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## SCIENTIFIC ARTICLE

# Perioperative warming with a thermal gown prevents maternal temperature loss during elective cesarean section. A randomized clinical trial



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### Abstract

**Background and objectives:** Decrease in body temperature is common during general and regional anesthesia. Forced-air warming intraoperative during cesarean section under spinal anesthesia seems not able to prevent it. The hypothesis considers that active warming before the intraoperative period avoids temperature loss during cesarean.

**Methods:** Forty healthy pregnant patients undergoing elective cesarean section with spinal anesthesia received active warming from a thermal gown in the preoperative care unit 30 min before spinal anesthesia and during surgery (Go,  $n=20$ ), or no active warming at any time (Ct,  $n=20$ ). After induction of spinal anesthesia, the thermal gown was replaced over the chest and upper limbs and maintained throughout study. Room temperature, hemoglobin saturation, heart rate, arterial pressure, and tympanic body temperature were registered 30 min before (baseline) spinal anesthesia, right after it (time zero) and every 15 min thereafter.

**Results:** There was no difference for temperature at baseline, but they were significant throughout the study ( $p<0.0001$ ; repeated measure ANCOVA). Tympanic temperature baseline was  $36.6\pm 0.3^\circ\text{C}$ , measured  $36.5\pm 0.3^\circ\text{C}$  at time zero and reached  $36.1\pm 0.2^\circ\text{C}$  for gown group, while control group had baseline temperature of  $36.4\pm 0.4^\circ\text{C}$ , measured  $36.3\pm 0.3^\circ\text{C}$  at time zero and reached  $35.4\pm 0.4^\circ\text{C}$  ( $F=32.53$ ; 95% CI 0.45–0.86;  $p<0.001$ ). Hemodynamics did not differ throughout the study for both groups of patients.

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**PALAVRAS-CHAVE**

Temperatura corporal;  
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Espinhal;  
Cesariana;  
Complicações no intraoperatório/  
prevenção e controle

**Conclusion:** Active warming 30 min before spinal anesthesia and during surgery prevented a fall in body temperature in full-term pregnant women during elective cesarean delivery.

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## O aquecimento no perioperatório com avental cirúrgico térmico impede a perda de temperatura materna durante a cesariana eletiva. Estudo clínico randômico

**Resumo**

**Justificativa e objetivos:** A redução da temperatura corporal é comum durante a anestesia tanto geral quanto regional. O sistema de ar forçado aquecido no intraoperatório durante a cesariana sob anestesia peridural não parece conseguir impedi-la. A hipótese considera que o aquecimento ativo antes do período intraoperatório evita a perda de temperatura durante a cesariana.

**Métodos:** Quarenta pacientes grávidas, saudáveis, submetidas à cesariana eletiva com anestesia espinal receberam aquecimento ativo de um avental térmico na unidade de cuidados pré-operatórios 30 minutos antes da anestesia e durante a cirurgia (Go, n = 20) ou nenhum aquecimento ativo a qualquer momento (Ct, n = 20). Após a indução da anestesia espinal, o avental térmico foi colocado sobre o tórax e membros superiores e mantido durante o estudo. Temperatura ambiente, saturação de hemoglobina, frequência cardíaca, pressão arterial e temperatura corporal timpânica foram registradas 30 minutos antes (fase basal) da anestesia espinal, logo após a anestesia (tempo zero) e a cada 15 minutos subsequentemente.

**Resultados:** Não houve diferença de temperatura na fase basal, mas as diferenças foram significativas ao longo do estudo ( $p < 0,0001$ ; ANCOVA de medida repetida). A temperatura timpânica na fase basal foi de  $36,6 \pm 0,3^\circ\text{C}$ , mediu  $36,5 \pm 0,3^\circ\text{C}$  no tempo zero e atingiu  $36,1 \pm 0,2^\circ\text{C}$  no grupo avental, enquanto a temperatura basal do grupo controle foi de  $36,4 \pm 0,4^\circ\text{C}$ , mediu  $36,3 \pm 0,3^\circ\text{C}$  no tempo zero e atingiu  $35,4 \pm 0,4^\circ\text{C}$  ( $F = 32,53$ ; IC de 95% 0,45-0,86,  $p < 0,001$ ). A hemodinâmica não diferiu ao longo do estudo em ambos os grupos de pacientes.

**Conclusão:** O aquecimento ativo 30 minutos antes da anestesia espinal e durante a cirurgia evitou a queda da temperatura corporal em mulheres grávidas a termo durante a cesariana eletiva.

