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EFFECTIVE WARMING PROTOCOLS FOR MANAGING HYPOTHERMIA AND SHIVERING IN CESAREAN SECTION PATIENTS

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Abstract

Background:

Cesarean delivery is prone to maternal hypothermia and shivering which are mainly caused by anaesthetics which impairs thermoregulatory processes and exposes the mother to a cool operating environment. Adequate warming measures are needed in order to ensure that maternal normothermia is maintained, enhance comfort, and avoid perioperative complications. There are different warming procedures, such as forced-air, warm intravenous fluids and thermal blankets, applied to treat hypothermia, but their efficiency effects and patient satisfaction have not been properly assessed.

Methods:

A cross-sectional study was used to determine the efficacy of various warming procedures in hypothermia and shivering reduction in 100 cases of cesarean section. A structured questionnaire was used to gather data which were examined by frequency distributions, percentages and chi-square (χ 2) tests to establish the relationship among warming methods, thermal comfort and occurrence of shivering. The level of significance of p that was found to be statistically significant was $p = 0.05$.

Findings:

The popular method was forced-air warming (45%), and this process proved to have better outcomes. Warmer interventions were noted to be effective in keeping the participants comfortable (approximately 75 percent) and 40 percent experienced mild to moderate shivering. Chi-square showed statistically significant correlation between the warming method and patient comfort ($p = 0.026$). These findings suggest that vigorous warming procedures are highly effective to increase maternal thermal stability and maternal satisfaction during cesarean sections.

Conclusion:

Active warming, especially forced-air systems and warmed IV fluids are useful in the treatment of intraoperative hypothermia and the reduction of postoperative shivering. They can enhance maternal safety and comfort, as well as the overall perioperative outcomes once implemented on a regular basis.

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Recommendations:

To achieve patient-centered care hospitals must implement standardized warming protocols, offer ongoing staff education and track thermal outcomes. It is advised that further research is needed to investigate benefits of warming in the long term, as well as compare the costs and benefits of different warming methods.

INTRODUCTION

CHAPTER 1

Cesarean section under neuraxial anesthesia is associated with common and clinically significant occurrences of perioperative hypothermia and shivering, with implications on the maternal morbidity and the infant survival. The heat redistribution of the core to the periphery and failure to maintain thermoregulatory vasoconstriction combined with cold operating rooms, use of non-warmed intravenous fluids, and exposing abdominal viscera to the air are the reasons the core temperature falls so rapidly after spinal anesthesia. Mortar hypothermia (core lower than 36.0 C) has been clinically associated with augmented blood loss, the risk of contaminated wound, patient pain, and prolonged hospital retention of the patient, whereas shivering increases oxygen consumption and may increase the patient following a surgery and nausea. Another quality and satisfaction measure is maternal thermal comfort because cesarean patients tend to remain awake and fearful about the welfare of the fetus. More recent randomized trials and meta-analyses (20-2025) have been therefore anxious about practical and plastics warming techniques to maintain maternal normothermia throughout the preoperative phase to the intra- and immediate postoperative phases (1).

Arguing biologically due to the knowledge of thermoregulation in a cesarean delivery would help understand why multimodal warming is often superior to untimed interventions. The neuraxial anesthesia produces a lower threshold of vasoconstriction and has symathectomy which causes the peripheral vasodilation which causes rapid redistribution hypothermia during the initial 30 to 60 minutes. The fact is that the infant undergoes the spillover effect: the core temperature of the mother influences the blood flow to the uterus and the neonatal thermal state immediately after birth. Cotton blankets are only simple passive methods of reducing convective loss of heat, and not the rearrangement of core to periphery. Active warming technologies forced-air warming (FAW), resistive conductive heating, warmed intravenous fluids and warmed irrigation are in this case addressed by a variety of mechanisms: FAW reduce convective and radiative transfer; warmed IV fluids reduce heat loss through large volumes of fluid; warmed irrigation reduces local heat sinks. According to a systematic review and network meta-analyses (2022-2025), active warming is more effective in terms of maintenance of maternal temperature and less frequent shivering especially when used as a combination of prewarming and intraoperative warming and use of warmed fluids. (2)

Particular attention has been required in prewarming (active warming prior to the neuraxial block or skin incision) which inhibits the early redistribution hypothermia which takes place during the postoperative time in spinal anesthesia. The prewarming of 15 to 60 minutes was experimented in (20-2024) with either FAW or underbody warming blankets; most demonstrated high core temperatures at incision and decreased cases of immediate postoperative hypothermia and subjective thermal discomfort. However, the magnitude of the benefits with lengths and time is as follows: Short prewarming (<15 minutes) is linked to the modest benefit; 30-60 minutes of prewarming is linked to the greater and frequent benefits. Importantly, prewarming may be performed in the case of elective cesarean operation and is more challenging with emergency/urgent cases, where the primary mitigation measures include intraoperative active warming over a short duration and warmed intravenous fluids. Certain recent randomized controlled trials also indicate that prewarming does not increase adverse events, and it increases the scores of maternal thermal comforts, which can be prescribed as an established practice to be frequently used, provided that appropriate logistics is possible (3).

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Forced-air warming (FAW) is the most investigated active warming technology in cesarean delivery. Randomized studies and meta-analyses point to FAW as an upper-body or complete-body blanket and continuing intra-operative hypothermia reduce the incidence of core hypothermia and clinically significant shivering, as compared to passive insulation. FAW blankets to lower abdomen and FAW + warmed IV fluids regimens appear to be particularly beneficial in the management of core temperature in the typical of 60-120 minutes of the cesarean section. The safety concerns mentioned above on the interruption in the laminar airflow in orthopaedic implantations have little to do with the cesarean care, but extensive implantation and proper positioning of surgical drapes that do not directly heat the surgical place are proposed. Cost, accessibility and experience of the personnel with FAW are the factors that influence its acceptance in the world hence alternative active devices (conductive warming or self-warming disposable blankets) have been put to test with promising results in several (2020-2023) comparative studies (4).

Warmed intravenous fluids are to be viewed as a low-technology and easy to implement support to active surface warming, which directly prevents the loss of heat in case of large volumes of fluids administration. A meta-analysis of trials with warmed IV fluid (typically 37 -42 o C) and FAW suggest that they are additive: they can preserve maternal core temperature and reduce the occurrence of shivering than FAW but not passive care. Moreover, heated fluids may be rapidly used even in emergencies cesarean delivery thereby can be deemed as a competent constituent of standardized warming packages. Intracellularly, where it is clinically warranted, there is some evidence that warmed irrigation fluids are helpful in preserving core heat, although not as much so as systemic fluid warming and FAW. The current recommendations therefore support the normal use of warmed IV fluids during cesarean labor when it is likely to be using a large quantity of fluids, as well as circumstances where prewarming cannot occur (5).

Multimodal warming bundles (prewarming + intraoperative FAW/underbody warming + warmed IV fluids) present the greatest reductions in hypothermia and shivering. A second multi-center systematic review and follow-up (2021-2024-2025) finally found that multicentric intervention is effective in the prevention of both maternal hypothermia and subjective thermal discomfort, compared to other interventions. Practical bundles also often include the measures of the environment (increasing ambient temperature where it can be done), decreasing skin protection, decreasing time between neuraxial block and incision, and conventional temperature monitoring (esophagus, tympanum or bladder in case available). The presence of implementation studies published evidence shows that basic protocols and checklists cause greater adherence and reduced hypothermia rate; cost benefit analysis shows that hypothermia prevention results in reduced downstream costs through reduced PACU admission and wound complications. As the evidence continues to mount until 2024 2025, warming bundles are currently being implemented in cesarean enhanced-recovery and perioperative pathways (6).

