestations were also excluded. Elective abdominal surgery patients with malignant hyperthermia and epilepsy, characterized by involuntary movements, were also excluded to avoid confusion with shivering.

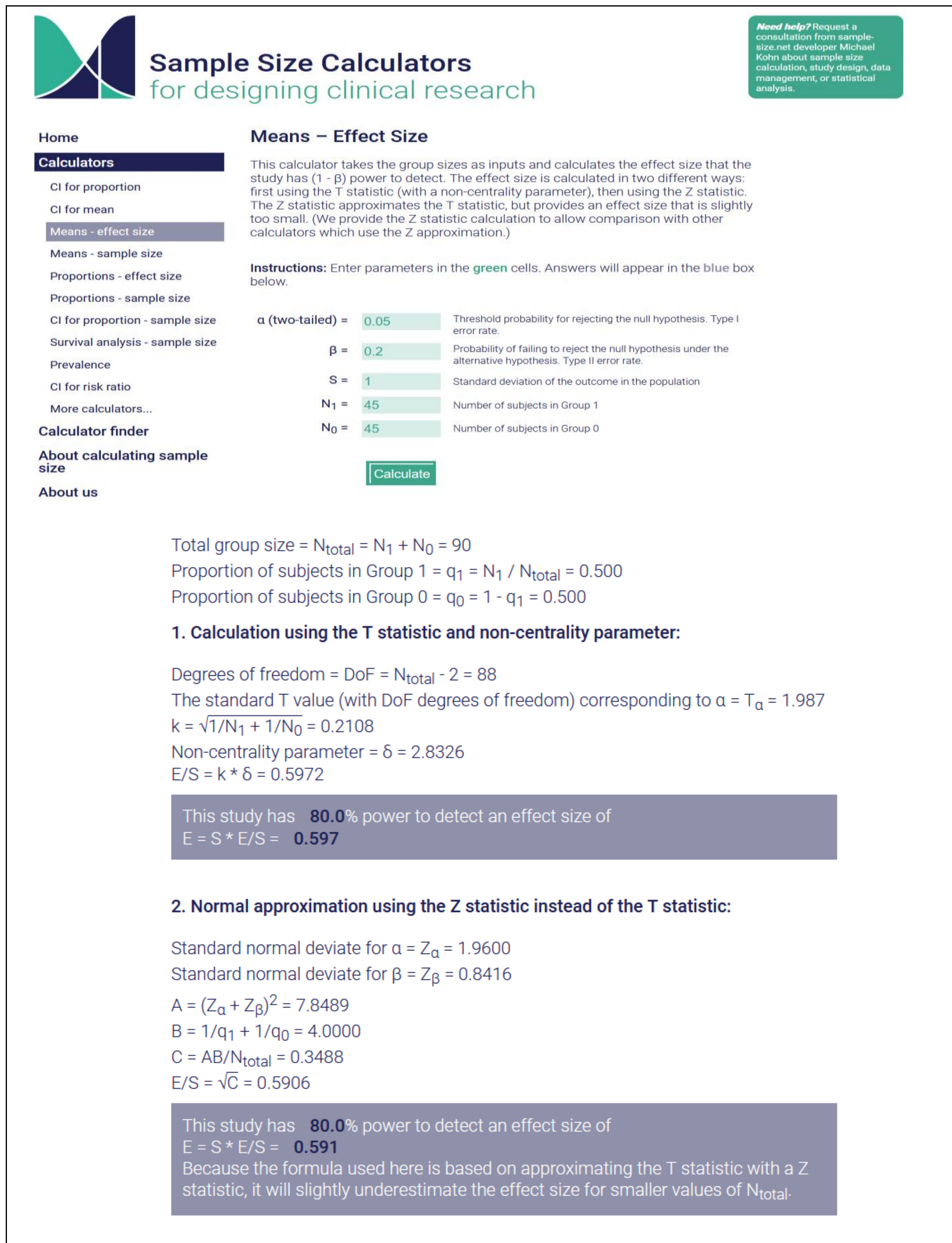
2.4 Sample size and sampling method

The sample size was estimated based on the previous related studies (52, 54-59, 61, 63, 74). In this study, the sample size was calculated using a sample size calculator (https://sample-size.net) as shown in Figure 4. A two-tailed alpha of 0.05, beta of 0.2, standard deviation of 1, and number of elective abdominal surgery patients in each group was 45. The calculated power of the study was 80.0%.

The elective abdominal surgery patients were randomly assigned to either intervention or control groups. elective abdominal surgery patients were assigned odd and double numbers. The elective abdominal surgery patients who had odd numbers were randomized to the intervention group and the elective abdominal surgery patients who had double numbers were randomized to the control group.

Figure 4

Sample size calculation method



2.5 Data collection and variables

A data collection form was used to collect the data needed for this study. Information on the age, gender, smoking habits, and kind of surgery planned for each elective abdominal surgery patients was recorded. Before undergoing surgery, every elective abdominal surgery patients had an evaluation to ascertain the presence of any chronic conditions. In addition, the elective abdominal surgery patients were subjected to a thorough assessment that included a complete blood count (CBC), vital signs, body temperature, electrocardiogram (ECG), respiratory rate, body mass index (BMI), and a detailed examination following the guidelines established by the American Society of Anesthesiologists (ASA). Observations were made on white blood cells (WBCs), red blood cells (RBCs), hemoglobin (Hb), hematocrit (Htc), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platelets (PLT), and prothrombin time (PT).

Blood pressure, body temperature, systolic blood pressure, and peripheral capillary oxygen saturation (SpO2) are the things that are measured. The measures were taken before the elective abdominal surgery patients went into surgery, during surgery, when they were admitted to the post-anesthesia care unit (PACU), and 30 minutes after they were admitted to the PACU. Similarly, the Bedside Shivering Scale was administered on the elective abdominal surgery patients upon entry of the elective abdominal surgery patients to the operation room, during surgery, upon admission of the elective abdominal surgery patients to the PACU, and 30 min after admission of the elective abdominal surgery patients to the PACU (75). The elective abdominal surgery patients were rated as: 0: None (no signs of masseter, neck or chest wall shivering, through palpitations), 1: Mild (shivering limited to neck and/or thorax), 2: Moderate (with shivering gross movements of upper extremities creep in from ‘neck and thorax region’), 3: Severe (shivering comes into play and includes gross movements of the trunk, upper and lower extremities).

During surgery, the temperature of the IV fluids, total IV fluids volume, duration of surgery, amount of blood loose during surgery, the operating room temperature, and the operating room humidity were noted. Similarly, during elective abdominal surgery patients stay at the PACU, the PACU temperature and the PACU humidity were also noted.

Preoperative liquid fasting and fasting were conducted as part of the procedure, and preoperative medications were administered. Subsequently, elective abdominal surgery patients were transferred to the operation room, where a multi-function monitor was used to constantly monitor their ECG, SpO_2, and non-invasive blood pressure. A G-18 peripheral cannula was inserted into a large vein, and an IV-line of 180 cm was utilized to provide a sodium lactate Ringer's solution at a rate of 200 cc per hour.

The induction of general anesthesia was achieved using propofol at a dosage of 2.0-2.5 mg/kg, and it was maintained using a combination of propofol and nitrous oxide (N_2O) at a concentration of 60% mixed with oxygen. The use of non-depolarizing relaxants (atracurium) aided in the process of tracheal intubation and surgery. The adjunct medications administered included fentanyl. Anesthetic gases were administered via a tracheal tube utilizing a circular system, heat and moisture exchanger, and a COP soda lime absorber. The ventilation was regulated to sustain normal levels of carbon dioxide in the blood (PETCO~ 30- 35 mm Hg) using fresh gas flows of 2 L/min. During the procedure, body temperatures of the tympanic membrane was taken before the elective abdominal surgery patients was anesthetized, and after 15 minutes of the start of surgery. The temperature probe remained in place while the elective abdominal surgery patients was being transferred to the PACU.