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**Introduction**

The reduction in body temperature is a common occurrence following the induction of anesthesia even when active warming measures are taken during the intraoperative period.<sup>1,2</sup> However, when such measures are established immediately prior to anesthesia, the onset of hypothermia is slower, and its intensity is milder due to increases in peripheral and core temperatures without any modification to metabolic rates.<sup>3-6</sup>

Body temperature decreasing with general or regional anesthesia is caused by a core-to-peripheral redistribution of heat, as demonstrated by several previous studies.<sup>7-12</sup> Perioperative hypothermia and its complications have been widely studied in patients subjected to non-obstetric surgery. There is no guidelines for the obstetric population, but the NICE provides a framework with which to improve perioperative thermal management that could be transferable to obstetrics.<sup>13</sup> The incidence of shivering can be as high as 60% in these patients.<sup>14-16</sup> Previous studies based

on the use of forced-air warming unit during intraoperative periods during cesarean delivery reached conflicting results for hypothermia and shivering in patients given epidural (reducing) or spinal anesthesia (not changing).<sup>17,18</sup>

Several methods have been developed to help maintain normothermia during surgery, including warming patients before inducing anesthesia. The forced-air system is by far the most commonly used intraoperative warming approach. However, blanket-forced air warming, circulating-water garments, or water mattresses do not easily allow the changing of position on the bed, especially when the patient is in a sitting position.

Therefore, we designed a study to establish the efficacy of a pre-warming system that keeps the garment throughout the perioperative period, without interruption, initiated 30 min before the induction of spinal anesthesia for elective cesarean delivery. The aim of this study was to test the hypothesis that active warming 30 min before spinal anesthesia should better prevent a fall in pregnant body temperature. A secondary goal evaluated the incidence of shivering, as well as thermal comfort during the procedure.

## Methods

This study is registered with clinicaltrials.gov (<http://www.clinicaltrials.gov/ct2/home>) (NCT02091466). After obtaining Institutional Review Board approval from the Ethics Research Committee of Hospital Central, Irmandade de Misericórdia da Santa Casa de São Paulo, city of São Paulo, and written informed consent from patients, 40 healthy ASA physical status I or II pregnant women presenting for scheduled cesarean delivery under spinal anesthesia were enrolled in this prospective, randomized study. The invitation occurred during their admission to the hospital when a random computer-generated code that was maintained in sequentially numbered opaque envelopes was opened.

Eligible participants were pregnant women between 18 and 40 years of age, with singleton pregnancy and gestation longer than 37 weeks, scheduled for elective cesarean section, between March 18, 2010 and July 17, 2010. Patients with fever (peripheral temperature  $> 37.8^{\circ}\text{C}$ ) and/or infectious conditions, familial history of potential malignant hyperthermia, body mass index (BMI) values below  $18.5\text{ kg m}^{-2}$  or above  $36\text{ kg m}^{-2}$ , thyroid disorders, dysautonomia, Raynaud's syndrome, and those in labor were excluded.

Participants remained seated in the preoperative care unit and were allocated into one of two groups. Control group (Ct,  $n=20$ ) received no active warming in the preoperative setting and received passive thermal insulation from regular blankets during surgery; the gown group (Go,  $n=20$ ) received active warming from a thermal gown (Bair Paws Standard Warming Gown model 810, Bair Hugger® model 850 warming unit, Arizant Healthcare Inc., Eden Prairie, MN, USA) with forced-air flow at  $40^{\circ}\text{C}$ . Patients with gown remained covered entirely in the pre-operative care unit 30 min before the induction of spinal anesthesia. Once they transferred to the operative room, the system switched to cover the chest and upper limbs and maintained until the end of surgery.

All the patients received a venous catheter inserted into the forearm and an infusion of Ringer's lactate solution fluids at  $37^{\circ}\text{C}$  was initiated. Spinal anesthesia was administered using 10 mg of hyperbaric bupivacaine, combined with  $10\text{ }\mu\text{g}$  of fentanyl and  $80\text{ }\mu\text{g}$  of morphine. Puncture was performed at level L2–L3 or L3–L4 of the lumbar vertebra, and surgery began when the sensory blockage reached a level between the T4 and T6 thoracic vertebra, as established by the loss of sensitivity to needle pricks. Intraoperative hydration was maintained using 500 mL of  $37^{\circ}\text{C}$  Ringer's lactate solution before fetal extraction and  $800\text{ }\mu\text{g}$  metaraminol was provided via slow infusion or  $400\text{ }\mu\text{g}$  was delivered as an IV bolus whenever the arterial pressure decreased by more than 25% of the baseline value. Following fetal extraction but before the end of surgery, 1000 mL of heated Ringer's lactate solution with 20 IU of oxytocin was infused – a service protocol. Obstetricians did not apply any fluid irrigation to the surgical field after uterine suture ligation.

Demographic variables included age, weight, height and BMI. Patients were monitored with hemoglobin peripheral saturation ( $\text{SpO}_2$ ), heart rate (HR), noninvasive systolic arterial pressure (SAP) and diastolic arterial pressure (DAP).