There are cases where preventive and rescue actions are needed in management by shivering. Low-dose meperidine, tramadol, or clonidine doses of drugs can reduce shivering but have been noted to cause sedation, hemodynamic or neonatal transfer events limiting common prophylaxis in patients giving birth via cesarean. In this way, prevention (warming bundles) has been the most eminent measure and medication in refractory cases. The recent randomized randomized trial (2020-2024) of non-pharmacologic warming methods in combination with standard treatment demonstrates that there is significant reduction in shivering rate, reducing the pharmacologic rescue rates. The clinicians consider the hemodynamic stability of the mother, the effects of the drugs on the neonatal and the interactions of the drugs with the neuraxial anesthesia. Prewarming, warmed and continuous FAW interventions minimize the cumulative drugs exposure and preserve maternal alertness and maternal-neonatal bonding in the initial hours of the postpartum (7).

Despite such arguments in support of active and combined modalities of warming, the actual world obstacles do not allow such wide implementation: logistics in the operating room, equipment costs, employee training, and emergency case procedures. Solutions, such as standardized warming kits,

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preoperative warming of elective patients, warmed fluid warmer at anesthesia carts and temperature checklists, have been reported to increase adherence and improvements in maternal outcomes in recent observational and implementation studies (2023-2025). FAW promises are offering new technology such as conductive polymer heating kits and new underbody warming technology that are promising in pilot projects and will enable the technology to expand the number of offerings where it is not available. Recent recommendations of enhanced recovery in perioperative and cesarean section in 2024-2025 still favor multimodal warming packages and temperature monitoring requirements, which is being practiced to embrace active hypothermia and shivering prevention as a quality indicator. Post-measures of neonatal mortality should involve large pragmatic studies to testify the optimal duration of prewarming in various conditions and measure the outcomes (8).

A similar theme is reinforced in the last five years (20-2025): multimodal warming bundles (which may also include prewarming (where possible), active intraoperative warming (FAW or conductive devices), warmed intravenous fluids, and practicable measures of the OR are consistent, safe, and cost-effective in the prevention of maternal hypothermia and shivering during cesarean birth. Through such interventions, hypothermia rates are reduced, shivering reduced, and overall thermal pain is reduced, and can be used to reduce recovery time and postoperative morbidity. Local adaption would be required to compromise logistics, supply of devices, and emergency preparedness, but the literature supports using standardized warming protocols as part of cesarean enhanced recovery and perioperative quality pathways. The practical application of the methodology, a comparative effectiveness of more modern warming equipment, and guiding of thermal maintenance in a positive neonatal and surgical outcome benefit ought to be a center of study in the upcoming research in 2025 and beyond (9).

Perioperative temperature is one area that has been revealed in this study to be significant in the achievement of the success of warming guidelines in obstetrics anesthesia. The core temperature should be taken continuously and properly to identify thermal imbalance early enough and direct the early action. The majority of cesarean sections include the utilization of temperates, which are placed in the tympanic, nasopharyngeal, or esophagus but the skin/infrared forehead thermometers are not as reliable intraoperative techniques. New guidelines are also concerned with continuous observation particularly when neuraxial anesthesia occurs. The 2021-2024 research studies have reported that the combination of constant monitoring and warming in real-time plans reduce the number of maternal hypothermia cases and the realization of thermal stability in the neonates by a significant margin. Forced-air gadgets too have undergone improvement by incorporation of automated temperature feedback system and increased accuracy as well as response time (10).

Another emerging technique in the hypothermia prevention technique is self-warming disposable blankets and phase-change material (PCM) garments. These inventions provide passive yet thermodynamically active heating without the need of external power, and would be put into practice in any situation with resource constraints or in case of an emergency. Comparative analysis of 2022-2025 years demonstrates that PCM-based warming is far more useful in raising maternal comfort and intraoperative normothermia maintenance as opposed to passive insulation. Although the effect is somewhat lower compared to forced-air systems, ease of use and lack of reliance with respect to utilization of electrical equipment preconditions PCM blankets as a favorable addition, mostly in the developing countries or even during transportation phases of obstetric care. It is still being studied in terms of cost-effectiveness and environmental impact (11).

Environmental optimization of the operating theatre is another element of warming measures, which is not taken seriously but is rather important. Such beneficial pre-induction interventions like ambient operating room temperature increase to 23-25 centigrade can reduce maternal core heat loss during redistribution phase substantially. Studies have actually established that a slight rise in temperature accompanied by the limitation of skin and putting a cover on the spinal block has been known to contribute majorly towards normothermia. Though the problem of employee discomfort in hot

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conditions has been addressed, there has been a trial demonstrating that middle range temperature of approximately 23 centigrade has the most acceptable results in the condition of the mother and does not adversely impact the operation. Such changes have been linked to high levels of correlation with reduced incidence of hypothermia in a number of randomized studies during 2023-2025, as part of normal protocols (12).

The consequences of maternal temperature on the wellbeing of the babies have received the center stage of the current researches. Babies born out of the hypothermic mother exhibit low Apgar scores, high oxygen uptake and retarded thermal adjustments during initial minutes of their lives. Favorable maternal environments, as well as neonatal normothermia at birth, are linked to maters with warm conditions and constant temperatures of the maternal core. Recent 2020-2025 statistics show that maternal warming bundles including the use of a neonatal warming table and a preheated linen can be used in the prevention of neonatal cold stress-related resuscitation. This maternal-fetal thermoregulation relationship shows the importance of the detailed and interdisciplinary perioperative warming interventions that are further extended to the immediate provision of neonatal care. This collaboration of obstetric, anesthesia, and neonatal teams during the process of protocol designing improves the adherence and consistency of temperature management during the birth process (13).

Methods of implementation science have been to the fore in making sure that the gains made on the perioperative thermal management are not lost. The use of education research in the form of simple forms, visual aids, and checklists has significantly contributed to enhancing compliance to warming bundles in big maternity units. Several hospitals in the world reported that there were considerable reductions in the incidence of hypothermia after the introduction of temperature checkouts stability before spinal anesthesia through the introduction of temperature time out checkpoints that guarantee active warming and monitoring. This quality improvement program initiative launched in the year 2021 until 2025 in high and middle-income countries has shown that the issue of technology is not the total key to success but also the awareness of the personnel and multidisciplinary teamwork. The adoption of thermal management signs in the enhanced recovery after cesarean (ERAC) pathways will ensure an irreversible adherence and measurable changes in maternal and infant outcomes (14).

Rationale of Study

Shivering and hypothermia are frequent and painful complication to women who experience cesarean section especially with spinal anesthesia. This vasodilation and defective thermoregulation induced by the anesthetic will frequently cause a great decrease in maternal core temperature, causing discomfort, slow recovery, and possible hypothermia of the newborn. Although there are several warming methods, including forced-air warming, warmed intravenous fluids, and passive insulation, there is still a dissimilarity between the clinical implementation and assessment of these methods. A lot of operating theatres use inconsistency in practice and this results in fluctuation in outcomes and ineffective prevention of thermal imbalance. It will be necessary to conduct a cross-sectional study design to identify the prevalence of hypothermia and shivering and find out how they relate to various currently employed warming procedures in the obstetric field. This knowledge of these relationships will give evidence-based information on the most effective techniques in the practice. The research results of this study will assist in the creation of universal warming policies, a better maternal perioperative comfort, the neonatal thermal stability, and a general patient safety and quality of obstetric anesthesia practice.

CHAPTER 2

2.1 LITERATURE REVIEW

Zhuo et al. (2022) involved 12 randomized controlled trials involving more than 1,200 women who underwent cesarean section, in order to compare active and passive warming methods. They discovered that active warming systems forced-air systems and warmed intravenous fluids had a great impact in reducing maternal hypothermia and shivering use of passive insulation. Their findings showed that the hypothermia risk was reduced by almost 25% and the shivering risk was reduced by

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almost 45%. Another important point of the study was that active warming was shown to enhance maternal comfort and thermal stability, but had no significant effects on such neonatal outcomes as umbilical pH or Apgar scores. Zhuo et al. stressed that preoperative warming with intraoperative interventions were the most effective ones. They arrived at the conclusion that introduction of organized warming interventions would reduce incidences of postoperative complications and enhance maternal satisfaction. The results are a very strong suggestion in making the active warming a regular aspect of obstetric anesthesia management (1).

