Received: 15 October 2022 | Revised: 2 November 2022 | Accepted: 4 November 2022

DOI: 10.1111/apa.16590

ACTA PÆDIATRICA NURTURING THE CHILD WILEY

ORIGINAL ARTICLE

Immediate skin-to-skin contact after birth ensures stable thermoregulation in very preterm infants in high-resource settings

Karoline Lode-Kolz[1,2,3] | Charlotte Hermansson[4] | Agnes Linnér[4,5] | Stina Klemming[4,6] | Hanne Brit Hetland[7] | Nils Bergman[8] | Siri Lilliesköld[8,4] | Hanne Markhus Pike[1] | Björn Westrup[8] | Wibke Jonas[8] | Siren Rettedal[1,2]

[1]Department of Paediatrics, Stavanger University Hospital, Stavanger, Norway

[2]Faculty of Health Sciences, University of Stavanger, Stavanger, Norway

[3]Department of Clinical Neurophysiology, Stavanger University Hospital, Stavanger, Norway

[4]Department of Neonatology, Astrid Lindgren Children's Hospital, Karolinska University Hospital, Stockholm, Sweden

[5]Department of Clinical Science, Intervention and Technology at Karolinska Institutet, Stockholm, Sweden

[6]Lund-Malmö NIDCAP Training and Research Center, Department of Neonatology, Skåne University Hospital, Lund, Sweden

[7]Departement of Biostatistics, Stavanger University Hospital, Stavanger, Norway

[8]Department of Women's and Children's Health, Karolinska Institutet, Stockholm, Sweden

Correspondence
Karoline Lode-Kolz, Department of Clinical Neurophysiology, Helse Stavanger HF, Postboks 8100, 4068 Stavanger, Norway.
Email: karoline.cecilie.lode@sus.no

Funding information
2018 - Doctoral School in Health Care Science (FiV), Karolinska; 2018 - Strategic Area health Care Science (SFO-V) at KI; 2021 - Lilla Barnets foundation; Helse Vest, Norway, Grant/Award Number: F-12504-D11698; Lærdal foundation; Region Stockholm (ALF), Grant/Award Number: 2019-0374; Swedish Research Council (VR), Grant/Award Number: (2017-01497) and (2021-03169)

Abstract

Aim: To investigate the impact of immediate skin-to-skin contact with a parent after birth on thermal regulation in very preterm infants.

Methods: This clinical trial was conducted in three neonatal intensive care units in Scandinavia from 2018 to 2021. Infants born between 28 + 0 and 32 + 6 weeks and days of gestation were randomised to immediate skin-to-skin contact or conventional care in an incubator during the first 6 postnatal hours. We report on a secondary outcome: serial measurements of axillary temperature.

Results: Ninety-one infants were randomised to skin-to-skin contact or conventional care. Mean (range) gestational ages were 31 + 2 (28 + 6, 32 + 5) and 31 + 0 (28 + 4, 32 + 6) weeks and days, mean birth weights were 1572 (702, 2352) and 1495 (555, 2440) grams, respectively. Mean (95%CI, *p*-value) temperatures were within the normal range in both groups, 0.2°C (−0.29, −0.14, $p < 0.001$) lower in the skin-to-skin contact group. The skin-to-skin contact group had a lower relative risk (95%CI, *p*-value) of developing events of hyperthermia, RR = 0.70 (0.50, 0.99, $p = 0.04$).

Abbreviations: BW, birth weight; CI, confidence interval; CPAP, continuous positive airway pressure; GA, gestational age; IPISTOSS, Immediate Parent-Infant Skin-To-Skin Study; IQR, interquartile range; iSSC, immediate skin-to-skin contact; KMC, Kangaroo mother care; LBW, low birthweight; NICU, newborn intensive care unit; RR, Relative risk; SSC, skin-to-skin contact; VLBW, very low birthweight; VPT, very preterm.

Wibke Jonas, Siren Rettedal, Shared last authorship.

Conclusions: Very preterm infants, irrespective of clinical stability, do not develop hypothermia during immediate skin-to-skin contact after birth. Immediate skin-to-skin contact did protect against events of hyperthermia. Concerns about thermal regulation should not limit implementation of immediate skin-to-skin contact in high-resource settings.