Following pre-oxygenation, anesthesia was induced by delivering fentanyl and propofol to facilitate intubation. Anesthesia was then maintained by administering atracurium at a dose of 0.2 mg/kg, along with a mixture of 50% N_2O and 50% oxygen. Following the procedure, a muscle relaxant was administered for 15 minutes. To counteract the effects of the relaxant, atropine at a dosage of 0.02 mg/kg and neostigmine at a dosage of 0.04 mg/kg were given.

The intervention group received warned IV fluids (37 ˚C) and the control group received IV fluids at room temperature. The temperature in the operation room was about (22-25) ˚C and the humidity was about 36%. Body temperature values of the elective abdominal surgery patients were measured in the first minute of arrival to the operation room. The intraoperative temperature values of the elective abdominal surgery patients were measured after 15 min of the start of the surgery.

2.5.1 The study tools

The study tools consisted of five parts:

- **Part 1:** Demographic data: age, sex, BMI, gender, height, weight, history of diseases, allergy to any food or medication, and duration of surgery (min), duration of anesthesia, medical diagnosis, and surgery performed.

- **Part 2:** Blood pressure for all elective abdominal surgery patients was measured using the same technique, same sphygmomanometer. Heart rate of all elective abdominal surgery patients was measured using the same pulse oximeter. Body temperature of all elective abdominal surgery patients was measured by a tympanic membrane thermometer. Tympanic membrane thermometers use infrared sensors to measure the thermal radiation emitted by the tympanic membrane. The probe is securely placed into the ear canal, creating an airtight seal, and the temperature reading is obtained within a time span of 1-3 seconds. To take the temperature, put the probe securely into the outer ear, using mild but firm pressure. Angle the thermometer towards the elective abdominal surgery patients jawline, and then activate the device by pressing the trigger button. Temperature of all elective abdominal surgery patients was measured using the same thermometer. Similarly, the SpO_2 of all elective abdominal surgery patients was measured using the same oximeter.

- **Part 3:** The Bedside Shivering Scale was used to evaluate elective abdominal surgery patients shivering levels. The evaluation of shivering was conducted by an unbiased, highly experienced observer (a nurse) who was unaware of the details of the study. The shivering was assessed using a four-point scale: 0 indicated the absence of shivering. A score of 1 represented mild fasciculations in the face or neck. A score of 2 indicated noticeable tremors involving many muscle groups. A score of 3 represented significant muscular activity involving the whole body. In order to get an accurate assessment of the Bedside Shivering Scale, the evaluator was instructed to monitor the elective abdominal surgery patients for a duration of 2 minutes. During this time, the observer visually examined and touched the elective abdominal surgery patients neck, chest, arms, and legs.

- **Part 4:** The administration of fluids to the elective abdominal surgery patients during the procedure was recorded, including the specific type and volume. The type of fluid that was administered to the elective abdominal surgery patients included Ringer lactated and dextrose saline. The fluid was administered to the elective abdominal surgery patients simultaneously, using the same method, via an intravenous (IV) line of 180 cm, using a green cannula of size G 18. The delivery rate was 200 cc per hour. The temperature of the fluids in the test group was maintained at 37 ºC, whereas the fluids in the control group was kept at room temperature. Fluid administration was commenced upon the elective abdominal surgery patients arrival in the operating room. The fluids were heated by the warmer cabinet, with the temperature of the warmer cabinet being 37 ºC.

- **Part 5:** The quantity of blood lost during the surgery was estimated using specific guidelines. According to these guidelines, a surgical sponge measuring 10.16 cm (4 inches) by 10.16 cm (4 inches) and fully saturated with blood could hold approximately 10 mL of blood. Similarly, a gauze laparotomy tape measuring 30.48 cm (12 inches) by 30.48 cm (12 inches) and fully saturated with blood could hold approximately 100 to 150 mL of blood.

2.6 Statistical Analysis Methods

The data collected in this research were entered into SPSS v. 22.0 for Windows. Descriptive statistics like frequencies (n), percentages (%), mean, standard deviation (SD) were generated. Continuous data were compared using Student's t tests and categorical data were compared using Pearson's chi-square/Fisher's exact tests. A p value of < 0.05 was considered statistically significant.

2.7 Ethical approval

The study received approval from the research committee of the Faculty of Graduate Studies. Furthermore, the research received approval from the Institutional Review Board (IRB) of An-Najah National University. The elective abdominal surgery patients granted informed consent. Prior to their enrollment in the trial, the elective abdominal surgery patients were given the guarantee that all data gathered during this study would be handled with strict confidentiality.