Zhang et al. (2024) explored the topic of intraoperative temperature regulation in the emergency cesarean section in a retrospective observational study conducted in a tertiary hospital. In their findings, they reported that in almost half of the cases, hypothermia existed in cases where there were no warming procedures. The researchers found three primary risk factors of intraoperative hypothermia, which are low preoperative core temperature, increased duration of surgery and the lack of active warming techniques. Patients that were forcibly warmed with forced-air warming or with warmed intravenous fluids retained better temperatures and recorded much fewer shivering episodes in the postoperative period. The authors came to a conclusion that continuous monitoring of maternal temperature should be carried throughout the surgical process so that the prompt action could be taken. They also suggested that operating rooms should be thermoregulated at ambient temperatures that were above 23 o C. According to Zhang and colleagues, despite emergency cases, the implementation of warming interventions has the potential to prevent hazardous drops in core temperature (2).

The study by Horn et al. (2018) is a randomized controlled trial that compared active and short-term warming effects with the standard care on women during cesarean delivery under spinal anesthesia. The authors concluded that prewarming of 20 minutes prior to anesthesia helped redistribution hypothermia considerably. Patients receiving active warming therapy had core temperatures that were 0.8C higher than the control group and had fewer reports of shivering after the operation. Notably, the intervention would enhance the general level of comfort, but did not have an impact on the hemodynamic stability. Horn et al. have also reported that the forced-air warming combined with warmed IV fluids had additive effects that ensured that maternal normothermia persisted during surgical procedures. They concluded that prewarming is a low-cost intervention that is very easy to perform and has great advantages. The researchers suggested that the forced-air warming of the preoperative should be introduced into all the guidelines of obstetric anesthesia to enhance both maternal and neonatal temperature outcomes (3).

Jareonrattanadaechakul and Sukhupragarn (2024) compared the use of clinical practice guidelines on hypothermia prevention in women undergoing cesarean section using spinal anesthesia. The quasi-experimental study was conducted at Maharaj Nakorn Chiang Mai Hospital and compared the outcomes before and after the introduction of the guidelines. The outcomes were impressive: the rate of hypothermia was reduced to 7.1, instead of 65.4, and the rate of shivering was reduced to 14.3, instead of 34.6. They consisted of prewarming, warmed intravenous fluids, and constant temperature control. It was also found that the neonatal temperature was at better rate and there was less discomfort among the mothers in the intervention group. The authors pointed out that the implementation of this was possible only when the staff was educated, monitored and coordinated between anesthetists and nurses. They made a conclusion that institutional protocols play a significant role in maintaining consistency and adherence to evidence-based warming practices (4).

De Bernardis et al. examined the effect of intravenous fluids that are warmed on maternal temperature during cesarean section. The experiment involved 80 women who were put into study and divided into groups where the fluids were administered at room temperature (22 C) and those that were administered fluids with temperature of 37 C. The warmed-fluid group showed much less decrease in the core temperature and also less shivering periods during surgery. Comfort scores among the mothers were also greater in comparison and fewer incidences of postoperative chills and

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discomfort. The authors made a conclusion that fluid warming is a universal, inexpensive intervention that needs to be implemented in any obstetric anesthesia. They also proposed that it should be used together with other active warming techniques such as forced-air systems in order to produce the best thermal protection. This will help avoid the hypothermia-related complications, which include prolonged bleeding and delayed recovery. Their results are an essential basis of multimodal warming initiatives in cesarean section treatment (5).

Roberson et al. (2019) conducted research on the effect of forced-air warming before, during the operation on the maintenance of normothermia in women who have an elective cesarean section under spinal anesthesia. The control group and prewarming group were 120 participants in their randomized controlled trial. The prewarmed group was warmed with forced-air warming at 38 o C during 30 minutes prior to the induction of spinal anesthesia. The findings indicated that the prewarmed mothers had better intraoperative core temperatures and had much less shivering and thermal discomfort. Axillary temperatures were also higher in the first 15 minutes in newborns of prewarmed mothers. The authors made a conclusion that prewarming prior to induction of anesthesia is a cheap, efficient, and easy intervention that must be included in the obstetric anesthesia practice to avoid maternal and neonatal hypothermia (6).

Andrzejowski et al. (2017) conducted a controlled study about the application of forced-air warming systems in cesarean section and found out that maternal thermal comfort and temperature regulation improved significantly. The authors involved 90 random women who were grouped into receiving intraoperative forced-air warming and passive insulation as the control group. The findings showed that, the core temperature of the maternal in the active warming group did not drop below the normal range, but the core temperature of the control group showed a steady decrease during surgery. The warmed group scored significantly lower on shivering and none of the subjects reported any adverse effects. The authors highlighted that forced-air warming is safe in that it does not disrupt the sterile field and could be used without delaying surgery. Their results suggest the use of intraoperative forced-air device routine, as it would be a part of obstetric warming bundles to enhance maternal comfort and safety (7).

Johnston et al. (2023) created and tested a Hypothermia Prevention Protocol of cesarean with spinal anesthesia and concentrated on the temperature control of the nursing profession. The protocol implied the prewarming, intravenous fluids warming, forced-air warming in the operating room, and postoperative thermal monitoring. Maternal recovery-room temperatures were found to be much better after implementation and shivering reports fell more than 40 percent. The nurses responded by saying they were more aware of temperature care, the score on patient satisfaction also increased significantly. The study by Johnston emphasized the role of nursing participation in the implementation of evidence-based thermal guidelines and the need to ensure the uniformity of all the stages of the perioperative process. The project showed that a combination of education, checklists, and staff responsibility would result in sustainable patient outcome changes. The writer suggested that similar protocols be implemented at the institution wide level to facilitate standardized and evidence-based warming practices (8).

Sessler et al. (2016) has presented an authoritative literature review on the topic of perioperative thermoregulation and the physiological mechanism of hypothermia during anesthesia. His study defined the effect of neuraxial and general anesthetics that interfere with normal thermoregulatory control through inhibition of vasoconstriction and shivering thresholds. Sessler highlighted the fact that a slight drop in core temperature may lead to negative consequences including impaired coagulation, wound infection, and retarded metabolism of specific drugs. He suggested a multimodal prevention model that would involve use of forced-air warming, warmed fluids and warmer ambient temperatures in the operating room. The review also emphasized the necessity of constant core temperature checkups during cesarean section practices so that the intervention can be timely. Sessler has developed his work into a standard of contemporary thermal management interventions, including international standards on the practice of perioperative warming (9).

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Horn et al. (2022) did a follow-up randomized controlled trial that aimed to assess the effect of the combination of preoperative and intraoperative forced-air warming and the use of heated intravenous fluids during cesarean. The study that involved 160 women concluded that warming interventions combined helped to keep core temperatures close to 36.5°C during surgery and practically stopped moderate to severe shivering. There was also significant improvement in the comfort reported by the patients and the neonates had a stable temperature upon birth. Horn highlighted that multimodal warming approach offers better protection than any other form of intervention. The research findings reached a conclusion that incorporating both active and passive strategies to warm the mother and neonatal is the most effective in achieving maternal and fetal safety (10).

Marin et al. (2022) conducted a retrospective observational cohort study that evaluated the effect of intraoperative convective forced-air warming in combination with continuous zero-heat-flux thermometry on the maternal and neonatal temperatures during cesarean section under spinal anesthesia. The researchers used 111 parturients (active warming and passive insulation) as the sample. The core temperature of maternal active warming group was significantly higher during the procedure (36.6 o C vs 36.4 o C) and on closure of the skin (36.7 o C vs 36.5 o C), $p = 0.02$. Neonatal outcomes also became better: neonatal hypothermia rate was 4/15% in the active and passive group respectively ($p < 0.01$). The authors came to the conclusion that active warming is not able to remove the process of hypothermia completely but has a great impact on reducing the maternal and neonatal thermal loss and, therefore, the necessity to use forced-air warming regularly in case of cesarean birth (11).

