

## OBSTETRICS

# The impact of ambient operating room temperature on neonatal and maternal hypothermia and associated morbidities: a randomized controlled trial

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**BACKGROUND:** Neonatal hypothermia is common at the time of cesarean delivery and has been associated with a constellation of morbidities in addition to increased neonatal mortality. Additionally, maternal hypothermia is often uncomfortable for the surgical patient and has been associated with intraoperative and postoperative complications. Various methods to decrease the rates of neonatal and maternal hypothermia have been examined and found to have varying levels of success.

**OBJECTIVE:** We sought to determine whether an increase in operating room temperature at cesarean delivery results in a decrease in the rate of neonatal hypothermia and associated morbidities.

**STUDY DESIGN:** In this single-center randomized trial, operating room temperatures were adjusted weekly according to a cluster randomization schedule to either 20°C (67°F), which was the standard at our institution, or 23°C (73°F), which was the maximum temperature allowable per hospital policy. Neonatal hypothermia was defined as core body temperature <36.5°C (97.7°F) per World Health Organization criteria. The primary study outcome was neonatal hypothermia on arrival to the admitting nursery. Measures of neonatal morbidity potentially associated with hypothermia were examined.

**RESULTS:** From February through July 2015, 791 women who underwent cesarean deliveries were enrolled, resulting in 410 infants in the 20°C standard management group and 399 in the 23°C study group. The rate of neonatal hypothermia on arrival to the admitting nursery was lower

in the study group as compared to the standard management group: 35% vs 50%,  $P < .001$ . Moderate to severe hypothermia was infrequent when the operating room temperature was 23°C (5%); in contrast such hypothermia occurred in 19% of the standard management group,  $P < .001$ . Additionally, neonatal temperature in the operating room immediately following delivery and stabilization was also higher in the study group,  $37.1 \pm 0.6^\circ\text{C}$  vs  $36.9 \pm 0.6^\circ\text{C}$ ,  $P < .001$ . We found no difference in rates of intubation, ventilator use, hypoglycemia, metabolic acidemia, or intraventricular hemorrhage. Fever (temperature  $>38.0^\circ\text{C}$  or  $100.4^\circ\text{F}$ ) on arrival to the admitting unit was uncommon and did not differ between the study groups. Maternal temperature on arrival to the operating room was not different between the 2 groups, however by delivery it was significantly lower in the standard management group,  $36.2 \pm 0.6^\circ\text{C}$  vs  $36.4 \pm 0.6^\circ\text{C}$ ,  $P < .001$ . This effect persisted, as maternal temperature on arrival to the postoperative care area was lower in the standard management group,  $36.1 \pm 0.6^\circ\text{C}$  vs  $36.2 \pm 0.6^\circ\text{C}$ ,  $P < .001$ , and the rate of hypothermia was higher, 77% vs 69%,  $P = .008$ .

**CONCLUSION:** A modest increase in operating room temperature at the time of cesarean reduces the rate of neonatal and maternal hypothermia. We did not detect a decrease in neonatal morbidity, but the power to detect a small change in these outcomes was limited.

**Key words:** ambient temperature, cesarean, warming

## Introduction

Mild hypothermia is defined by the World Health Organization (WHO) as a temperature of 36.0–36.4°C (96.8–97.5°F) with moderate to severe hypothermia diagnosed if temperature falls <36.0°C (96.8°F).<sup>1</sup> Neonatal hypothermia at the time of delivery is thought to be the result of multiple factors, including the infant's poor ability to regulate temperature due to evaporative heat loss within a relatively cool delivery

room. Neonatal hypothermia is common at the time of cesarean delivery and in preterm infants has been associated with a constellation of morbidities including hypoglycemia, metabolic acidemia, intraventricular hemorrhage, respiratory distress, and need for intubation as well as increased mortality.<sup>2–11</sup> Warming interventions are known to improve the rate of hypothermia in preterm infants, however they are cumbersome and costly and therefore generally have been reserved for infants <32 weeks' gestation.<sup>11,12</sup> Moreover, hypothermia is not completely eliminated with these measures. Importantly the effect of operating room temperature has not been studied in either preterm or term births. In fact, the principle method of warming implemented with term infants is skin-to-skin maternal bonding,

which is effective with vaginal deliveries but has been associated with significant neonatal hypothermia at cesarean.<sup>13</sup>

WHO recommends a delivery room temperature of 25–28°C (77–82°F), which has been proven to decrease hypothermia in preterm infants.<sup>1</sup> However, the ambient temperature of cesarean operating rooms is often much lower for surgeon comfort. Our objective was to determine if a modest increase in ambient operating room temperature decreased the rate of neonatal and maternal hypothermia as well as associated morbidities.