Chapter Three

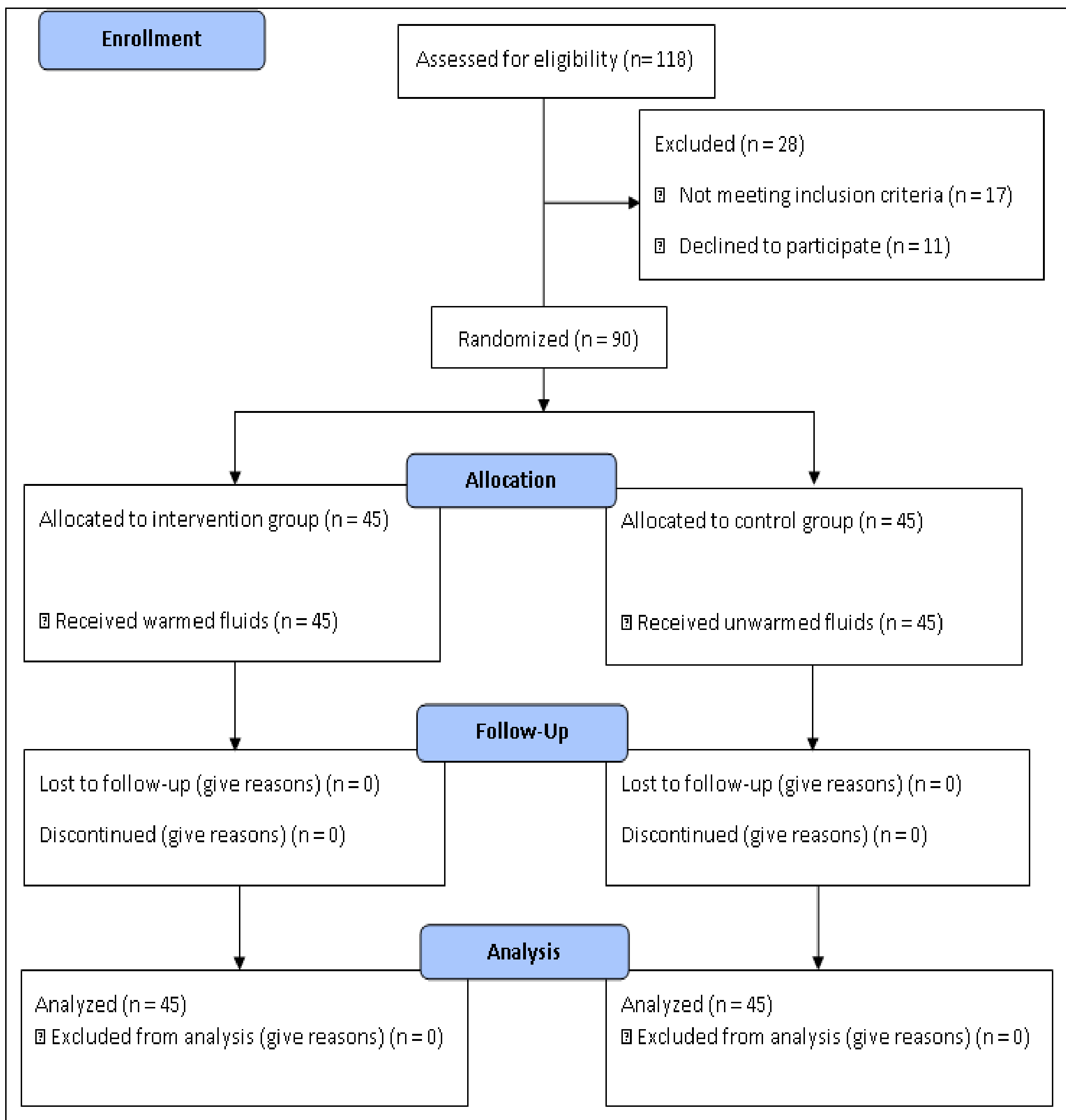
Results

3.1 Selection of the elective abdominal surgery patients

In this study, a total of 118 elective abdominal surgery patients were assessed for eligibility. Of those, 90 were randomized into the intervention (n = 45) and control (n = 45) groups. The elective abdominal surgery patients selection process is shown in Figure 5.

Figure 5

The patient selection process



3.2 Characteristics of the elective abdominal surgery patients

In this study, a total of 90 elective abdominal surgery patients were included. Of those, half (50%) received warmed fluids (intervention group) and half (50%) received unwarmed fluids. The characteristics of the elective abdominal surgery patients who were included in this study are shown in Table 3. The elective abdominal surgery patients were matched in terms of age, sex, body mass index, smoking status, presence of comorbid diseases, type of abdominal surgery, presence of electrocardiogram abnormalities, and the American Society of Anesthesiologists (ASA) class.

Table 3

Demographic and surgical characteristics of the elective abdominal surgery patients in the two groups

Variable	Intervention (warmed fluid) (n = 45)	Control (unwarmed fluid) (n = 45)	p
Age (years), mean ± SD	45.7 ± 18.6	48.5 ± 16.8	0.456 [a]
Body mass index (BMI) (kg/m^2), mean ± SD	26.5 ± 5.6	25.4 ± 3.9	0.283 [a]
Sex			
Male, n (%)	22 (48.9)	25 (55.6)	0.527 [b]
Female, n (%)	23 (51.1)	20 (44.4)	
Smoking			
No, n (%)	29 (64.4)	27 (60)	0.668 [b]
Yes, n (%)	16 (35.6)	19 (42.2)	
Body mass index			
Normal weight, n (%)	21 (46.7)	21 (46.7)	
Overweight, n (%)	13 (28.9)	17 (37.8)	0.491 [b]
Obese, n (%)	11 (24.4)	7 (15.6)	
Chronic diseases			
No, n (%)	21 (46.7)	23 (51.1)	0.833 [b]
Yes, n (%)	24 (53.3)	22 (48.9)	
Type of surgery			
Appendectomy, n (%)	15 (33.3)	11 (24.4)	
Cholecystectomy, n (%)	13 (28.9)	17 (37.8)	0.645 [b]
Exploratory laparotomy, n (%)	12 (26.7)	10 (22.2)	
Hernia, n (%)	5 (11.1)	7 (15.6)	
Electrocardiogram (ECG)			
Normal, n (%)	41 (91.1)	38 (84.4)	0.522 [b]
Abnormal, n (%)	4 (8.9)	7 (15.6)	
American Society of Anesthesiologists (ASA) class			
ASA 1, n (%)	22 (48.9)	17 (37.8)	
ASA 2, n (%)	16 (35.6)	19 (42.2)	0.563 [b]
ASA 3, n (%)	7 (15.6)	9 (20)	

Notes.

ASA: American Society of Anesthesiologists,

BMI: Body mass index,

ECG: electrocardiogram,

[a]: t-test,

[b]: Pearsons's chi-square/Fisher's exact test

3.3 Preoperative variables of the elective abdominal surgery patients

Similarly, there were no statistically significant differences in the preoperative variables of the elective abdominal surgery patients in both intervention and control groups including heart rate, oxygen saturation, systolic and diastolic blood pressure, respiratory rate, WBCs, RBCs, Hb, Htc, MCV, MCH, MCHC, PLT, and PT. Moreover, there were no statistically significant differences in the preoperative body temperature and Bedside Shivering Scale values of the elective abdominal surgery patients in both intervention and control groups. The preoperative variables of the elective abdominal surgery patients are shown in Table 4.

Table 4

Preoperative variables of the elective abdominal surgery patients in both groups

Variable	Intervention (warmed fluid) (n = 45)	Control (unwarmed fluid) (n = 45)	p
Heart rate (beats/min), mean ± SD	95.4 ± 18.9	98.2 ± 20.3	0.500 [a]
Peripheral capillary oxygen saturation (SpO_2) (%), mean ± SD	98.1 ± 1.8	97.6 ± 1.9	0.203 [a]
Systolic blood pressure (mmHg), mean ± SD	132.6 ± 22.3	128.4 ± 26.7	0.420 [a]
Diastolic blood pressure (mmHg), mean ± SD	85.9 ± 16.8	82.6 ± 17.3	0.361 [a]
Body temperature (˚C), mean ± SD	36.7 ± 0.4	36.7 ± 0.5	1.000 [a]
Respiratory rate (breaths/min), mean ± SD	22.4 ± 4.2	22.6 ± 5.1	0.840 [a]
WBCs (x 10^9/L), mean ± SD	4.9 ± 3.6	5.1 ± 4.5	0.816 [a]
RBCs (million/µL), mean ± SD	5.3 ± 2.6	5.7 ± 3.2	0.517 [a]
Hb (g/dL), mean ± SD	14.3 ± 4.6	14.1 ± 4.3	0.832 [a]
Htc (%), mean ± SD	40.1 ± 9.2	42.2 ± 8.7	0.269 [a]
MCV (fL), mean ± SD	88.6 ± 11.6	87.4 ± 13.5	0.652 [a]
MCH (picograms/cell)	29.0 ± 2.2	29.7 ± 1.9	0.110 [a]
MCHC (g/dL), mean ± SD	34.1 ± 1.8	34.6 ± 1.3	0.135 [a]
PLT (x 10^9/L), mean ± SD	370.0 ± 82.0	363.0 ± 116.0	0.742 [a]
PT (sec), mean ± SD	12.2 ± 1.1	12.1 ± 1.6	0.731 [a]
Bedside Shivering Scale (upon entering the operation room)			
0, n (%)	44 (97.8)	43 (95.6)	1.000 [b]
1, n (%)	1 (2.2)	2 (4.4)	
2, n (%)	0 (0)	0 (0)	
3, n (%)	0 (0)	0 (0)	

Notes.

