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Research

The Impact of Perioperative Warming in an Outpatient Aesthetic Surgery Setting

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Abstract

Background: Perioperative hypothermia can lead to surgical complications, including bleeding, infection, increased patient discomfort, and longer recovery time. Plastic surgeons have become increasingly aware of this important patient safety issue.

Objectives: The authors evaluate the impact of perioperative warming in an outpatient plastic surgery setting.

Methods: A retrospective review was performed of 108 patients who received several simple measures to prevent perioperative hypothermia. Patients dressed in warm clothing and were covered with an electric blanket in both the holding area and the recovery room. Intraoperative interventions included higher ambient room temperature, skin exposure only at the surgical site, forced-air warming, and the use of warmed fluids. This warmed group was compared with a historical control group of 106 patients who underwent plastic surgery in the period immediately before implementation of these measures. Patient demographics and procedural characteristics were similar for the 2 groups.

Results: The requirement for intraoperative analgesia was significantly lower for the warmed group (111 vs 125 μg fentanyl in the control group; $P = .042$). Patients in the warmed group required less time in the recovery room and met discharge criteria sooner (127 vs 141 minutes; $P = .001$). No significant difference was observed in the incidence of complications.

Conclusions: Simple measures to maintain perioperative normothermia improve patient comfort and recovery following aesthetic surgery. Through a continuous-improvement culture, the authors have successfully implemented warming strategies that prevent perioperative hypothermia and improve surgical outcomes.

Level of Evidence: 3

Keywords

aesthetic surgery, cosmetic surgery, patient safety, warming, normothermia, hypothermia, research

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Temperature regulation in the operative setting is an important aspect of best surgical practices. Thermoregulatory defenses become compromised during anesthesia, resulting in decreased intrinsic capacity to maintain core body temperature.¹⁻³ The effect of temperature on a variety of patient-related outcomes has received growing attention in the past decade.³⁻⁷

Perioperative hypothermia, defined as a core body temperature of $\leq 96.8^{\circ}\text{F}$ (36.0°C), has been associated with various complications.⁴⁻⁶ Young and Watson³ reviewed adverse outcomes related to perioperative hypothermia, including cardiac events such as ventricular tachycardia, increased mortality in the setting of trauma, increased incidence of wound infection,⁸⁻¹⁰ bleeding and blood transfusion,¹¹ and delayed wound healing. Moreover, factors such as increased recovery time¹² and prolonged hospital admission,¹⁰ which substantially affect health care resource

utilization, have been linked to inadequate maintenance of perioperative normothermia. Therefore, concerted efforts to maintain normothermia perioperatively are highly desirable from both a patient safety and health economics perspective.

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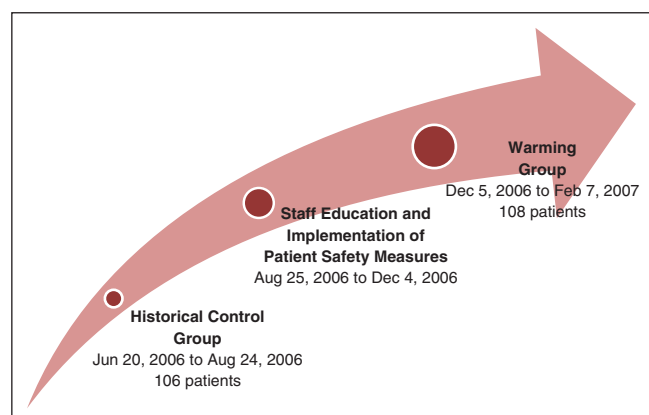


Figure 1. Study timeline. The warming group of 108 patients underwent surgery after staff education and implementation of patient safety measures. These patients were compared with the historical control group of 106 patients, who underwent surgery before the warming interventions were instituted.