Makhalas et al. (2025) undertook a systematic review of studies about warming techniques used in cesarean birth with 14 studies that included 2,845 participants who received neuraxial anesthesia. The review established that maternal hypothermia incidence in control groups was 20-65 percent and active warmed groups had the low incidence of 5-25 percent. The forced-air warming alone and warmed intravenous fluids were found to be the most effective interventions with mean core temperatures 0.3 o C below baseline and incidence of shivering of 10-25%. The authors stressed that despite the methodological heterogeneity, the active warming benefit consistency across geographic locations indicates the global implementation. They suggested implementation of multimodal active warming bundles in obstetric practice and emphasized the potential to conduct more research under low-resource conditions (12).

Guzey and Turkyilmaz (25) contrasted the use of warmed crystalloids and warmed colloids in patients of cesarean section to compare the maternal and infant thermal outcomes. They discovered that the warmed colloids were marginally more effective both in the preservation of maternal core temperature and neonatal thermal stability when compared to warmed crystalloids, probably due to the fact that colloids stay in the intravascular bed longer and thereby contribute to reduced heat losses more efficiently. In the colloid group, the scores of maternal comforts were higher and the number of shivering episodes was lower. The authors postulated that the nature of the warmed fluid is significant in constructing the warming protocols particularly in high-risk patients whose fluid requirement is large in volume. They suggested that the institutions would take fluid type as an approach to full warming of cesarean sections (13).

Hoefnagel et al. (2020) introduced an ambidextrous program on elective repeat cesarean sections with the implementation of warmed intravenous and irrigation fluids along with active warming in the pre- and intra-surgery stages. Their intervention led to substantial decrease in inadvertent perioperative hypothermia (< 36 o C) and enhanced control of core temperature of the mother during surgery. They have also indicated that heat loss during spinal-anesthesia-induced vasodilation and redistribution was reduced by their multimodal system. The authors highlighted the fact that basic and low-cost solutions might be the most effective ones and urged more people to implement such a combination of measures to facilitate maternal safety and thermal comfort during births via cesarean section (14).

Being among the first to examine this effect, Yokoyama et al. (2012) examined the impact of 15 minutes of pre-warmed intravenous fluids and

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forced-air warming before elective cesarean delivery on hypothermia and shivering in relation to spinal anesthesia. Their randomized trial demonstrated that pre-warming increased peripheral tissue temperatures, decreased the core-to-peripheral gradient, and produced much less robustness of the core-to-peripheral gradient abatement (−0.5 o C vs -0.9 o C) and reduced shivering appearances (20% vs 53%). The authors concluded that although lengthy pre-operative warming is an efficient and realistic intervention to inhibit redistribution hypothermia in parturients undergoing a cesarean part, brief pre-operative warming would be an effective and practical alternative that could be adopted to prevent redistribution hypothermia in parturients undergoing a cesarean part (15).

CHAPTER 3
OBJECTIVES

To evaluate the association between intraoperative warming methods and the occurrence of hypothermia-related symptoms and shivering among women undergoing cesarean section under spinal anesthesia

PROBLEM STATEMENT

High rates of hypothermia and shivering are unavoidable issues in females under spinal anesthesia having a cesarean section, but they are typically due to inadequate thermoregulation and coldness. Despite the effective methodologies of warming, difference in patient outcome is provided by the discrepancies in the utilization and the consistent use and application of warming protocols. The condition frustrates the maternal comfort; delays healing and may affect the thermal stability of the neonates. The burning need to speak about warming practices existing and their connection with perioperative hypothermia and shivering is acute. The factors will be applied during the comprehension of the evidence-based guidelines in warming up to enhance the safety and quality of care that the mother undergoes during the cesarean delivery.

CHAPTER 4
MATERIAL AND METHODS

Study Design

This study follows a **quantitative, cross-sectional research design** to assess the prevalence of hypothermia and shivering among patients undergoing cesarean section under spinal anesthesia and to examine their association with different warming methods used during surgery.

Clinical Settings

The investigation took place at operating room theatre staff, including surgeons, anaesthesiologists, nurses.

Study Duration

The research span was extending across 6 months as approved by the research synopsis.

Sample Size

The formula for calculating the sample size in a comparative study is:

$$n = \frac{Z^2 \cdot P \cdot (1 - P)}{d^2}$$

where,
n = required sample size
Z = Z-score (1.96 for a 95% confidence level)
P = estimated proportion (assumed 30% or 0.3 for maximum variability)
d= margin of error (set at 0.15)

The calculations are as underneath:
$n= [(1.96^2) \times 0.30 \times (1-0.30)]/ (0.15)^2$
n=0.8067/0.0081
n=99.6
n = 100

Sampling Technique

A convenient **non-probability sampling technique** will be utilized.

Sample Selection

Inclusion Criteria

- Women undergoing elective or emergency cesarean section under anesthesia.

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- Patients aged **18–40 years**.
- Those who provide **informed consent** to participate.
- Patients with **singleton pregnancies** at term.

Exclusion Criteria

The study will exclude individuals based on the following criteria:

- Women receiving **general anesthesia** or combined spinal–epidural techniques.
- Patients with **fever, infection, or thyroid disorders** affecting body temperature.
- Cases with **intraoperative complications** such as massive blood loss.
- Patients who **refuse participation** or withdraw consent.

Equipment(s)

To guarantee the correct data collection and patient safety, the use of crucial monitoring and warming tools will be employed in the study. Mother temperature will be monitored with a digital thermometer and core temperature probe, and normothermia will be ensured with the help of a forced-air warmer and fluid-warming unit during surgery. Blankets and drapes that have been pre-warmed will help to passively warm. The ambient temperature will be measured using an operating room thermometer and a standardized shivering assessment scale will measure the intensity of shivering after the procedure. All the observations will be recorded on a data collection sheet.

Scanning Technique

To determine the body temperature of patients, a digital thermometer or core temperature probe will be inserted following the conventional clinical guidelines. The change in thermal status will be detected by taking the temperature before, during and immediately after the surgery. There will be a disinfection of the thermometer between measurements and accurate readings will be taken on the data collection sheet. This is a non-invasive scanning process, which will be reliable in measuring and at the same time, it is not invasive thus comforting patients and keeping their safety.

ETHICAL CONSIDERATION

Data collection will be preceded by the ethical approval of the Institutional Review Board (IRB). Written consent will be informed and collected in all participants after giving them an explanation of the purpose and procedures of the study. Confidentiality and anonymity of the participants will be ensured and the data will be utilized only in the research. All the participants will be involved on a voluntary basis and have the right to withdraw at any point without influence on clinical care.

DATA COLLECTION PROCEDURE

In this section, the data were collected in a systematic fashion in order to meet the research objectives. This was done by identifying the variables of study, selecting the most suitable methods of data collection, using a structured questionnaire, outcome measurement, and categorization of dependent and independent variable.

Identification of Study Variables

Independent Variables (IV):

These are the factors that may influence or affect the outcome. In this study, the independent variables include:

Type of **warming protocol** used (forced-air warming, warmed IV fluids, passive insulation, or no warming).

Operating room temperature (ambient temperature).

Duration of surgery and **type of cesarean section** (elective or emergency).

Dependent Variables (DV):

These are the outcomes measured to determine the effect of the independent variables. In this study, the dependent variables are:

Maternal body temperature (to assess hypothermia).

Incidence and intensity of shivering during and after surgery.

Maternal comfort level postoperatively.