SpO_2: peripheral capillary oxygen saturation,
WBCs: white blood cells count,
RBCs: red blood cells count,
Hb: hemoglobin,
Htc: hematocrit,
MCV: mean corpuscular volume,
MCH: mean corpuscular hemoglobin,
MCHC: mean corpuscular hemoglobin concentration,
PLT: platelets,
PT: prothrombin time,
0: None (no shivering noted on palpation of the masseter, neck, or chest wall),
1: Mild (shivering localized to the neck and/or thorax only),
2: Moderate (shivering involves gross movement of the upper extremities “in addition to neck and thorax”,
3: Severe (shivering involves gross movements of the trunk and upper and lower extremities),
[a]: t-test,
[b]: Pearsons’s chi-square/Fisher’s exact test

3.4 Intraoperative variables of the elective abdominal surgery patients

The intervention group received warmed IV fluids and the control group received IV fluids at room temperature (37.0 ± 0.3 vs 22.5 ± 2.1 ˚C, $p < 0.001$). The elective abdominal surgery patients in the control group had significantly lower heart rate ($p = 0.044$), intraoperative body temperature ($p = 0.003$), and more moderate and severe Bedside Shivering Scale ratings ($p = 0.043$) compared to the elective abdominal surgery patients who received warmed IV fluids.

On the other hand, the elective abdominal surgery patients in the control group lost significantly more ($p = 0.020$) blood compared to the elective abdominal surgery patients in the intervention group. The intraoperative variables of the elective abdominal surgery patients in both groups are shown in Table 5.

Table 5

Intraoperative variables of the elective abdominal surgery patients

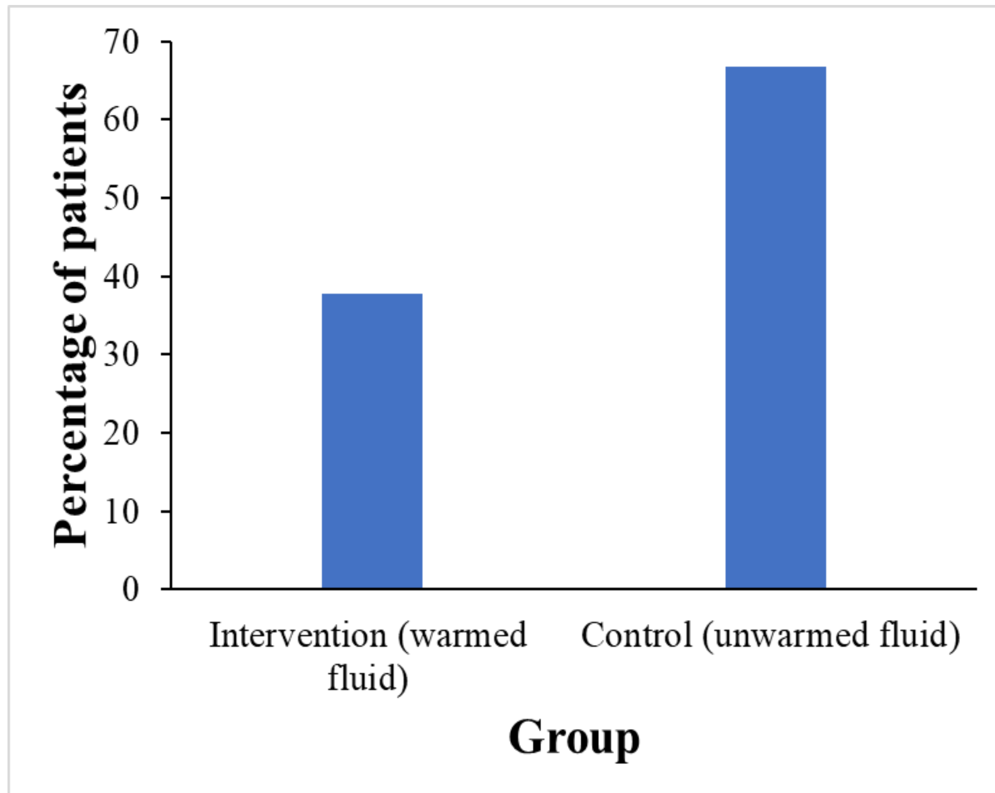
Variable	Intervention (warmed fluid) (n = 45)	Control (unwarmed fluid) (n = 45)	p
IV fluids temperature (˚C), mean ± SD	37.0 ± 0.3	22.5 ± 2.1	< 0.001 [a]
Total IV fluids volume (L), mean ± SD	2.8 ± 2.4	3.1 ± 2.7	0.579 [a]
Heart rate (beats/min), mean ± SD	94.7 ± 16.4	88.6 ± 11.4	0.044 [a]
Peripheral capillary oxygen saturation (SpO_2) (%), mean ± SD	97.9 ± 1.9	97.4 ± 2.3	0.371 [a]
Systolic blood pressure (mmHg), mean ± SD	126.3 ± 23.1	125.4 ± 25.6	0.861 [a]
Diastolic blood pressure (mmHg), mean ± SD	83.9 ± 17.2	81.4 ± 17.9	0.501 [a]
Intraoperative body temperature (˚C), mean ± SD	35.8 ± 2.1	34.3 ± 2.5	0.003 [a]
Duration of surgery (min), mean ± SD	132.2 ± 74.2	143.1 ± 81.4	0.509 [a]
Amount of blood loose during surgery (mL), mean ± SD	611.2 ± 422.3	882.3 ± 640.6	0.020 [a]
Operating room temperature (˚C), mean ± SD	22.0 ± 1.5	21.9 ± 1.8	0.775 [a]
Operating room humidity (%), mean ± SD	38.2 ± 17.6	38.7 ± 15.9	0.888 [a]
Bedside Shivering Scale (intraoperative)			
0, n (%)	28 (62.2)	15 (33.3)	0.043 [b]
1, n (%)	8 (17.8)	11 (24.4)	
2, n (%)	6 (13.3)	11 (24.4)	
3, n (%)	3 (6.7)	8 (17.8)	

Notes.
SpO_2: peripheral capillary oxygen saturation,
0: None (no shivering noted on palpation of the masseter, neck, or chest wall),
1: Mild (shivering localized to the neck and/or thorax only),
2: Moderate (shivering involves gross movement of the upper extremities “in addition to neck and thorax”,
3: Severe (shivering involves gross movements of the trunk and upper and lower extremities),
[a]: t-test,
[b]: Pearsons’s chi-square/Fisher’s exact test

Intraoperatively, 17 (37.8%) of the elective abdominal surgery patients in the intervention group suffered hypothermia compared to 30 (66.7%) elective abdominal surgery patients in the control group. The incidence of hypothermia among the elective abdominal surgery patients in both groups are shown in Figure 6.

Figure 6

Incidence of hypothermia among the elective abdominal surgery patients in both groups intraoperatively



3.5 Postoperative variables of the elective abdominal surgery patients

At admission to the PACU, the elective abdominal surgery patients in the control group had significantly lower heart rate (p = 0.046), body temperature (p = 0.018), and more moderate and severe Bedside Shivering Scale ratings (p = 0.036) compared to the elective abdominal surgery patients who received warmed IV fluids. The postoperative variables of the elective abdominal surgery patients in both groups are shown in Table 7.

Similarly, 30 min after admission to the PACU, the elective abdominal surgery patients in the control group had significantly lower heart rate (p = 0.048), body temperature (p = 0.031), and more moderate and severe Bedside Shivering Scale ratings (p = 0.018) compared to the elective abdominal surgery patients who received warmed IV fluids. These differences are shown in Table 6.