To maintain core temperature during general or regional anesthesia, multiple strategies have been suggested, for use independently or in combination. Maintaining operating room ambient temperatures of at least 71.6°F (22.0°C) and applying both passive and active warming methods have been advocated by various authors.^{3,7,13} *Passive* warming strategies include the use of blankets, reflective covers, and other insulative materials in an effort to sequester heat between the patient and the insulator.^{3,14,15} *Active* warming methods include the use of forced-air heaters, warm irrigation and intravenous fluids, and pharmacologic agents that promote vasodilation, such as nifedipine.^{3,14,15} More recently, the infusion of amino acid mixtures has been advocated as a method to promote endogenous thermogenesis by increasing the metabolic rate.¹⁶

To date, much of the plastic surgery literature concerning perioperative hypothermia has been limited primarily to liposuction procedures and the use of warmed tumescent solutions to counteract decreases in core body temperature.¹⁷⁻¹⁹ To our knowledge, no studies have examined the effects of perioperative warming in an outpatient aesthetic surgery setting. The present study assessed the effect of a comprehensive approach to warming patients perioperatively with respect to the following outcomes: duration of surgery, perioperative analgesia requirements, time spent in the recovery room, and complications.

METHODS

This retrospective study was conducted in an outpatient surgical center. All surgeries were performed by the senior author (FL). Between August 25, 2006, and December 4, 2006, as a quality improvement measure for patient safety, we introduced a new protocol for perioperative warming of patients (Figure 1). The following interventions were implemented:

1. The room temperature of the preoperative and recovery area was maintained at 75.2°F (24.0°C).
2. The operating room temperature was always 75.2°F (24.0°C) or warmer.
3. In the preoperative area, patients changed into their pajamas and wore a robe, hat, socks, and slippers. In addition, they were covered with an electric warming blanket and instructed to keep this blanket on at all times prior to their procedure (Figure 2).
4. Once in the operating room, only the clothing necessary to expose the surgical field was removed during the operation. A forced-air warming blanket was placed across the chest and arms or legs, as permitted. The temperature of the blanket was set at 100.4°F (38.0°C).
5. All fluids used intraoperatively were warmed to 95.0°F (35.0°C). This included intravenous, infiltration, and irrigation fluids, along with saline used to fill implants.
6. Upon transfer to the recovery area, the electric warming blanket was reapplied and worn until shortly before discharge.

All staff involved in perioperative patient care were educated about the importance of perioperative hypothermia and the strategies to prevent it (Table 1). All interventions were fully and consistently implemented by December 4, 2006, and incorporated into our perioperative protocol. To evaluate the impact of these interventions, we examined the records of 108 consecutively treated patients who underwent an aesthetic surgery procedure under general anesthesia from December 5, 2006, to February 6, 2007. A historical control group, consisting of 106 consecutively treated patients who underwent an aesthetic surgery procedure under general anesthesia from June 20 to August 24, 2006, was used for comparison. Until August 25, 2006, none of the above-mentioned warming interventions had been practiced routinely.

Patient demographics and procedural characteristics were analyzed during the retrospective chart review (Table 2). Demographic data included age, body mass index (BMI), and gender. Procedural characteristics included type of procedure, operative time, intraoperative fentanyl requirements, recovery room time, postoperative meperidine requirements, and complications. Statistical analysis was performed using the Student *t* test and Fisher's exact test (where appropriate). *P* values of < .05 were considered significant. The principles outlined in the Declaration of Helsinki were followed throughout the study.

RESULTS

Among the warmed group (*n* = 108), the average age was 35.8 years, the average BMI was 23.8 kg/m², and 18% were smokers. Thirteen percent were male and 87% were female. In the historical control group (*n* = 106), the average age was 34.2 years, the average BMI was 23.9 kg/m²,



Figure 2. (A) In the preoperative area, patients wear their pajamas, robe, hat, socks, and slippers. (B) In addition, patients are covered with an electric warming blanket in the preoperative area, which is reapplied when they are transferred to the recovery area.

Table 1. Warming Strategies to Prevent Hypothermia

Preoperative
Preoperative area temperature: 75.2°F (24.0°C)
Patients wear pajamas, robe, hat, socks, and slippers
Electric warming blanket
Intraoperative
Operating room temperature: 75.2°F (24.0°C) or greater
Only the clothing necessary to expose the surgical field is removed during the operation
Forced-air warming blanket set at 100.4°F (38.0°C)
All fluids (ie, intravenous, infiltration, irrigation, implant fill) warmed to 95.0°F (35.0°C)
Postoperative
Recovery area temperature: 75.2°F (24.0°C)
Electric warming blanket reapplied

and 19% were smokers. Ten percent were male and 90% were female. There was no statistically significant difference in these demographics between the 2 groups (Table 2).