KEYWORDS
hyperthermia, hypothermia, immediate skin-to-skin contact, thermal stability, very preterm infants

1 | INTRODUCTION

Thermoregulation is a well-known problem for newborn infants and more so for infants born preterm and especially infants with very low birthweight (VLBW).[1]

Heat is lost by convection, radiation, conduction and evaporation. Preterm born infants are at risk for hypothermia due to their high ratio of skin surface area to body mass, lack of subcutaneous fat, high respiratory rate and metabolic immaturity. Thermoregulation is also dependent on extrinsic factors like humidity and temperature of the immediate surroundings and neonatal procedures with frequent exposure of the infant's body to ambient temperature. In conventional neonatal care, heat loss is mitigated through covering of the infant with different fabrics or plastic wraps, heated humidified air in tubings for respiratory support and in incubators, and radiant warmers. Thermostability is defined as the maintenance of body temperature within 36.5–37.4°C. Above this is hyperthermia. Mild, moderate and severe hypothermia is defined as 36.0–36.4°C, 32.0–35.9°C and less than 32°C, respectively.[2] Early life hypothermia is associated with increased morbidity and mortality, as cold stress hampers the physiological adaption to extrauterine circulation.[1,3] For preterm and VLBW infants in high-resource settings, temperature on admission to the neonatal intensive care unit (NICU) is correlated with 28% increase in mortality per 1°C below normothermia, and also 11% increase in late-onset sepsis.[4]

A Cochrane review showed that Kangaroo mother care (KMC) reduced the incidence of hypothermia by 72% in stabilised low-birthweight (LBW) infants in low-resource settings.[5] Furthermore, a recent randomised controlled trial showed that immediate KMC in infants with birth weights (BWs) of 1000–1799 grams in low-resource settings reduced hypothermia by 35%, when compared to conventional care.[6]

Most published studies focus on early hypothermia as a risk factor for increased morbidity and mortality in preterm and VLBW infants. However, hyperthermia on admission is associated with neurological injury, retinopathy, necrotising enterocolitis, bronchopulmonary dysplasia, nosocomial infection and a longer duration of mechanical ventilation, as reported the Canadian Neonatal Network national study, including infants born before 33 weeks of gestation.[7] A retrospective study from a low-resource setting showed that hyperthermia-related events in the first hours and days of life were associated with up to 35% of deaths in extremely low-birthweight infants.[8]

Keynotes

- Immediate skin-to-skin contact after birth between the very preterm infant and a parent is associated with improved thermoregulation.
- Immediate skin-to-skin contact protects the very preterm infant from hyperthermia and does not expose the infant to clinically significant hypothermia.
- Concerns about hypothermia should not limit implementation of immediate skin-to-skin contact in high-resource settings.

The practice of skin-to-skin contact (SSC) has been adapted from the KMC strategy to be used in high-resource settings, to be offered to infants receiving intensive care and provided by caregivers for intermittent or continuous sessions.[9] Studies have shown that early SSC is associated with improved thermal control in both preterm and term infants.[10,11] Early SSC is recommended for all stable newborn infants. However, immediate SSC has not yet been sufficiently studied to be recommended as routine practice for very preterm infants in high-income settings.[12] A Swedish register study on very preterm infants, born between gestational age (GA; weeks+days) 28+ 0 to 31+ 6, analysed SSC data from the Swedish Neonatal Quality Register from 2020 to 2021. The results showed that median (interquartile range) skin-to-skin contact initiation time was at 14 postnatal hours (4–36) and 34% had skin-to-skin contact on the first day. These observations imply that few very preterm infants receive skin-to-skin contact on the first day of life, and even less in the first hours. The existing evidence for SSC is inconsistently translated into clinical practice.[13]

A Norwegian prospective study of preterm infants born between GA 32+ 0–34+ 6 and who received immediate SSC during the first 2 h after vaginal birth, showed no difference in the first measured body temperature at admission compared to when in conventional care.[14] In contrast, in a Swedish study, immediate SSC in very preterm infants was related to lower temperature at 1 h after birth, 36.3°C versus 36.6°C.[15]

In a recently conducted randomised clinical trial in three Scandinavian NICUs on immediate SSC enrolling infants with GA 28 + 0–32 + 6, we showed that immediate SSC improved cardiorespiratory stabilisation after birth.[16,17] We now report on a secondary outcome of this study: infant thermal regulation in terms of mean temperature during the first 6 postnatal hours, and possible correlation to BW and GA, as well as proportion of infants with events of hypo- or hyperthermia.