Table 6

Postoperative variables of the elective abdominal surgery patients in both groups

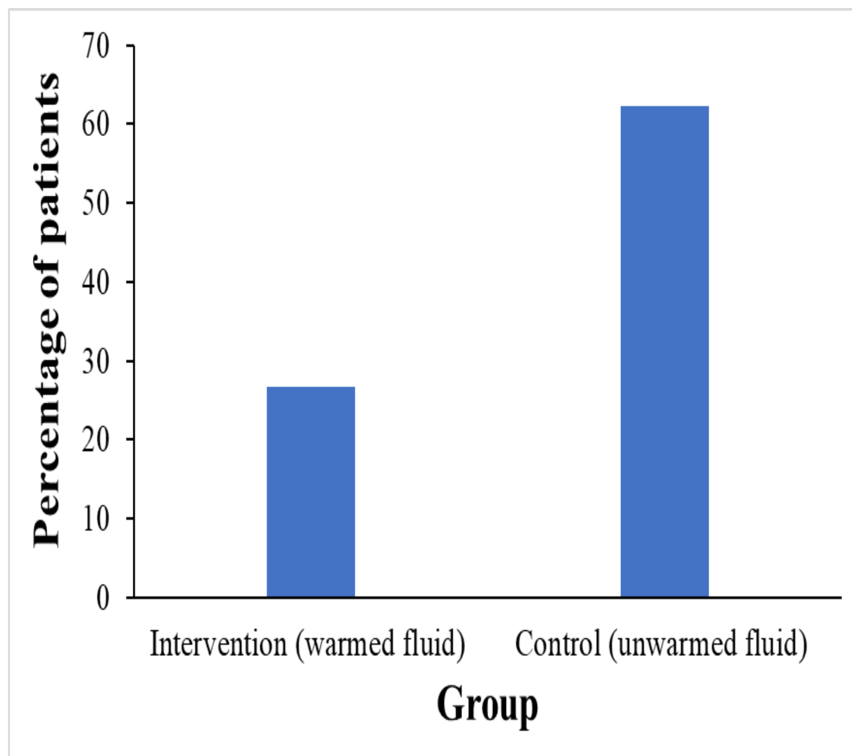
Variable	Intervention (warmed fluid) (n = 45)	Control (unwarmed fluid) (n = 45)	p
At admission to the post anesthesia care unit (PACU)			
Heart rate (beats/min), mean ± SD	95.5 ± 17.2	89.3 ± 11.2	0.046 [a]
Peripheral capillary oxygen saturation (SpO_2) (%), mean ± SD	98.3 ± 1.3	97.8 ± 1.8	0.135 [a]
Systolic blood pressure (mmHg), mean ± SD	124.6 ± 22.3	122.7 ± 26.4	0.713 [a]
Diastolic blood pressure (mmHg), mean ± SD	82.2 ± 16.3	82.3 ± 18.4	0.978 [a]
Body temperature (˚C), mean ± SD	36.1 ± 2.4	34.8 ± 2.7	0.018 [a]
Recovery room temperature (˚C), mean ± SD	25.9 ± 3.5	25.2 ± 4.2	0.393 [a]
Recovery room humidity (%), mean ± SD	39.4 ± 18.2	38.4 ± 17.9	0.793 [a]
Bedside Shivering Scale at admission to the post anesthesia care unit (PACU)			
0, n (%)	30 (66.7)	18 (40)	0.036 [b]
1, n (%)	9 (20)	10 (22.2)	
2, n (%)	4 (8.9)	9 (20)	
3, n (%)	2 (4.4)	8 (17.8)	
30 min after admission to the post anesthesia care unit (PACU)			
Heart rate (beats/min), mean ± SD	94.9 ± 12.9	89.8 ± 11.2	0.048 [a]
Peripheral capillary oxygen saturation (SpO_2) (%), mean ± SD	98.4 ± 1.5	97.9 ± 1.6	0.130 [a]
Systolic blood pressure (mmHg), mean ± SD	123.8 ± 22.7	121.6 ± 25.6	0.667 [a]
Diastolic blood pressure (mmHg), mean ± SD	81.4 ± 16.1	82.8 ± 18.9	0.706 [a]
Body temperature (˚C), mean ± SD	36.4 ± 2.6	35.1 ± 3.0	0.031 [a]
Recovery room temperature (˚C), mean ± SD	25.8 ± 3.7	25.5 ± 4.8	0.741 [a]
Recovery room humidity (%), mean ± SD	39.6 ± 19.1	38.9 ± 18.2	0.859 [a]
Bedside Shivering Scale at admission to the post anesthesia care unit (PACU)			
0, n (%)	32 (71.1)	21 (46.7)	0.018 [b]
1, n (%)	11 (24.4)	14 (31.1)	
2, n (%)	1 (2.20	7 (15.6)	
3, n (%)	0 (0)	3 (6.7)	

Notes.
SpO_2: peripheral capillary oxygen saturation,
PACU: post anesthesia care unit,
0: None (no shivering noted on palpation of the masseter, neck, or chest wall),
1: Mild (shivering localized to the neck and/or thorax only),
2: Moderate (shivering involves gross movement of the upper extremities "in addition to neck and thorax",
3: Severe (shivering involves gross movements of the trunk and upper and lower extremities),
[a]: t-test,
[b]: Pearsons's chi-square/Fisher's exact test

At admission to the PACU, 12 (26.7%) of the elective abdominal surgery patients in the intervention group suffered hypothermia compared to 28 (62.2%) elective abdominal surgery patients in the control group. The incidence of hypothermia among the elective abdominal surgery patients in both groups are shown in Figure 7.

Figure 7

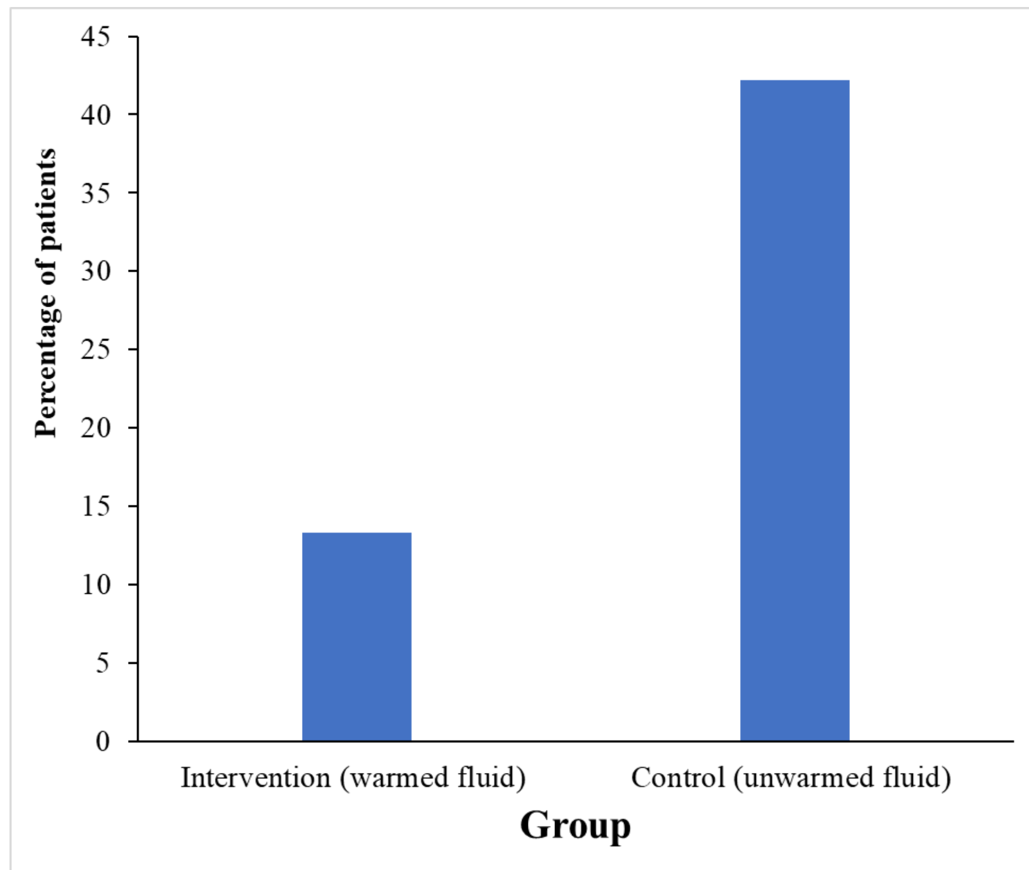
Incidence of hypothermia among the elective abdominal surgery patients in both groups at admission to the PACU



30 min after admission to the PACU, 6 (13.3%) of the elective abdominal surgery patients in the intervention group suffered hypothermia compared to 19 (42.2%) of the elective abdominal surgery patients in the control group. The incidence of hypothermia among the elective abdominal surgery patients in both groups are shown in Figure 8.