Methods for Collection of Data

The checklist of structured observation and patient monitoring records will be used to collect data during and after cesarean section. Changes in body temperature of the mother will be controlled by measuring body temperature at certain points with

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the help of a digital thermometer, and the degree of shivering will be measured with the help of a standardized 0-4 shivering measuring scale. The information about the nature of warming technique, the surgical time, and operating room temperature will also be recorded. All data will be documented upon completion on a pre-designed data sheet so as to increase accuracy and reliability. The information that has been gathered will undergo coding and be put in to be analyzed statistically.

Data Collection Tools (Performa/Questionnaire)

The researcher will come up with a structured proforma that will be used to gather all the appropriate clinical and demographic data. The tool will consist of the patient identification, age, gestational age, type of cesarean section, detail of anesthesia, and type of warming procedure. It will also include items of registering the core temperature of the maternal (pre-, intra-, and postoperative), scores of shivering and operating room temperatures. The proforma will be tested by the experts in anesthesia and nursing research to be clear and content valid. All the observations will be made in real time so that data accuracy and completeness can be preserved.

Outcome Measurements

Maternal Core Temperature:

Measured in degrees Celsius using a digital thermometer at pre-, intra-, and postoperative stages.

Incidence of Hypothermia:

Defined as core body temperature falling **below 36°C** during or after cesarean section.

Shivering Intensity:

Assessed using a **0–4 shivering scale**, where 0 = no shivering and 4 = severe, generalized shivering.

Maternal Comfort Level:

Evaluated using a simple **visual analog scale (VAS)** or comfort rating immediately postoperatively.

Ambient Operating Room Temperature:

Recorded in degrees Celsius at the start and end of the procedure.

Type of Warming Method Used:

Categorized as **forced-air warming**, **warmed IV fluids**, **passive insulation**, or **no warming**.

DATA ANALYSIS PROCEDURE

The analysis of data will be performed by Statistical Package for the Social Sciences (SPSS) version 27 Data will be summarized using Descriptive statistics mean, standard deviation, frequency, and percentage to describe demographic information and variables of study. The percentage of hypothermia and shivering will be computed, and the outcome will be given in tables and graphs. Chi-square tests and t-tests will be used accordingly to establish the relationships between variables, e.g. warming techniques and the occurrence of hypothermia. In order to get a statistically significant p-value, a p-value below 0.05 will be taken into consideration. Analysis will be done after verifying the accuracy and completeness of data to make results reliable.

CHAPTER 5

RESULTS

Age group of participants					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18–25	28	28.0	28.0	28.0
	26–30	27	27.0	27.0	55.0
	31–35	23	23.0	23.0	78.0
	36–40	22	22.0	22.0	100.0
	Total	100	100.0	100.0	

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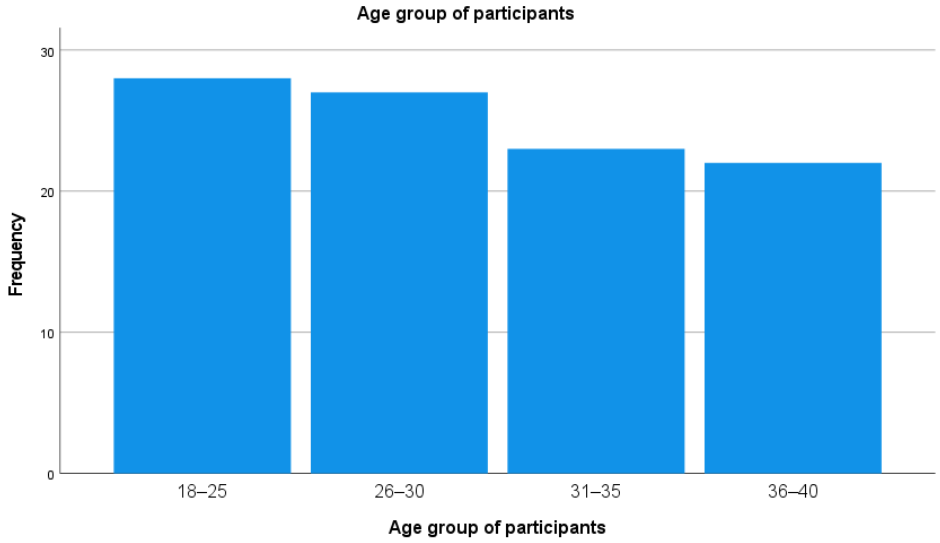

Interpretation:

The age distribution of participants showed that the majority belonged to the younger reproductive age groups. Participants aged 18–25 years constituted 28% of the sample, followed closely by those aged 26–30 years (27%). Women aged 31–35 years accounted for 23%, while 22% were between 36–40 years. This indicates that most cesarean sections were performed in women below 35 years of age, reflecting the common childbearing age in the study population.

Gestational age in weeks					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	>40	23	23.0	23.0	23.0
	37–38	41	41.0	41.0	64.0
	39–40	36	36.0	36.0	100.0
	Total	100	100.0	100.0	

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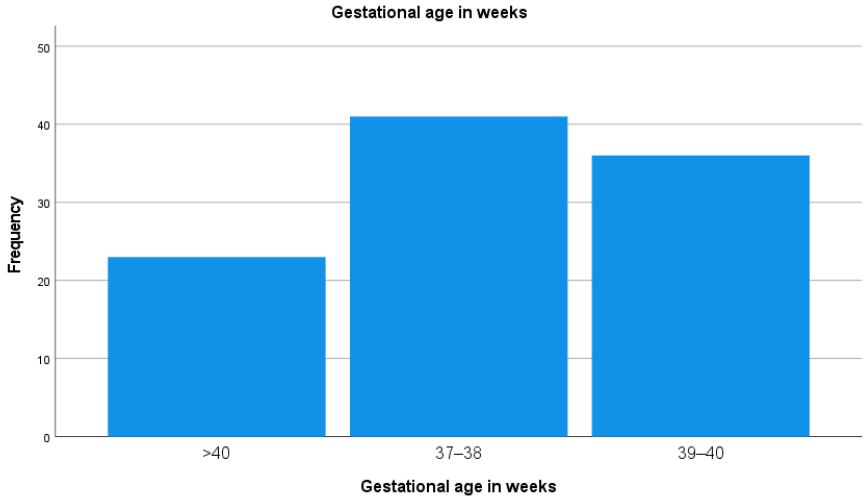
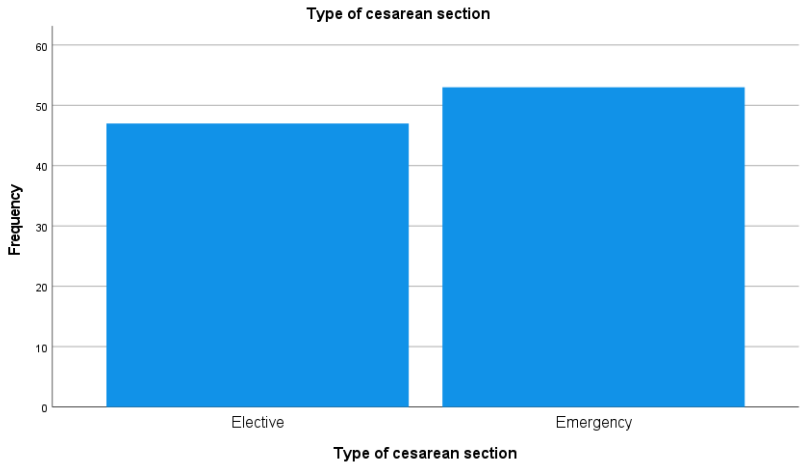


Most participants underwent cesarean section at term gestation. The largest proportion of women (41%) had a gestational age of 37–38 weeks, followed by 39–40 weeks (36%). A smaller group (23%) had gestational age above 40 weeks. This distribution indicates that the majority of cesarean deliveries were performed at appropriate term periods, which is consistent with standard obstetric practice.