Both groups included a variety of aesthetic surgery procedures; breast augmentation, breast reduction, and gynecomastia surgery were the most common procedures (Figure 3). Breast procedures (ie, breast augmentation, breast reduction, breast implant capsulotomy/exchange/explantation, mastopexy, breast augmentation-mastopexy, gynecomastia surgery) comprised 76% of procedures in the warmed group and 75% in the control group. Surgical procedures of the face (ie, rhinoplasty, otoplasty, face-lift, blepharoplasty) comprised 6% of procedures in the warmed group and 8% in the control group.

The minimum postoperative follow-up period was 3 months. The overall complication rate was 9%. Complications occurred in 8% of patients in the warmed group and 9% in the control group; there was no statistically significant difference between the groups. Surgical-site infection was the most common complication in the warmed group (4% of patients), and implant-related complications were

Table 2. Patient Demographics and Procedural Characteristics

	Historical Control Group	Warmed Group	P Value
No. of patients	106	108	
Average age, y	34.2	35.8	.253
Average body mass index, kg/m ²	23.9	23.8	.795
Gender, No.			.671
Male	11	14	
Female	95	94	
No. of complications	10	9	.814
Type of complication, No.			
Infection	1	4	.369
Hematoma	0	1	1.000
Seroma	3	1	.367
Superficial wound dehiscence	1	2	1.000
Implant related (capsular contracture, rupture, malposition)	6	1	.064
Operating room time, min	71	75	.300
Intraoperative intravenous fentanyl requirements, µg	125	111	.042 ^a
Recovery room time, min	141	127	.001 ^a
Recovery room intravenous meperidine requirements, mg	17	17	.960
Recovery room PO oxycodone hydrochloride 5 mg/acetaminophen 325 mg, tablets	0.49	0.37	.217

^aSignificant difference between the study groups.

the most frequent complication in the control group (6% of patients). Although less than 1% of the patients in the historical control group had a surgical-site infection, the between-group difference was not statistically significant. Hematoma occurred in less than 1% of patients in the warmed group and in none of the historical control cases; the difference was not statistically significant. There was no significant difference between study groups in the incidence of other complications, including seroma, superficial wound dehiscence, or implant-related complications.

Although operating room time was similar for the 2 groups (75 minutes in the warmed group; 71 minutes in the control group), the time spent in the recovery room was significantly shorter for the warmed group (127 minutes vs 141 minutes; $P = .001$).

Intraoperative analgesia requirements for fentanyl were significantly lower in the warmed group (111 µg vs 125 µg in the control group; $P = .042$). Postoperative analgesia requirements in the recovery room, consisting of oxycodone hydrochloride 5 mg/acetaminophen 325 mg and/or meperidine, did not differ significantly between the groups.

DISCUSSION

The body's reduced ability to thermoregulate under general anesthesia is a significant contributor to intraoperative hypothermia. Under normal circumstances, the body allows for a narrow acceptable core temperature range of approximately $\pm 0.36^\circ\text{F}$ (0.2°C) from the normal core temperature.¹⁻⁴ This is known as the "interthreshold range." Variance outside this range triggers an autonomic response—such as vasoconstriction if below normal core temperature or vasodilatation if above—to maintain normal core temperature. When a patient is under general anesthesia, this tightly calibrated range is uncoupled and widens significantly, to approximately 20 times normal (approximately $\pm 7.2^\circ\text{F}$ [4.0°C]), thus preventing the triggering of autonomic responses that would normally conserve core body temperature much sooner. In combination with a typically cool operating room and exposed skin and tissue, general anesthesia can cause the patient to become acutely susceptible to intraoperative hypothermia. This concern is particularly important in aesthetic surgery procedures in which large areas of skin and underlying tissues are exposed, such as abdominoplasty or breast reduction.