Figure 8

Incidence of hypothermia among the elective abdominal surgery patients in both groups 30 min after admission to the PACU



3.6 Postoperative pain, hospital stay, and complications among the elective abdominal surgery patients in both groups

When the elective abdominal surgery patients were followed up for postoperative pain, hospital stay, and complications, the elective abdominal surgery patients who received warmed IV fluids suffered significantly lower pain intensity ($p = 0.020$) compared to the control group. These differences are shown in Table 8. The PACU recovery time was significantly shorter ($p = 0.013$) for the elective abdominal surgery patients who received warmed IV fluids compared to the control group. Moreover, the length of hospital stay was also significantly shorter ($p = 0.016$) for the elective abdominal surgery patients who received warmed IV fluids compared to the control group. In addition, the incidence of surgical site infections among the elective abdominal surgery patients who received warmed IV fluids was significantly lower ($p = 0.029$) compared to the control group. These differences are shown in Table 7.

Table 7

Postoperative pain, hospital stay, and complications among the elective abdominal surgery patients in both groups

Variable	Intervention (warmed fluid) (n = 45)	Control (unwarmed fluid) (n = 45)	p
Pain (on a scale of 0-10 (0 = no pain, 10 = worst imaginable pain), mean ± SD	5.8 ± 1.9	6.8 ± 2.1	0.020 [a]
Post anesthesia care unit (PACU) recovery time (hours), mean ± SD	1.5 ± 1.1	2.2 ± 1.5	0.013 [a]
Length of hospital stay (days), mean ± SD	4.5 ± 2.5	5.6 ± 2.9	0.016 [a]
Surgical site infection			
No, n (%)	41 (91.1)	32 (71.1)	0.029 [b]
Yes, n (%)	4 (8.9)	13 (28.9)	

Notes.

PACU: post anesthesia care unit,

[a]: t-test,

[b]: Pearsons's chi-square/Fisher's exact test

Chapter Four

Discussion and Conclusion

4.1 Summary of key findings

Intraoperative hypothermia is one of the common complications associated with significant postsurgical complications and negative outcomes (1-3, 56, 66). The objective of this study was to evaluate the effects of administering heated intravenous (IV) fluids in order to decrease hypothermia and shivering in elective abdominal surgery patients undergoing clean open abdominal surgery. Researchers were interested in finding out how often cold and shaking happened in elective abdominal surgery patients who were given fluids at 37˚C during and after surgery compared to those who were given fluids at 25˚C. The experiment looked at people who had clean open stomach surgery to see if giving them warmed intravenous (IV) fluids might make them less likely to get cold and start shaking.

The study findings indicate that elective abdominal surgery patients who received heated intravenous fluids saw a significant decrease in the prevalence of hypothermia and shivering, both during and after the surgical operation. A noteworthy discovery from the research is that elective abdominal surgery patients had a reduced occurrence of hypothermia when they were administered intravenous fluids that were heated to a temperature of 37 °C during the surgical procedure (53.3% vs. 8.9%) and after they were transferred to the postoperative care unit (66.7% vs. 22.2%). Administering warmed intravenous fluids significantly reduced post-surgical shivering in elective abdominal surgery patients, in comparison to those who did not get warmed fluids. Other beneficial outcomes seen were diminished postoperative pain intensity, quicker recovery time in the postoperative care unit (PACU), reduced hospital stay, and lower incidence of surgical site infections.

The significance of these findings lies in their indication that the use of uncomplicated interventions, such as warming intravenous fluids, might significantly enhance elective abdominal surgery patients outcomes by reducing surgical complications and expediting recovery periods. The main finding of this research is that the use of heated intravenous fluids is a successful and economical method for decreasing postoperative hypothermia and shivering. Healthcare systems have the ability to create cost savings by enhancing

elective abdominal surgery patients comfort, minimizing problems, and even lowering the length of hospital stays.

4.2 Discussion of the main findings

Multiple multinational research have shown the effectiveness of using warmed intravenous fluids to prevent postoperative hypothermia and shivering (1-3, 10, 13, 15, 18, 52, 53, 55, 57-59, 61, 63, 65, 76). Several multinational studies have shown that warmed intravenous fluids greatly decrease hypothermia during and after surgery. This study's results corroborated those of the previous ones, adding to the growing amount of data in favor of this method. Research has shown that elective abdominal surgery patients having abdominal surgery benefit from a core temperature boost and less postoperative shivering when given a heated Ringer's solution at 38°C rather than room temperature (17, 56, 58, 59, 74, 76). Together, these studies have shown that warming intravenous fluids successfully kept the elective abdominal surgery patients at a normothermic temperature throughout surgery, which in turn reduced the risk of hypothermia-related complications. Active warming methods, such as warmed intravenous fluids, considerably decrease perioperative hypothermia. These findings were previously confirmed in systematic reviews and meta-analyses of randomized controlled studies. It is noteworthy to mention that the evidence on the positive effect of warmed intravenous fluids on shivering was conflicting. Nevertheless, it is crucial to acknowledge that there may be discrepancies within studies, including changes in the kind of operation conducted, the volume of fluids given, and the criteria used to define hypothermia. Additional examination may be conducted on these characteristics with more accuracy. Several studies have shown a range of elective abdominal surgery patients reactions and the possible impact of variables such as the temperature in the operating room and individual elective abdominal surgery patients characteristics. These trials found no statistically significant difference in shivering rates between the groups who received warmed fluids and those that received fluids at room temperature.

The results of this research revealed significant differences between the group that received warmed intravenous (IV) fluid and the control group in terms of pain intensity, post-anesthesia care unit (PACU) recovery time, duration of hospital stay, and incidence of surgical site infections. This research supports the argument for including warmed intravenous fluids as a standard practice in surgical treatment to improve elective

abdominal surgery patients outcomes. By correlating these discoveries with the broader spectrum of preexisting studies (1, 17, 18, 74), one may highlight the consistency and reliability of using heated intravenous fluids to reduce the incidence of intraoperative hypothermia and its associated issues. Maintaining a stable body temperature during surgery is crucial for optimizing postoperative results. Hypothermia during surgery may lead to several outcomes, including increased pain, delayed recovery, longer hospital stay, and heightened vulnerability to surgical site infections (1-3, 6, 61, 65, 68). A study has been carried out to investigate the use of warmed intravenous fluids as a means to avoid hypothermia during surgical procedures and improve post-operative results.