2 | METHOD

2.1 | Study design

The Immediate Parent-Infant Skin-To-Skin Study (IPISTOSS) was a superiority randomised clinical trial with two parallel, non-blinded arms. Enrolment was conducted between April 2018 and June 2021.

2.2 | Study setting and participants

The study was conducted at the NICUs in Huddinge and Danderyd at Karolinska University Hospital in Stockholm, Sweden and at Stavanger University Hospital in Stavanger, Norway. Danderyd is a level two NICU, with 11 000 births per year. Huddinge and Stavanger are level three NICUs, with 5000 and 4400 births per year, respectively.

Screening of women for possible preterm birth between GA 28 + 0–32 + 6 was performed and informed consent was obtained from both parents. Singletons and twins with GA 28 + 0–32 + 6 with a caregiver willing to partake in SSC were included regardless of mode of birth. Higher order births, infants with known congenital infection, major malformations or other conditions deemed contraindicating participation were excluded.

Randomisation was performed electronically with variable block sizes at a 1:1 ratio, with three strata for sites, and two for GA 28 + 0–30 + 6 and 31 + 0–32 + 6.

2.3 | Procedures

All infants were cared for according to national and European guidelines.[17,18] For infants allocated to the intervention group, SSC was started as soon as possible at the discretion of the neonatologist in charge. The infant was dried before being placed in SSC and covered with pre-heated cloths. Following Caesarean section, SSC was initiated with the partner until the mother could be transferred to the NICU.

Placement of monitoring equipment, positive pressure ventilation, nasal continuous positive airway pressure (CPAP), insertion of peripheral lines and nasogastric tube were, when possible, performed during SSC. During endotracheal intubation, placement of umbilical catheters and radiology, SSC was paused, whereby the infant was placed in an incubator or under a radiant warmer for the duration of the procedure. During transport to the NICU, SSC with a parent was maintained.

Infants allocated to the control group were stabilised on a resuscitaire or in an Omnibed incubator (GE Healthcare, Laurel, Maryland, USA). The infant was transported to the NICU in an incubator and intermittent SSC was initiated after the 6 first hours. Parents were allowed to be bedside, actively included in the care of their infant and able to hand hold the infant. The full details of the IPISTOSS research protocol is described in a former publication from our group.[17]

2.4 | Definitions

The intervention of immediate SSC was defined as SSC with a caregiver started as soon as possible after birth and continued throughout the first 6 postnatal hours. Normothermia was defined as 36.5–37.4°C. An infant with one or more measurements with temperatures outside normothermic range was defined as an infant with a hypo- or hyperthermia event.

2.5 | Data collection

Temperature was measured by an axillary thermometer (Sweden: *Terumo Thermometer* Digital Axillary, Dustin, Japan; Norway: Isotherm Basic, Bosch and Son, Jungingen, Germany) and skin probe (Norway: Giraffe Incubator Carestation, GE Healthcare, USA) and documented at 15 and 60 min after birth, and thereafter every 60 min up to 6 h after birth.

2.6 | Data analysis

Data analyses were carried out according to intention to treat. Additional as-treated analyses were performed. Analyses were performed on the whole population of infants included in the study, and additional independent analyses were done on four subgroups of these same infants: GA 28 + 0–30 + 6; GA 31 + 0–32 + 6; BW below 1500 grams and BW above 1500 grams.

Statistical analyses were performed using IBM SPSS Statistics 26, Stata Statistical Software: Release 17 and MedCalc. Baseline characteristics were compared using Student's *t*-test for continuous variables, and Chi-square test for categorical variables. Linear mixed regression analysis was performed with repeated measures of temperature as the outcome variable and treatment group and time as a categorical variable as predictors. The model had a random intercept and autoregressive residual covariance structure. Marginal means of body temperature for the study groups were estimated using Stata command margins. All tests were two-tailed, *p*-values <0.05 were considered statistically significant. Levene's test was used to compare temperature variance at specific time-points between the two groups.

3 | ETHICS

The study was conducted according to Consolidated Standards of Reporting Trials guidelines. Approval was obtained by The Swedish Ethical Review.