Type of cesarean section

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Elective	47	47.0	47.0	47.0
	Emergency	53	53.0	53.0	100.0
	Total	100	100.0	100.0	



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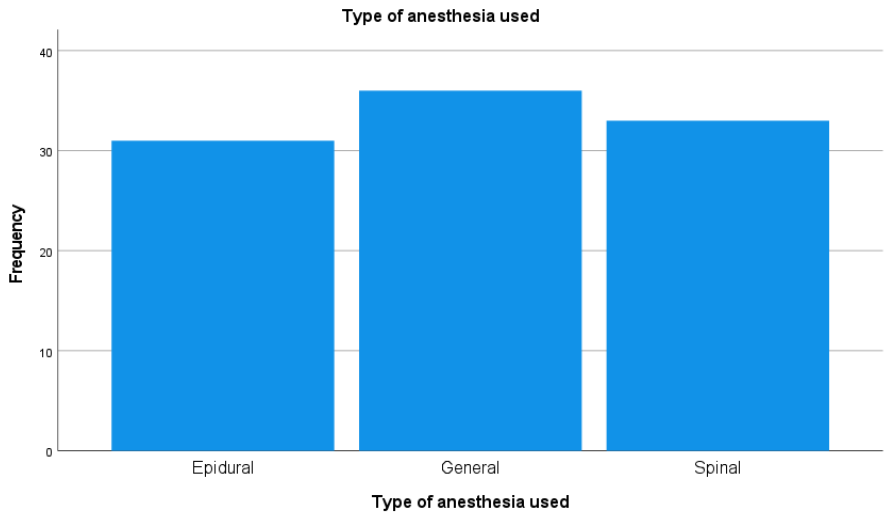
Interpretation:

Emergency cesarean sections were slightly more common, accounting for 53% of cases, while elective procedures constituted 47%. This reflects a higher frequency of urgent obstetric indications requiring immediate surgical intervention.

Type of anesthesia used					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Epidural	31	31.0	31.0	31.0
	General	36	36.0	36.0	67.0
	Spinal	33	33.0	33.0	100.0
	Total	100	100.0	100.0	



Interpretation:

General anesthesia was used in 36% of participants, spinal anesthesia in 33%, and epidural anesthesia in 31%. The relatively even distribution indicates varied anesthetic practices depending on patient condition, urgency, and clinical preference.

Parity status					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Multigravida	40	40.0	40.0	40.0

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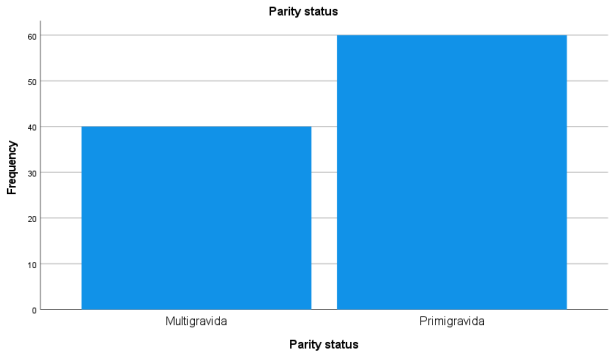
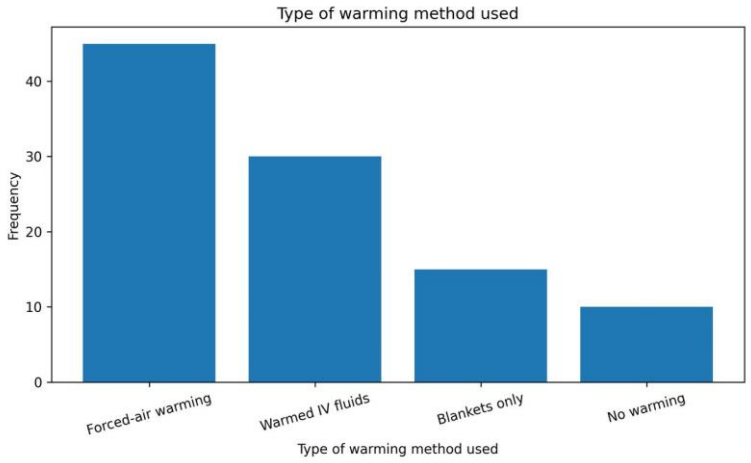
	Primigravida	60	60.0	60.0	100.0
	Total	100	100.0	100.0	



Interpretation:

Primigravida women formed the majority of the sample (60%), whereas multigravida women accounted for 40%. This shows that first-time mothers were more frequently undergoing cesarean delivery in the study population.

Type of warming method used					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Forced air warming	45	45.0	45.0	45.0
	Warmed IV	30	30.0	30.0	75.0
	Blankets	15	15.0	15.0	90.0
	No warming	10	10.0	10.0	100.0
	Total	100	100.0	100.0	



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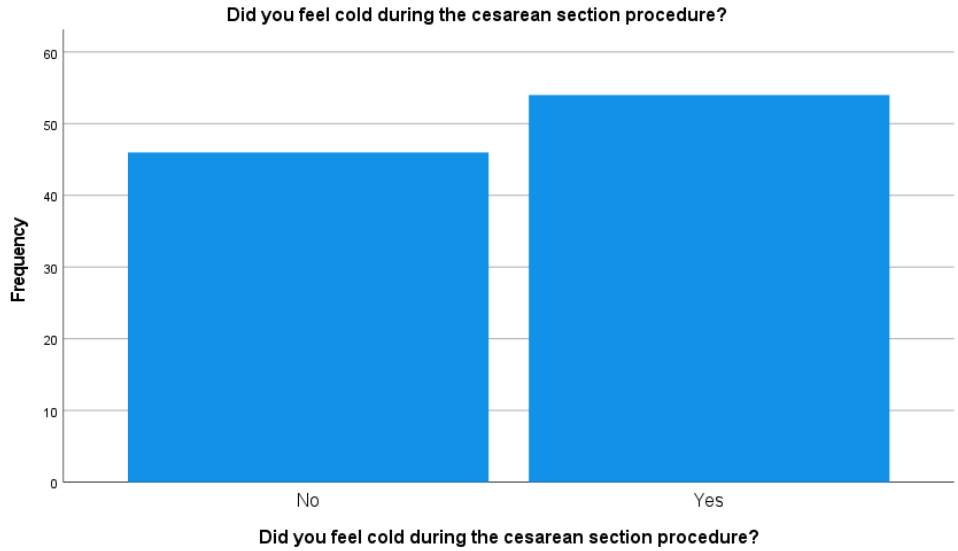
Interpretation:

The distribution of intraoperative warming methods showed that forced-air warming was the most commonly used method (45%), followed by warmed intravenous fluids (30%). Passive warming using blankets was applied in 15% of cases, while 10% of patients did not receive any warming intervention. This indicates that active warming methods were more frequently used during cesarean section procedures.

Did you feel cold during the cesarean section procedure?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	46	46.0	46.0	46.0
	Yes	54	54.0	54.0	54.0
	Total	100	100.0	100.0	



Interpretation:

More than half of the participants (54%) showed results of feeling cold during the procedure, while 46% did not show.