Previous studies have shown that intraoperative hypothermia may exacerbate surgical pain by inducing peripheral vasoconstriction and hindering drug metabolism (1-3, 6, 7, 9, 65, 68, 69). The observation that elective abdominal surgery patients who received heated intravenous fluids had a significantly lower degree of pain intensity ($p = 0.020$) aligns with the results of earlier studies (1-3, 6, 7, 9, 65, 68, 69). Administering warmed intravenous fluids helps to maintain normal body temperature, which can decrease constriction of blood vessels in the extremities and improve the efficacy of pain-relieving medications, resulting in reduced levels of discomfort after surgery (11, 28, 52, 53, 56, 57, 59, 63, 76).

The considerably reduced recovery time in the PACU ($p = 0.013$) for elective abdominal surgery patients who were administered warmed intravenous fluids aligns with existing literature that indicates maintaining normal body temperature improves overall recovery (1, 3, 6, 10, 11, 19, 28, 52, 53, 56, 57, 59, 63, 65, 76). Hypothermia can impede the elimination of anesthetic drugs and lengthen the duration of recovery. Elective abdominal surgery patients can achieve faster recovery from anesthesia by sustaining normothermia with the use of warmed intravenous fluids.

The statistically significant reduction in hospitalization duration ($p = 0.016$) observed in elective abdominal surgery patients who received warmed intravenous fluids aligns with previous research indicating that maintaining normal body temperature can expedite overall recovery and minimize problems, consequently resulting in shorter hospital stays (1-3, 6, 10, 11, 15, 19, 28, 52, 53, 56, 57, 59, 63, 65, 68, 76). This is especially crucial for the efficient flow of elective abdominal surgery patients and the optimal usage of healthcare resources.

The decreased occurrence of surgical site infections (p = 0.029) in individuals who were administered warmed intravenous fluids supports previous studies that suggest hypothermia can compromise immune function and elevate the likelihood of infections (1-3, 6, 10, 11, 15, 19, 28, 52, 53, 56, 57, 59, 63, 65, 68, 76, 77). Maintaining normal body temperature stimulates the immune response and increases the amount of oxygen in the tissues, which in turn lowers the chances of surgical site infections (78, 79). Administering intravenous fluids at an elevated temperature helps to sustain the body's protective normal temperature.

The results of this study align with the current body of research that emphasizes the advantages of maintaining normal body temperature during surgery by employing techniques such administering warmed intravenous fluids. The notable enhancements in pain management after surgery, recovery time in the post-anesthesia care unit, duration of hospital stay, and decreased occurrence of surgical site infections highlight the significance of this intervention. These findings endorse the consistent use of warmed intravenous fluids to enhance surgical outcomes and guarantee elective abdominal surgery patients welfare.

4.3 Strengths of the study

This study had a number of strength points including:

- The use of a randomized controlled design, which effectively reduced bias and facilitated a more precise assessment of the impact of the intervention.

- Furthermore, the research included a large sample size of 90 elective abdominal surgery patients , which ensured sufficient statistical power to detect significant differences between the intervention and control groups.

- The study's validity was increased by experts tools and statistic.

- Furthermore, the thorough evaluation of both the results during surgery and after surgery offered a complete perspective on the intervention's influence.

- Another strength point was the presence of a well-defined intervention and well-defined outcomes.

4.4 Limitations of the study

While this study had commendable characteristics, it also displayed some limitations. This research was subject to the following limitations:

- The findings of this research may not be generalizable to other situations or groups since the study was restricted in scope and performed at a single location. Additional multicenter studies are required to confirm these results in a larger population.

- Moreover, the investigation neglected to take into account any variations in surgical techniques or the administration of anesthesia that may potentially affect the outcomes.

- One further constraint was the short length of the follow-up period, which may not sufficiently capture any long-lasting challenges or benefits associated with the intervention.

- Furthermore, the study did not assess elective abdominal surgery patients satisfaction or comfort, which are essential aspects of perioperative treatment.

4.5 Implications for practice

The results of this research have significant implications for clinical practice. Implementing the routine use of heated intravenous fluid during surgeries could potentially reduce the incidence of hypothermia and muscle spasms, resulting in improved elective abdominal surgery patients outcomes and potentially reducing healthcare costs associated with complications arising from hypothermia. Furthermore, this methodology has the capability to enhance elective abdominal surgery patients comfort and contentment, hence augmenting the quality of therapy administered. In order to improve the quality of elective abdominal surgery patients care, anesthesiologists and surgical teams should consider including warm intravenous fluids into their perioperative protocols.

4.6 Recommendations

The study's results lead to the following recommended recommendations:

- Implement a standardized protocol for the use of heated intravenous fluids in hospitals for all elective abdominal surgery patients having significant abdominal procedures.

- Conduct staff training sessions to educate surgical and anesthesia personnel about the advantages of using warmed IV fluids and the correct methods for implementing them.

- Additional investigation: Carry out multicenter research to validate these results across diverse groups and situations, and assess the long-term consequences.

- Future research should include evaluations of elective abdominal surgery patients -centric outcomes, specifically focusing on the levels of comfort and satisfaction experienced by elective abdominal surgery patients in relation to the use of warmed intravenous fluids.

4.7 Conclusion

Overall, the provision of heated intravenous fluids effectively decreases the occurrence of hypothermia and shivering in elective abdominal surgery patients who are having clean open abdominal surgery. This simple but impactful technique improves elective abdominal surgery patients outcomes, shortens recovery time, and lowers the occurrence of surgical site infections. Introducing the use of heated intravenous (IV) fluids in surgical procedures might enhance the quality of care during the perioperative period, emphasizing the significance of this intervention in improving elective abdominal surgery patients safety and comfort.

List of Abbreviations

Abbreviation	Meaning
IV	Intravenous
ASA	American Society of Anesthesiologists
BMI	Body mass index
CBC	Complete blood count
ECG	Electrocardiogram
Hb	Hemoglobin
Htc	Hematocrit
IRB	Institutional review board
MCH	Mean corpuscular hemoglobin
MCHC	Mean corpuscular hemoglobin concentration
MCV	Mean corpuscular volume
N_2O	Nitrous oxide
PACU	Post anesthesia care unit
PLT	Platelets
PT	Prothrombin time
RBCs	Red blood cells
SD	Standard deviation
SpO2	Peripheral capillary oxygen saturation
WBCs	White blood cells