## Materials and Methods

### Trial design

This was an open randomized controlled trial of the impact of ambient operating room temperature on the rate of

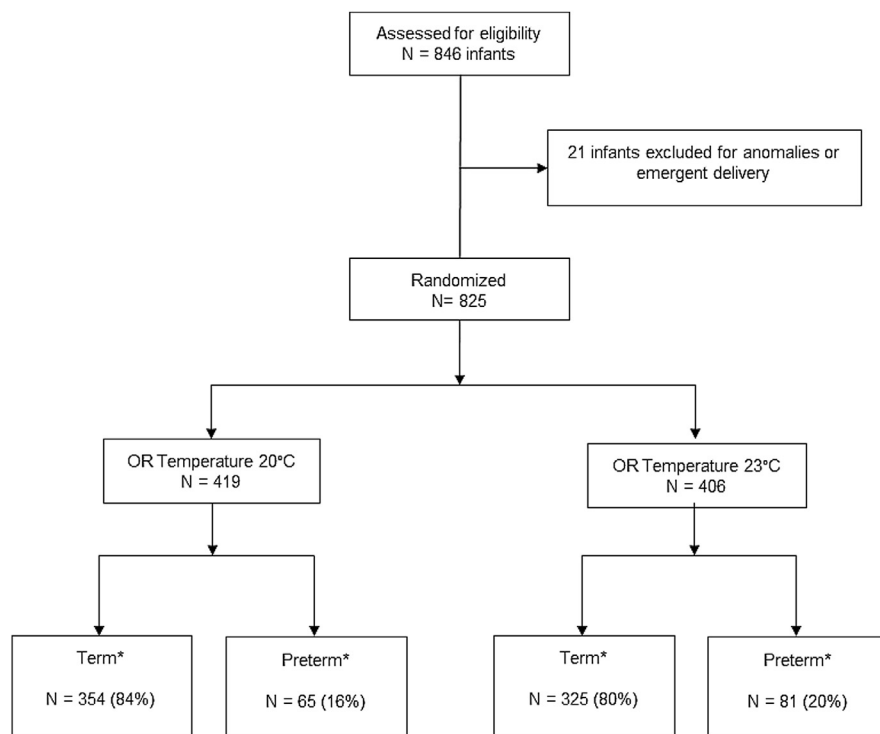
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FIGURE 1



\*Term is defined as 37 weeks gestation or greater, with preterm defined as 36 weeks gestation or less

Infants randomized to standard operating room (OR) temperature of 20°C or study temperature of 23°C.

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neonatal hypothermia. The study was approved by the University of Texas Southwestern Medical Center Institutional Review Board and was locally funded by the department of obstetrics and gynecology. Women undergoing cesarean delivery by the Parkland Obstetrics Service on the high-risk labor and delivery unit were included.

Cluster randomization was performed with the treatment group assigned on a rotating weekly basis according to a computer-generated random schedule. The preexisting standard for operating room temperature was 20°C (67°F); women were assigned via the schedule to either 20°C or 23°C (73°F), which was the maximum temperature allowable per hospital policy due to an increase in humidity with an increase in temperature. Operating room temperature as displayed on the room thermostat was recorded for each patient, and the accuracy of thermostat readings was

audited daily using an independently calibrated infrared thermometer. In addition, a continuous temperature recording device was placed in each operating room for the duration of the study period to be reviewed regularly for any temporary fluctuations in temperature. Providers were not blinded to room temperature, however the randomization schedule was only known to the primary investigator, statistician, and building engineering staff. Both study groups otherwise received identical care according to prevailing institutional practices. This included women undergoing cesarean delivery being covered with warmed gowns and blankets and receiving warmed intravenous fluids. Upper-body forced-air warming devices were placed if general anesthesia was used. For infants >32 weeks' gestation, resuscitation included use of radiant warming, thorough drying, and placement of prewarmed dry blankets and a

knitted cap. In contrast, for infants <32 weeks' gestation radiant warmers were used with drying, followed by placement of a plastic poncho and cap. Warmed gel mattresses were reserved for those infants <28 weeks' gestation. The infant, still wrapped in warmed blankets, was placed on the mother's chest as allowed by neonatal and maternal condition in those infants triaged to the newborn nursery. Transport to the nursery was in an open bassinets. Infants transported to the neonatal intensive care unit were placed in an incubator prewarmed to 38.0°C (100.4°F). A rectal temperature measurement was obtained for every infant in the operating room at approximately 5 minutes of life following initial evaluation and stabilization. Subsequently, axillary temperature was measured on arrival to the admitting nursery, which was the primary outcome.

## Outcomes

The primary outcome was neonatal hypothermia on arrival to the admitting nursery, which was defined as <36.5°C (97.5°F) by WHO criteria.<sup>1</sup> Assuming a neonatal hypothermia rate of 45% based on internal hospital data, 788 infants or 394 per treatment group would be required to have 90% power to detect a 25% reduction in hypothermia.<sup>14</sup> Secondary neonatal outcomes included moderate to severe hypothermia (defined as a temperature <36.0°C [96.8°F]), which, assuming a rate of 15% based on internal hospital data, would give us 90% power to detect a 50% reduction. Hyperthermia was defined as temperature ≥38.0°C (100.4°F). Other secondary outcomes included intubation in the operating room, ventilator use in the first 24 hours, diagnosis of respiratory distress, surfactant administration, hypoglycemia requiring treatment, umbilical artery pH <7.0, grade-3 or -4 intraventricular hemorrhage, and culture-proven sepsis.

Maternal outcomes were also examined including hypothermia in the operating room and upon arrival to the postoperative care area. Also studied were hyperthermia, endometritis, and wound infection. Chorioamnionitis was

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