The impact of hypothermia during major operations has been well studied, showing that perioperative warming reduces postoperative complications and improves patient comfort.²⁰⁻²⁴ In the present study, the importance of perioperative warming is extended to the ambulatory surgery setting, where the duration of surgery is typically short. Even with our average operating time of only 75 minutes, recovery time was significantly shorter when the perioperative warming protocol was employed. However, this finding is not entirely surprising because physiological changes in thermoregulation begin immediately upon induction of anesthesia. Intraoperative hypothermia develops in a characteristic pattern: (1) During induction of anesthesia, heat redistributes from the core to the periphery, causing an initial decrease in core temperature of 1.8 to 2.7°F (1.0 to 1.5°C). (2) In the following 3 hours, core temperature decreases linearly due to heat loss that exceeds metabolic heat production. (3) After 3 to 5 hours of anesthesia, the core temperature stops declining. This plateau in core temperature occurs because of peripheral vasoconstriction, preventing loss of centrally generated metabolic heat to peripheral tissues.^{2,20,25} The precise relationship between duration of surgery and complications secondary to perioperative hypothermia has not been established.

In other surgical disciplines, perioperative hypothermia has been correlated with a longer postoperative hospital stay. In a randomized controlled trial of 200 patients who

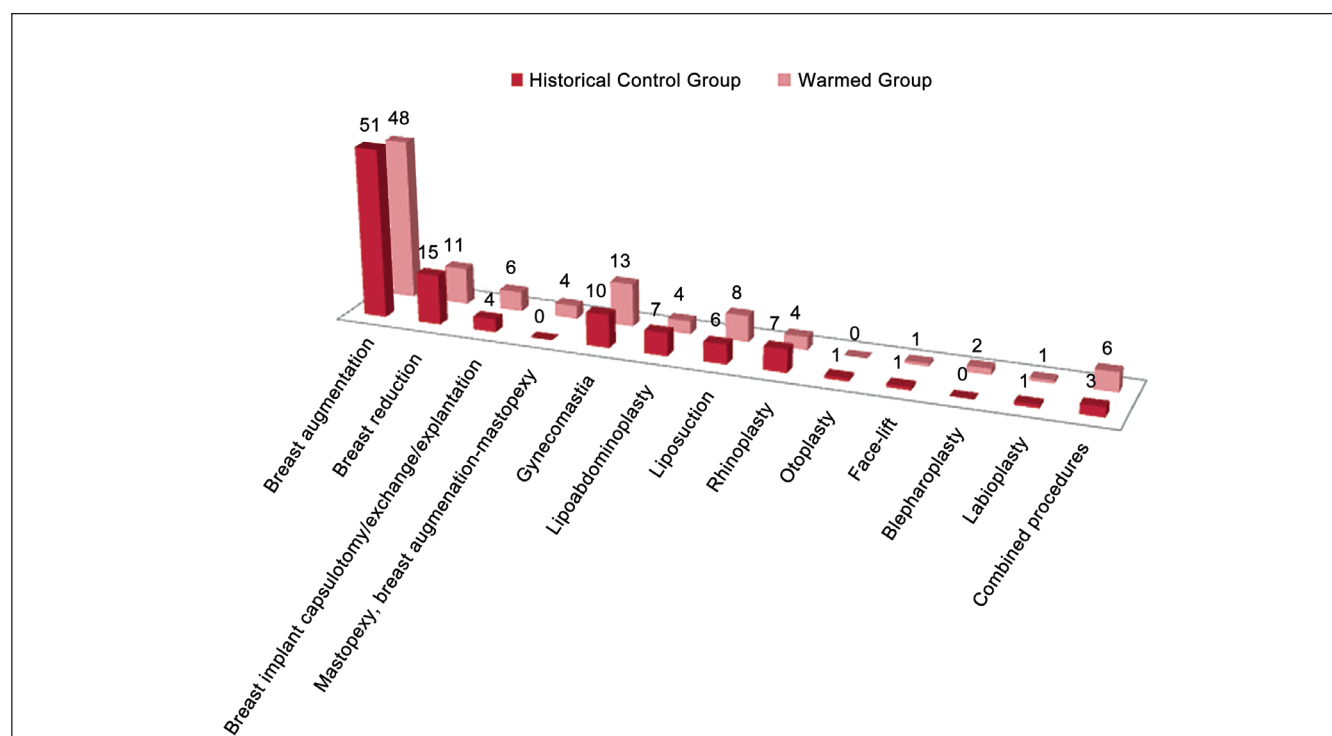


Figure 3. Types of procedures performed in each study group.