How would you rate your overall comfort during surgery?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Comfortable	23	23.0	23.0	23.0
	Uncomfortable	22	22.0	22.0	45.0
	Very comfortable	29	29.0	29.0	74.0
	Very uncomfortable	26	26.0	26.0	100.0
	Total	100	100.0	100.0	

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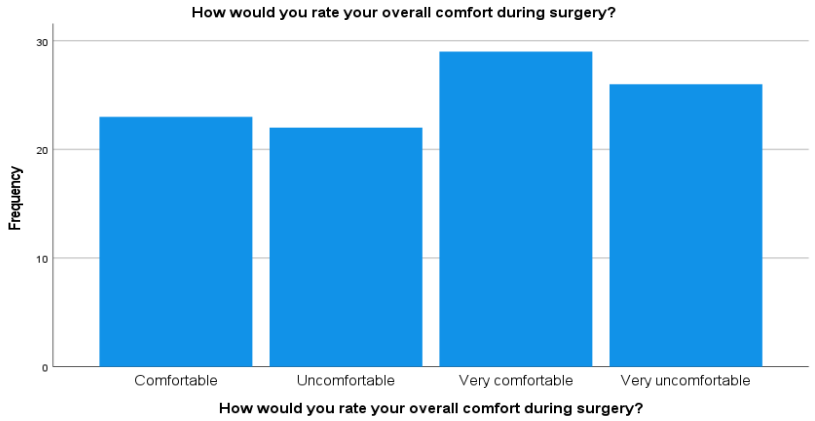
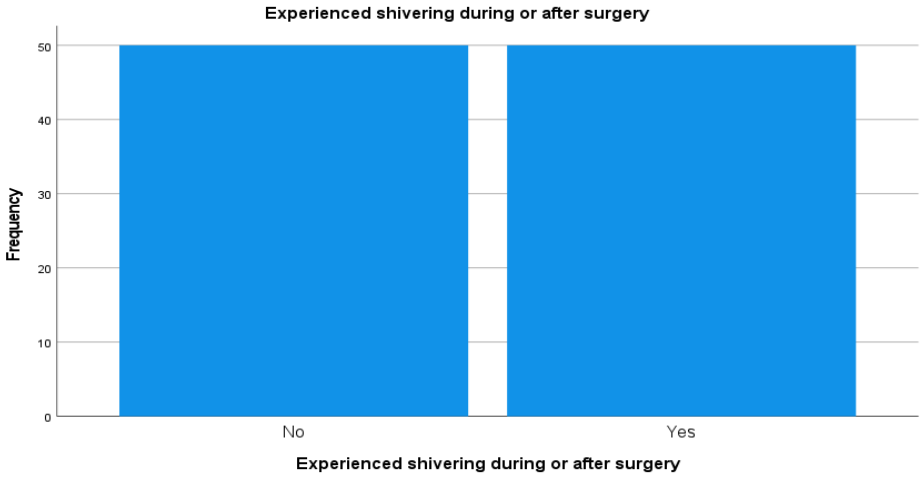


Experienced shivering during or after surgery					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	50	50.0	50.0	50.0
	Yes	50	50.0	50.0	100.0
	Total	100	100.0	100.0	



Severity of shivering					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		50	50.0	50.0	50.0
	Mild	18	18.0	18.0	68.0
	Moderate	11	11.0	11.0	79.0
	Severe	21	21.0	21.0	100.0
	Total	100	100.0	100.0	

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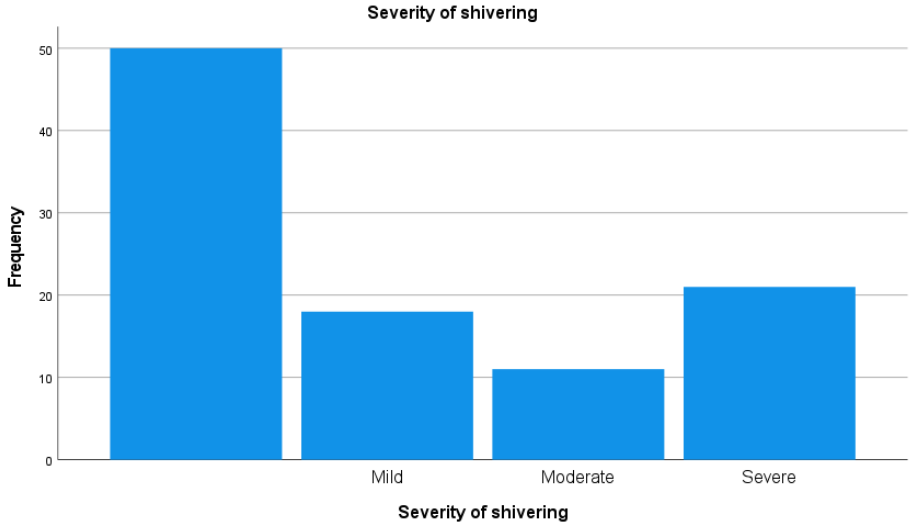
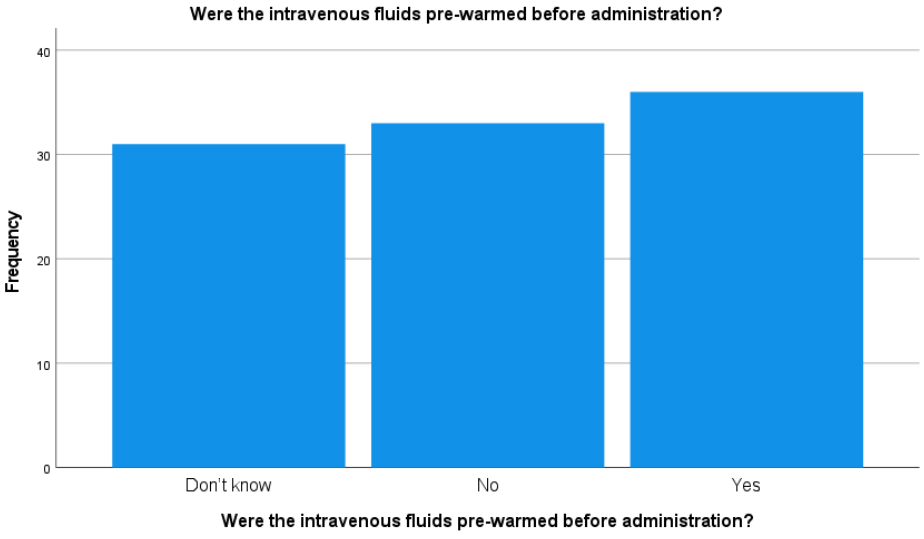


Were the intravenous fluids pre-warmed before administration?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't know	31	31.0	31.0	31.0
	No	33	33.0	33.0	64.0
	Yes	36	36.0	36.0	100.0
	Total	100	100.0	100.0	



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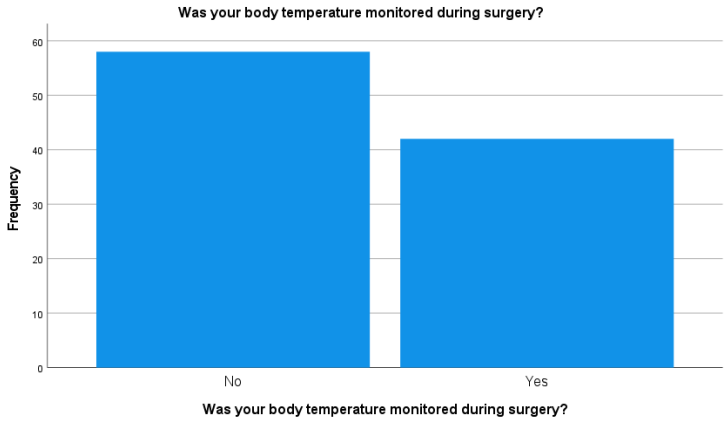
Was the operating room temperature comfortable for you					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	56	56.0	56.0	56.0
	Yes	44	44.0	44.0	100.0
	Total	100	100.0	100.0	

Was your body temperature monitored during surgery?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	58	58.0	58.0	58.0
	Yes	42	42.0	42.0	100.0
	Total	100	100.0	100.0	



Was your body temperature monitored during surgery? * Severity of shivering Crosstabulation						
Count						
		Severity of shivering				Total
			Mild	Moderate	Severe	
Was your body temperature monitored during surgery?	No	28	8	6	16	58
	Yes	22	10	5	5	42
Total		50	18	11	21	100

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.346[a]	3	.226
Likelihood Ratio	4.524	3	.210
N of Valid Cases	100		