The tympanic temperature was measured by means of a digital thermometer (Techline Model TS 201, Sao Paulo, SP, Brazil). Ambient temperature was maintained approximately at  $22^{\circ}\text{C}$  according to wall thermostat (ABNT NBR 7256 – Brazilian regulatory and normalization Agency).

All data were assessed at baseline, 30 min before induction of spinal anesthesia;  $T_0$  (immediately after the spinal anesthesia); and  $T_{15}$ ,  $T_{30}$ ,  $T_{45}$ , and  $T_{60}$  (15, 30, 45, and 60 min following the onset of spinal anesthesia, respectively).

In addition, postoperative data were assessed during the admission to the post-anesthesia care unit (PACU). Shivering was evaluated according to Wrench's scale that uses: 0 – no shivering; 1 – one or more symptoms of piloerection, peripheral vasoconstriction, and peripheral cyanosis without any other cause and without visible muscular activity; 2 – visible muscular activity confined to one muscle group; 3 – visible muscular activity in more than one muscle group; and 4 – gross muscular activity involving the entire body.<sup>19</sup> Thermal discomfort according to Horn's verbal numerical scale: 0 – worst imaginable cold, 100 – insufferably hot<sup>17</sup> and adverse effects during the immediate postoperative period were also registered. Moreover, patients received 12.5–25 mg meperidine whenever their shivering scores were equal to or greater than three.

Sample size was calculated to be 20 subjects in each group to ensure that a difference of  $0.5^{\circ}\text{C}$  at 60 min could be detected at significance level of 5% with a statistical power of 90%, assuming the standard deviation of differences to be  $0.5^{\circ}\text{C}$ , considering a temperature below  $36.0^{\circ}\text{C}$  could be considered hypothermia.<sup>13</sup>

Data are presented as mean and standard deviation or median and interquartile interval (25–75) according to tested distribution (Shapiro–Wilk test). Analysis of covariance for repeated measures (ANCOVA), adjusted for baseline values, compared tympanic temperatures between the groups. Statistical significance was established at  $p < 0.05$ , and the statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) software version 20.

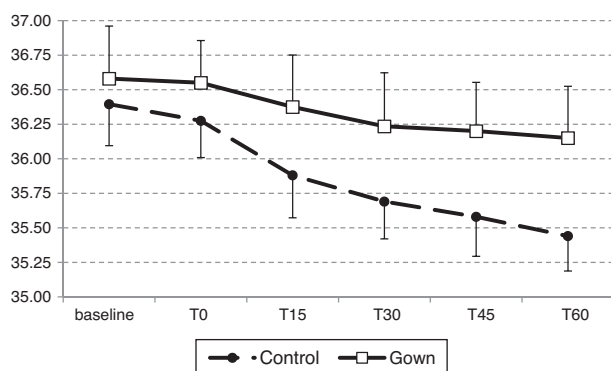
## Results

All the patients completed the study. The anthropometric data did not exhibit differences between the groups (Table 1). Demographic, monitored data and temperature data reached normal distribution according to Shapiro–Wilk test.  $\text{SpO}_2$ , HR, SAP, and DAP did not exhibit significant differences between groups and no deviations greater than 25% of the baseline measurements (data not shown). Intravenous hydration followed a protocol of 1500 mL of crystalloid solution of Ringer's lactate. The vasopressor was used at

**Table 1** Patient's characteristics.

	Control ( $n=20$ )	Gown ( $n=20$ )
Age (years)	$29.1 \pm 5.9$	$28.4 \pm 6.0$
Weight (kg)	$77.9 \pm 13.3$	$81.4 \pm 11.0$
Height (cm)	$164.8 \pm 7.7$	$164.1 \pm 8.4$
BMI ( $\text{kg m}^{-2}$ )	$28.6 \pm 3.8$	$30.17 \pm 2.6$
Total IV infusion (mL)	$1760 \pm 50$	$1735 \pm 49$

Data as mean  $\pm$  SD.



**Figure 1** Tympanic temperature – baseline to 60 min (mean  $\pm$  SD). Whiskers, SD.

anesthesiologist's discretion. Baseline tympanic temperature did not differ between groups ( $p=0.10$ ; Student's  $t$ -test). No patient experienced any delay from baseline time point to  $T_0$ . The only interruption in the active warming group was to the injection of spinal anesthesia that did not last more than 3 min, roughly, for every patient.

Tympanic temperatures in the control group compared to the gown group, adjusted for baseline values, reduced significantly throughout the study ( $F=32.53$ ; 95% CI 0.45–0.86;  $p<0.001$ ; Fig. 1). At time zero, the temperature difference already showed a lower value in the control group (36.40°C) compared to patients with gown (36.55°C) ( $0.19 \pm 0.08$ °C; 95% CI 0.30–0.37;  $p=0.02$ ). This trend continued until the end of observation at 60 min, as the patients in control group reached (35.44°C) while patients with gown warming had a mean temperature of (36.15°C) ( $0.66 \pm 0.10$ °C; 95% CI 0.45–0.87;  $p<0.001$ ).