underwent colorectal surgery, Kurz et al¹⁰ demonstrated that the mean length of stay in the hospital was 2.6 days shorter for patients who had been warmed with a forced-air cover and received warmed intravenous (IV) fluids, compared with controls. The study also showed a significantly higher incidence of wound infection in the unwarmed group, 3 times that of the warmed group. In a prospective randomized trial of patients who underwent total hip arthroplasty under spinal/epidural anesthesia, Casati et al²⁶ examined the effects of active warming with forced-air blankets. They demonstrated a significant difference in the length of time in the recovery room. Postoperatively, the patients who were warmed spent an average of 32 minutes in the recovery room, compared with 74 minutes for the control group. The results of the present study corroborate the findings of these studies, as we also observed a significantly shorter recovery time for patients who received perioperative warming. Although the surgical procedures in our study differ from those in studies of general and orthopedic surgery, the overall trend appears to be consistent. In the present study, the time spent in recovery was 14 minutes less for the warmed group.

During the course of a typical day, this difference becomes even more significant. For example, assuming that 5 to 6 procedures are performed in a typical day, this difference translates to a reduction of 1 hour in recovery time achieved simply through the implementation of warming measures. The greatest difference in recovery time was noted for patients who underwent breast reduction: Compared with controls, recovery time was 20 min-

utes shorter for the warmed patients. Breast reduction surgeries accounted for 12% of the patients included in this study, which is representative of our typical patient population.

Implementing strategies to prevent perioperative hypothermia has positively affected our practice by increasing its efficiency as well as improving patient safety. Longer recovery times and hospital stays consume more health care resources and likely increase the overall costs associated with surgery. Future cost-effectiveness analyses are warranted to confirm this assumption.

It may appear that the recovery times in the present study are longer than what would typically be expected for these ambulatory surgical procedures. However, in our outpatient setting, patients are discharged directly from the recovery room after meeting our facility's discharge criteria, as opposed to a 2-phase recovery pathway where less time may be spent in the Phase 1 recovery room before transfer to the Phase 2 step-down unit. Once patients meet recovery room discharge criteria, which include adequate analgesia, control of nausea/vomiting, ability to ambulate, and a modified Aldrete score of ≥ 9 ,^{27,28} they can be discharged from the facility.

The amount of fentanyl required by patients intraoperatively was significantly (14 μg) less for the warmed group relative to the control group. This represents an 11% reduction that cannot be attributed to the duration of surgery because there was no significant difference between the 2 groups in this respect. Moreover, the anesthesiologists who work in our outpatient center rotated randomly

through both groups, thereby minimizing any potential prescribing bias. To our knowledge, this is the first published report of reduced intraoperative narcotic requirements related to perioperative warming of patients.

With respect to the duration of surgery and the amount of postoperative analgesia required for patient comfort, there was no significant difference between the warmed and control groups. Although this finding is consistent with the study by Casati et al,²⁶ who also noted that the duration of surgery did not differ significantly between warmed and control patients, we expected the postoperative analgesia requirements of the control group to continue to be higher in the recovery period. A plausible explanation may be that, in the control group, intrinsic mechanisms for thermoregulation began to take effect after extubation, narrowing the difference in core temperature between the study groups. Observations of the impact of warming on postoperative pain and analgesia requirements vary. In a study by Hamza et al,²⁹ conducted in a postanesthesia care unit, patients who were insufflated with warmed intraperitoneal gases had significantly lower opiate requirements than those infused with gases at room temperature. Their warmed patients also had a higher quality of recovery at 48 hours. However, Nguyen et al³⁰ found no significant difference in postoperative analgesic requirements and no difference in visual analog pain scores between patients who were insufflated with warmed gases and draped with a forced-air blanket and patients who received only forced-air warming. Slim et al³¹ reported that patients who received warmed insufflated gases actually had higher postoperative pain scores (shoulder tip and subcostal) than patients who did not receive gas warming, but there was no significant difference in the amount of postoperative analgesic required. Further investigation is required to evaluate the impact of maintaining perioperative normothermia on postoperative pain and analgesia requirements.