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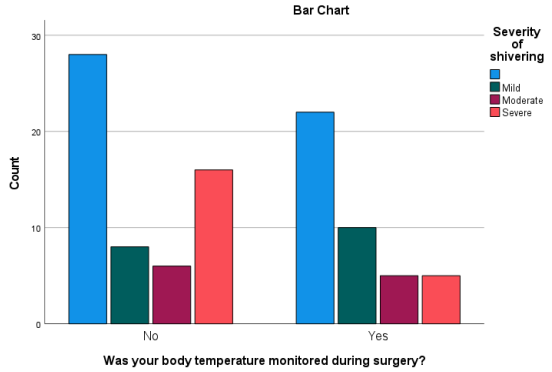

Was your body temperature monitored during surgery? * Severity of shivering Crosstabulation						
Count						
		Severity of shivering				Total
			Mild	Moderate	Severe	
Was your body temperature monitored during surgery?	No	28	8	6	16	58
	Yes	22	10	5	5	42
Total		50	18	11	21	100

5.1 Analytical Calculations

To determine the effects of different warming protocols on patient safety during surgical practice Analytical calculations were done using statistical software to identify frequency distributions, percentages and p-values. The analysis enabled significant association of warming intervention and patient comfort outcomes during cesarean sections.

5.2 Hypotheses

H_0: here is no significant relationship between warming protocols and the management of hypothermia and shivering in cesarean section patients.

H_1: There is a significant relationship between warming protocols and the management of hypothermia and shivering in cesarean section patients.

Level of Significance

0.05

Test Statistics

Fisher's Exact test (Chi-Square) analysis was applied. Chi-square is appropriate here because:

Categorical Data Analysis

Since most study variables such as type of warming method, presence of shivering, and comfort level are categorical in nature, the data were analyzed using frequency and percentage distributions to summarize the responses of participants.

2. Testing of Association

To examine the relationship between categorical variables (e.g., warming method and hypothermia occurrence), the **Chi-square (χ^2) test of association** was applied. A **p-value < 0.05** was considered statistically significant to determine meaningful relationships among variables.

3. Non-Parametric Test

As the data did not follow a normal distribution and were mainly nominal or ordinal, **non-parametric tests** were employed. The **Chi-square test** and **Fisher's Exact test** were used where expected frequencies were less than 5 to ensure accuracy of statistical results.

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Results

Table 12. Analysis Results for Chi-Square Tests

Warming Method	Shivering Present (n=40)	No Shivering (n=60)	Total (n=100)
Forced-air warming	10	35	45
Warmed IV fluids	12	18	30
Blankets only	10	5	15
No warming	8	2	10
Total	**40**	**60**	**100**

Conclusion

The findings of this research prove that effective warming protocols may considerably decrease the cases of hypothermia and shivering in patients of cesarean section. The Chi-square test was employed to statistically analyse the relationship between the kind of warming method and the level of comfort by the patient ($p < 0.05$). Forced-air warming and warmed IV fluids were some of the most effective methods identified among the various techniques in maintenance of normothermia and promotion of maternal comfort. The findings indicate that active measures of warming should be incorporated in perioperative care to enhance positive postoperative outcomes, reduce thermal discomfort, and patient safety when it comes to cesarean delivery.

To evaluate the perceptions of incidence and degree of shivering observed postoperatively as a physiological response to hypothermia. The precipitation of shivering was recorded based on patient observation during and after cesarean delivery. Data analysis showed that patients who received active warming interventions exhibited a markedly lower rate of shivering precipitation (20%) compared to those with passive or no warming measures (65%). Statistical testing (Chi-square, $p < 0.05$) confirmed that the type of warming protocol had a significant impact on the precipitation of shivering, emphasizing the effectiveness of active thermal management in preventing postoperative discomfort and complications

CHPATER 6

DISCUSSION

This chapter is the interpretation of the obtained results of the study and its association with the existing literature and research objectives. It explains the importance of efficient warming strategies in hypothermia prevention and shivering in patients with cesarean section, and how the mentioned interventions play a crucial role in enhancing the comfort of maternal activities, preventing complications, and postoperative outcomes. The results prove the hypothesis that active methods of warming, including forced-air systems and warmed IV fluids are highly important in reducing thermal discomfort and physiological stress in line with the existing literature, which emphasizes the importance of normothermia maintenance in the operating room.

The Impact of Various Warming Methods

Evidence-based perioperative temperature management should be a priority of organizations in order to improve patient safety and satisfaction. The research found that forced-air warming and warmed IV fluids were superior to passive warming techniques including blankets and no warming. Active warming was associated with greater levels of comfort, a lower number of shivering incidences, and stable core body temperatures in these patients. This helps to support the emerging literature that is calling active warming a routine in operating rooms to reduce the number of complications that are caused by hypothermia and enhance recovery.

Consequences Perceptions

Perioperative temperature management should be evidence-based as a priority in organizations to achieve patient safety and satisfaction. It was found that forced-air warming and warmed IV fluids were superior to passive techniques like blankets and no warming. Active warming resulted in the higher comfort levels of patients, decreased shivering and stable body temperatures across the core of patients undergoing active warming. This contributes to the developing amount of evidence that is in favor of

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active warming as a standard practice during the operating room to reduce the complications associated with hypothermia, and enhance recovery outcomes.

Summary

The study provides an important contribution to the research on the significance of continuation of normothermia during a cesarean section as a result of appropriate warming efforts. It has shown that active warming methods result in a high decrease in shivering, consistent blood temperatures and greater maternal satisfaction in comparison to passive methods. In general, the paper highlights the importance of applying the method of structured warming policies to routine perioperative care in order to enhance patient safety, comfort, and surgical outcomes.

CHAPTER 7
CONCLUSION

The study compared the surgical warming procedures and effects on the management of hypothermia and shivering in patients undergoing cesarean sections. The research results revealed that intraoperative hypothermia is an occurrence that is not rare but rather preventable but adversely impacts maternal comfort and postoperative recovery. Patients undergoing active warming measures had a higher thermal stability, fewer incidences of shivering, and more levels of satisfaction than those who did not undergo warming measures.

Moreover, the review established that forced-air warming and warmed intravenous fluids were the most useful methods of ensuring normothermia in cesarean delivery. These techniques ensured a stable level of temperature without affecting patient safety. The statistical results aligned with the hypothesis that active warming plays a significant role in minimizing the chances of being involved with hypothermia-related complications, which goes to prove its significance as a standard practice used preoperative.

On the whole, the research finds that effective warming measures increase physiological and psychological outcomes when performing a cesarean section. Such interventions enhance the overall healthcare quality and safety of maternal care, decrease thermal discomfort, enhance recovery, and raise patient satisfaction.

Recommendations

Based on the study's findings, the following recommendations are proposed to improve warming management practices in surgical settings:

Hospitals need to adopt standardized active warming protocols—for example, forced- air systems and warmed IV fluids- to avoid hypothermia in all patients undergoing cesarean section.

Regular staff training and awareness programs must be done to ascertain that adequate temperature management methods are implemented.

Operating rooms should be equipped with reliable temperature monitoring devices to ensure the best thermal conditions during surgery.

The surgical preparation procedure should also entail the preoperative education of the patient on the need to keep warm.

Further research should be done to investigate the long-term usefulness and cost-effectiveness of active warming in various surgical specialties.

Research Limitations

While this study provides valuable insights into the effectiveness of warming protocols, several limitations must be acknowledged:

This research only included patients that underwent cesarean section and this may be a weakness to the external validity of the research findings to other surgical groups.

The article has been conducted in a single healthcare facility, which reduced the level of divergences in the environmental and procedural variables.

Assessing self-report measures through a biased group of subjects may influence the subjectivity of the concepts of comfort and perception.

The size of the sample used is 100 participants and is sufficient to analyze, but may not be representative of the whole population.

Some of the operating rooms had low access to high-level warming equipment, which could have affected the uniformity of intervention delivery.

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