Authority: 2017/1135–31/3, 2018/213–32/1 and 2019–03361, and the Norwegian Regional Ethical Committee: 2015/889. When the study protocol was elaborated in 2014–2015 and the trial started in 2018 the gold standard of care during the first hours of life for preterm infants born between GA 28 + 0–32 + 6 was conventional care in incubator or cot.[13,15]

4 | RESULTS

Ninety-one infants were randomised, 46 to immediate SSC and 45 to conventional care. Missing temperature data was 4.9% for the immediate SSC group and 4.0% for the control group which was considered acceptable for valid statistical inferences and no imputations were done. We used a mixed model with random intercept and AR1 as autocorrelation function handling missing at random missingness.

Baseline characteristics were equally distributed, except infant sex, with a significantly larger proportion of boys in the SSC group, 72%, as compared to the conventional care group with 40%, see Table 1.

Median SSC durations with interquartile range (IQR) in the SSC and control groups during the first 6 h were 5.0 (4.5, 5.5) and 0.0 (0.0, 0.0) hours. In the SSC group, median maternal SSC duration (IQR) was 0.6 (0.0, 2.75) hours and median paternal SSC duration (IQR) was 3.4 (2.3, 4.8) hours.[16]

Median time from birth to SSC initiation (IQR) was 0.4 (0.3, 1.0) hours. In the younger infants born at GA 28 + 0–30 + 6 and for infants with BW below 1500 grams, the median SSC initiation time (IQR) was 1.0 (0.5, 1.3) hours and 0.5 (0.4, 1.3) hours, respectively.

Mean (range) of measured room temperatures in birth rooms and NICU was 23.0 (21.0, 26.4)°C.

4.1 | Mean axillary temperature

4.1.1 | Mean temperatures by randomisation group

Mean temperatures calculated from all individual measurements over the 6 h were within the normal range for both SSC and control infants. This was also true when analysed in subgroups for GA and BW. The mean temperature with 95% confidence interval (95%CI, *p*-value) of infants allocated to SSC was 0.20°C (−0.29, −0.14, $p < 0.001$) lower compared to controls, as shown in Table 2. This difference remained when corrected for sex.

4.1.2 | Mean temperature at 15 and 60 minutes by randomisation group

Mean temperature at 15 min did not significantly differ in the two allocations. However, in the subgroup of GA 28 + 0 to 30 + 6, mean temperature (95%CI) at 15 min in the SSC group was 0.40°C (−0.74, −0.08, $p = 0.015$) lower compared to controls. This difference also persisted when correcting for sex. This was also found for the subgroup BW below 1500 grams at 15 min post birth 0.34°C (−0.64, −0.04, $p = 0.027$), although not significant when corrected for sex, Table 2.

Mean temperature at 60 min did not differ in the SSC group versus control group, neither when analysing the whole study group nor the subgroups for BW and GA, Table 2; Figures 1, 2A,B.

4.1.3 | Mean temperature at 120, 180, 240, 300 and 360 minutes by randomisation group

The mean temperature (95%CI) of infants allocated to SSC was lower at 120, 180, 300 min by 0.29°C (−0.49, −0.08, $p < 0.007$), 0.35°C (−0.59, −0.10, $p = 0.006$) and 0.30°C (−0.47, −0.14, $p = 0.0003$), respectively, compared with controls. This difference also persisted when correcting for sex, Table 2; Figure 1.

TABLE 1 Baseline characteristics

Baseline characteristics	Skin-to-skin care $n = 46$	Conventional care $n = 45$	*p*
Gestational Age, weeks+days: mean (range)	31 + 2 (28 + 6–32 + 5)	31 + 1 (28 + 4–32 + 6)	ns
Birth Weight, grams: mean (range)	1572 (702–2352)	1495 (555–2440)	ns
Sex: n female (%)	13 (28)	27 (60)	**0.002**
APGAR score, 1 min: median (mean)	8 (7.4)	8 (7.4)	ns
APGAR score, 5 min: median (mean)	9 (8.2)	9 (8.6)	ns
APGAR score, 10 min: median (mean)	10 (9.3)	9 (9.0)	ns
Singleton, number: (%)	30 (65)	26 (58)	ns
Length, cm: mean (range)	40.3 (33–46.5)	40.1(30–46)	ns
Head circumference, cm: mean (range)	28.6 (24.5–31.5)	28.4 (21.5–32)	ns
Body surface, m2: mean (range)	0.13 (0.08–0.17)	0.13 (0.07–0.18)	ns

Bold values are statistically significant *p*-values ($p < 0.05$).