The incidence of shivering as measured using Wrench's scale was 10% in the Go group and 40% in the Ct group during the time spent in the PACU ( $p=0.02$ ;  $\chi^2$  test) (Table 2). Median thermal discomfort value according to Horn's verbal numerical scale was 50 for both groups ( $p=0.27$ ; Mann–Whitney).

## Discussion

This study demonstrated that the active warming by means of a thermal gown for 30 min before spinal anesthesia and the use this device as a blanket during elective cesarean section prevented a significant lowering of temperature during perioperative period in full-term pregnant women.

**Table 2** Incidence of shivering in the PACU according to Wrench's scale.

Score of shivering	0	1	2	3	4
Control	12	8	0	0	0
Gown	18	2	0	0	0

0, no shivering; 1, one or more symptoms of piloerection, peripheral vasoconstriction, and peripheral cyanosis without any other cause and without visible muscular activity; 2, visible muscular activity confined to one muscle group; 3, visible muscular activity in more than one muscle group; and 4, gross muscular activity involving the entire body. Values are 'n'.

Based on previously published studies regarding the best method for delivering active perioperative warming,<sup>20–23</sup> preoperative use of a thermal gown followed by the intraoperative covering of patients using a thermal blanket were selected for the current study. It should be noted that pregnant women scheduled for elective cesarean section generally wait in a sitting position in the pre-operative care unit, which makes the use of traditional thermal blankets very unlikely. The use of a thermal gown would make this use possible.

During the preoperative period, peripheral temperature reduced moderate but significantly in the control group. The use of a preoperative warming device for 30 min seemed sufficient to avoid further fall of temperature after the onset of anesthesia. These findings are in agreement with previous studies.<sup>24,25</sup> It is also interesting to notice that studies that applied prewarming protocols observed a reduced incidence of lower temperature during surgery.<sup>3</sup> However, it is unclear how long pre-anesthetic warming must be set up to prevent a fall in intraoperative temperature and deal at the same time with surgical center's routine.<sup>26</sup> Although tympanic temperature measurements reduced by a small margin, the control group showed a consistent and progressive reduction in tympanic temperature reaching 35.4°C, while the perioperative warming avoided the temperature to reach levels below 36.0°C.

These results corroborate those of Horn et al.<sup>17</sup> in which pre- and intraoperative warming was performed in pregnant women subjected to elective cesarean section by covering the upper limbs with a thermal blanket at 43°C for 15 min prior to the onset of epidural anesthesia and found that only the warmed group maintained a normal temperature. In addition, it is worth noting that patients from this study received spinal anesthesia with morphine, an association that may intensify the hypothermic effect of bupivacaine spinal anesthesia.<sup>27,28</sup>

Previous results suggest that warming methods do not affect physiological parameters in pregnant women. Butwick et al. applied intraoperative blankets and found a 27% incidence of shivering among warmed patients as compared to an incidence of 47% in the control group.<sup>18</sup> Moreover, a study by Horn et al. applied blankets to patients 15 min prior to the induction of anesthesia and found a 13% prevalence of shivering in the treated group as compared to a prevalence of 60% in the control group.<sup>17</sup> However, the study of Woolnough et al. showed that the infusion of warmed solutions did not contribute to any significant differences in the prevalence of shivering between groups.<sup>29</sup> In the present study, there was a clear difference in the incidence of shivering, which was 10% in the group that received the thermal gown and 40% in the control group.

Evaluation of thermal discomfort can be therefore an important issue during regional anesthesia. Indeed, considering results from a recent survey where only a minority of obstetrics units in UK monitored patient temperature while in the operating room (27%) or used active warming (18%), the results of the present investigation may point to the humane necessity of promoting active warm to the obstetrics population during cesarean section.<sup>30</sup>

Limitations of this study included the fact that the control group did not receive any alternative active warming, although patients did receive passive insulation with the



use of blanket that is a reality in many services, even though unfortunately as a sole measure. It was shown that high-quality evidence supporting the accuracy of tympanic thermometry is lacking,<sup>31</sup> but this method could provide an acceptable and comfortable way for this healthy population. Another limitation is that the protocol was an open randomized controlled trial without blinding. Finally, adrenoceptor-mediated vasoconstrictor, like phenylephrine, was reported to attenuate hypothermia during spinal anaesthesia and the total amount of metaraminol used within both groups were not reported.<sup>32</sup>

## Conclusion

The results of the present study demonstrated the beneficial effects of using a thermal gown at 40°C from 30 min before and throughout a 60 min cesarean section to maintain the patient's body temperature.

## Conflicts of interest

The authors declare no conflicts of interest.

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