The negative consequences of perioperative hypothermia are particularly pertinent to the practice of plastic surgery. Melling et al³² studied the effect of preoperative warming on the incidence of postoperative wound infection after clean breast and varicose vein surgery. Their randomized, controlled trial showed that 30 minutes of preoperative warming using a forced-air warming blanket, applied to the entire body or the surgical site, significantly reduced the rate of wound infection. Cavallini et al³³ examined the effect of mild hypothermia on blood coagulation in a variety of elective cases of plastic surgery. The warming group received warmed fluids and forced-air skin warming, and the control group received standard sterile drapes alone. The control group had significantly longer activated partial thromboplastin and bleeding times. Although this would seem to pose an increased risk for bleeding complications, no difference in the incidence of hematoma was found between the 2 groups. In another study, Ikeda et al³⁴ examined the effect of local heating on subcutaneous oxygen tension, a factor known to improve wound healing.¹⁰ They demonstrated an increase in subcutaneous tissue oxygen tension of ~50% in the heated group.

The overall complication rate in the present study was 9%, with no significant difference in incidence between the study groups. The impact of perioperative hypothermia prevention has been described for both surgical-site infections and bleeding complications.^{8-11,32-34} However, given the low incidence of these complications in our study, a post hoc power analysis was performed, which demonstrated that the study had a low power to detect clinically significant differences in these outcomes. Assuming statistical power of 0.80, a significantly larger study population, to the magnitude of ~500 patients per study group, would be needed to appropriately study the effect of maintaining perioperative normothermia on these complications in the aesthetic surgery population. A limitation of this study is its retrospective nature. Despite this, confounding variables appeared to be evenly distributed; patients generally were healthy, and there were no significant differences in age, BMI, gender distribution, or smoking status. Another limitation of this study is the lack of perioperative serial core temperature recordings. Although considerable efforts were made at all times to ensure that patients “felt warm” (subjectively) and that they were warm to touch, empirical variations in core body temperature over time were not obtained.

In the past few years, plastic surgeons have become increasingly aware of potentially avoidable surgical complications, and greater attention has been paid to risk reduction through prophylactic measures.³⁵⁻³⁸ Areas of focus include surgical-site infections,^{39,40} capsular contracture,⁴¹ and venous thromboembolism.⁴²⁻⁴⁴ The effects of hypothermia on surgical outcomes have been well documented. As emphasized by Adams et al,¹⁵ prevention of hypothermia is an important element of a comprehensive approach to patient safety in aesthetic surgery. Although various strategies have been described, including both passive and active warming, maintenance of normothermia in the perioperative period can be straightforward and relatively risk free; it should be practiced routinely to optimize patient outcomes and minimize morbidity. The impetus for this study was observations made by staff members that patients appeared more comfortable and seemed to recover more rapidly once the strategies to maintain normothermia had been implemented at our outpatient surgical center. As part of an ongoing effort to improve patient safety-related standards of care and to facilitate a culture of continuous improvement in our practice, we successfully implemented strategies to maintain perioperative normothermia and improve surgical outcomes. As noted by Adams et al,^{15,35} this process involves recognizing opportunities for improvement, educating staff on the benefits of preventing perioperative hypothermia, applying strategies to prevent perioperative hypothermia, implementing team-based problem solving, and monitoring the effects of these changes, especially through retrospective studies such as this one. We have found this approach particularly applicable in our aesthetic surgery practice because the “small business” structure, responsiveness of staff, and focused nature of our practice facilitate effective and efficient implementation of patient safety strategies. This study confirms that

developing or enhancing the continuous-improvement elements of a practice is important for successful implementation of new tools and techniques that improve clinical outcomes.

CONCLUSIONS

Maintaining perioperative normothermia is a critical component to a comprehensive approach to patient safety. This study emphasizes the importance of preserving perioperative normothermia and preventing hypothermia. Significant decreases in intraoperative narcotic requirements and duration of stay in the recovery room were observed after the implementation of several safe, easy, and effective warming measures to maintain perioperative normothermia. These findings support the existing literature outlining the many potential benefits of perioperative warming. Prospective studies are needed to further investigate the potential benefits of this patient safety measure.

Disclosures

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