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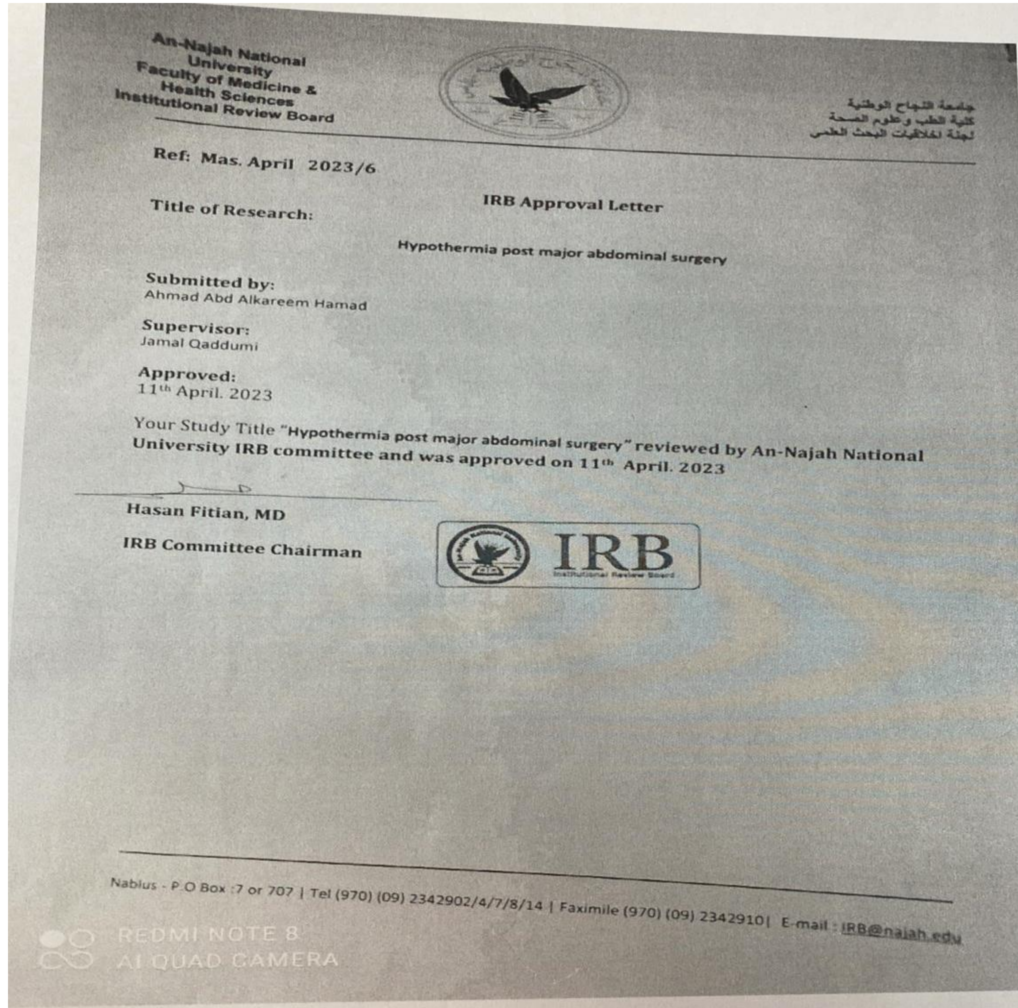
Appendices

Appendix A

IRB Approval



An-Najah National University
Faculty of Medicine & Health Sciences
Institutional Review Board

جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
لجنة اخلاقيات البحث العلمي

Ref: Mas. April 2023/6

IRB Approval Letter

Title of Research:

Hypothermia post major abdominal surgery

Submitted by:
Ahmad Abd Alkareem Hamad

Supervisor:
Jamal Qaddumi

Approved:
11th April. 2023

Your Study Title "Hypothermia post major abdominal surgery" reviewed by An-Najah National University IRB committee and was approved on 11th April. 2023

Hasan Fitian, MD

IRB Committee Chairman

IRB
Institutional Review Board

Nablus - P.O Box :7 or 707 | Tel (970) (09) 2342902/4/7/8/14 | Faximile (970) (09) 2342910 | E-mail : IRB@najah.edu

REDMI NOTE 8
AI QUAD CAMERA

Appendix B

Study approval

An- Najah National University
Faculty of Medicine & Health Sciences
Department of Nursing

بسم الله الرحمن الرحيم

جامعة النجاح الوطنية
كليـة الطب وعلـوم الصحة
دائرة التمريض

التاريخ: 2024/02/01

تحية طيبة وبعد،

الموضوع: تسهيل مهمـة طلبة التمريض والقبالة

أرجو من حضرتكم التكرم بالموافقة على مخاطبة كل من:

مدير مستشفى المقاصد المحترم .

مدير تمريض مستشفى المقاصد المحترم .

من أجل تسهيل مهمة الطالب : أحمد عبد الكريم حمد .

حيث أنه يقوم بعمل دراسة بغرض البحث العلمي لمشروع التخرج تحت عنوان:

(Hypothermia post major abdominal surgery (

انخفاض درجه حراره الجسم بعد اجراء عمليات البطن الرئيس

وسنقوم بمراقبة المرضى الذين تم ادخالهم الى غرف العمليات وذلك في الفترة الواقعة بين شهر 2 لسنة 2024 الى شهر 7 لسنة 2024 بإشراف د. جمال قدومي

وتفضلوا بقبول الطلب ولكم فائق الاحترام،

مديرة دائرة التمريض والقبالة

الدكتورة عائدة القيسي

مشرف البحث: د. جمال قدومي

Makassed Hospital- Jerusalem
Dr. Sameer M. Almtour
Chief of Internal & Cardiology Dept
Interventional Cardiologist

المرفقات:

- **موافقة IRB**

جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

تأثير اعطاء السوائل الدافئة مقارنة مع السوائل على درجة حرارة الغرفة في انخفاض درجة حرارة الجسم بعد عمليات البطن المقررة

إعداد

أحمد عبد الكريم حمد

إشراف

د جمال القدومي

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في تمريض العناية المكثفة، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2024

تأثير اعطاء السوائل الدافئة مقارنة مع السوائل على درجة حرارة الغرفة في انخفاض درجة حرارة الجسم بعد عمليات البطن المقررة

إعداد

أحمد عبد الكريم حمد

إشراف

د جمال القدومي

الملخص

خلفية الدراسة: تعد انخفاض حرارة الجسم اثناء الجراحة من المضاعفات الشائعة التي ترتبط بتداعيات سلبية على ما بعد الجراحة. تهدف الدراسة الى تقييم تأثير اعطاء السوائل الوريدية الدافئة للمرضى الذين يخضعون لجراحة البطن المفتوحة النظيفة على تقليل انخفاض حرارة الجسم والرعشة.

منهجية الدراسة: اجريت الدراسة في مستشفى جراحي رئيسي في الضفة الغربية – فلسطين على 118 مريضا يخضعون لجراحة بطن مقررة. تم توزيع المرضى عشوائيا الي مجموعتين: مجموعة التدخل (45) مريض تلقت السوائل الدافئة ومجموعة التحكم (45) مريض تلقت سوائل غير دافئة. تم تقيم درجة حرارة المرضى ومستويات الارتعاش في عددة مراحل: قبل الجراحة و اثناء الجراحة وبعد الجراحة وبعد 30 دقيقة في وحدة الرعاية بعد التخدير.

نتائج الدراسة: اظهرت النتائج ان المرضى في مجموعة التدخل الذين تلقوا السوائل الوريدية الدافئة سجلوا درجات حرارة اعلى ومعدلات ضربات قلب اعلى ومستويات اقل من الرعشة مقارنة مع مجموعة التحكم. اثناء الجراحة عانى 37.8% من المرضى في مجموعة التدخل من انخفاض حرارة الجسم مقارنة ب66.7% في مجموعة التحكم. بعد الجراحة كان المرضى في مجموعة التدخل اقل عرضة ل الرعشة وانخفاض الحرارة. كما كان لديهم معدل ضربات قلب اعلى بشكل ملحوظ.

استنتاجات الدراسة: توفر السوائل الوريدية الدافئة يقلل بشكل فعال من انخفاض حرارة الجسم والرعشة لدى المرضى الذين يخضعون لجراحة البطن المفتوحة النظيفة. هذه الطريقة البسيطة تحسن نتائج المرضى وتقلل وقت التعافي وتقلل المضاعفات مثل العدوى.

كما تدعم الدراسة اهمية استخدام السوائل الوريدية الدفئة في الجراحة لتحسين جودة الرعاية وسلامة المرضى.

الكلمات المفتاحية: انخفاض حرارة الجسم، جراحة البطن، الرعاية الجراحية، المضاعفات، نتائج المرضى.