TABLE 2 Mean axillary temperature by randomisation group/intention-to-treat

All children	Skin-to-skin °C (SD) N or *N*	Range °C	Control °C (SD) N or *N*	Range °C	Diff °C [95% CI]	*p*	Diff in marginal means adjusted for gender °C [95% CI]	*p*
Over the 6 h period	36.94 (0.47) *306*	35.4–39.1	37.16 (0.50) *305*	35.8–38.9	−0.22 [−0.29, −0.14]	**<0.001**	−0.20 [−0.33,-0.07]	**0.003**
15 min	36.82 (0.52) 43	35.6–37.9	36.91 (0.55) 44	35.9–38.8	−0.09 [−0.32, 0.14]	0.4210	−0.07 [−0.28, 0.14]	0.507
60 min	36.97 (0.55) 46	35.4–38.3	37.11 (0.51) 44	36.0–38.4	−0.14 [−0.36, 0.08]	0.2325	−0.11 [−0.31, 0.09]	0.294
120 min	37.03 (0.47) 43	36.0–37.9	37.32 (0.48) 42	35.8–38.9	−0.29 [−0.49, −0.08]	**0.0065**	−0.287 [−0.50, −0.08]	**0.007**
180 min	36.98 (0.54) 45	35.9–39.1	37.32 (0.62) 44	36.4–38.8	−0.35 [−0.59,-0.10]	**0.0058**	−0.32 [−0.53,-0.12]	**0.002**
240 min	36.92 (0.40) 44	36.3–38.0	37.09 (0.46) 43	36.3–38.7	−0.17 [−0.35, 0.01]	0.0630	−0.16 [−0.34, 0.05]	0.131
300 min	36.90 (0.32)	36.4–37.8	37.20 (0.43)	36.6–38.8	−0.30 [−0.47, −0.14]	**0.0003**	−0.27 [−0.48, −0.07]	**0.010**
360 min	37.06 (0.45) 42	36.3–38.3	37.15 (0.36) 43	36.6–38.1	−0.19 [−0.36, 0.01]	0.0342	−0.17 [−0.37, 0.04]	0.110
Subgroup GA 28 + 0 to 30 + 6	Skin-to-skin N	Range	Control N or *N*	Range	Diff 95% CI	*p*	Diff in marginal means adjusted for gender [95% CI]	*p*
Over the 6 h period	36.83 (0.48) *121*	35.6–39.1	37.11 (0.51) *125*	35.8–38.8	−0.28 [−0.41,-0.16]	**0.0000**	−0.25 [−0.46,-0.03]	**0.026**
15 min	36.53 (0.44) 17	35.6–37.3	36.94 (0.50) 18	35.9–37.7	−0.41 [−0.74, −0.08]	**0.0153**	−0.37 [−0.71,-0.03]	**0.031**
60 min	36.86 (0.39) 18	36.3–37.6	36.98 (0.49) 18	36.0–37.7	−0.12 [−0.42, 0.18]	0.4121	−0.09 [−0.42, 0.24]	0.603
300 min	36.79 (0.23) 17	36.5–37.4	37.22 (0.43) 18	36.6–38.0	−0.42 [−0.66, −0.18]	**0.0011**	−0.388 [−0.72, −0.05]	**0.023**
360 min	36.79 (0.46) 16	36.3–38.3	37.21 (0.41) 18	36.6–37.8	−0.42 [−0.73, −0.12]	**0.0073**	−0.390 [−0.73, −0.05]	**0.024**
Subgroup <1500 grams	Skin-to-skin N	Range	Control N or *N*	Range	Diff 95% CI	*p*	Diff in marginal means adjusted for gender [95% CI]	*p*
Over the 6 h period	36.88 (0.51) *120*	35.6–39.1	37.11 (0.47) *152*	36.0–38.8	−0.22 [−0.34,-0.11]	**0.0002**	−0.17 [−0.35,0.00]	0.055
15 min	36.52 (0.43) 17	35.6–37.3	36.86 (0.47) 22	36.0–37.7	−0.34 [−0.64,-0.04]	**0.0265**	−0.28 [−0.58, 0.02]	0.069
60 min	36.81 (0.38) 18	36.0–37.3	36.96 (0.46) 22	36.0–37.7	−0.15 [−0.43, 0.12]	0.2688	−0.10 [−0.40, 0.20]	0.504

Abbreviations: CI, Confidence Interval; Diff, Difference; N, Number of infants; *N*, Number of measures; SD, Standard Deviation.

Bold values are statistically significant *p*-values ($p < 0.05$).

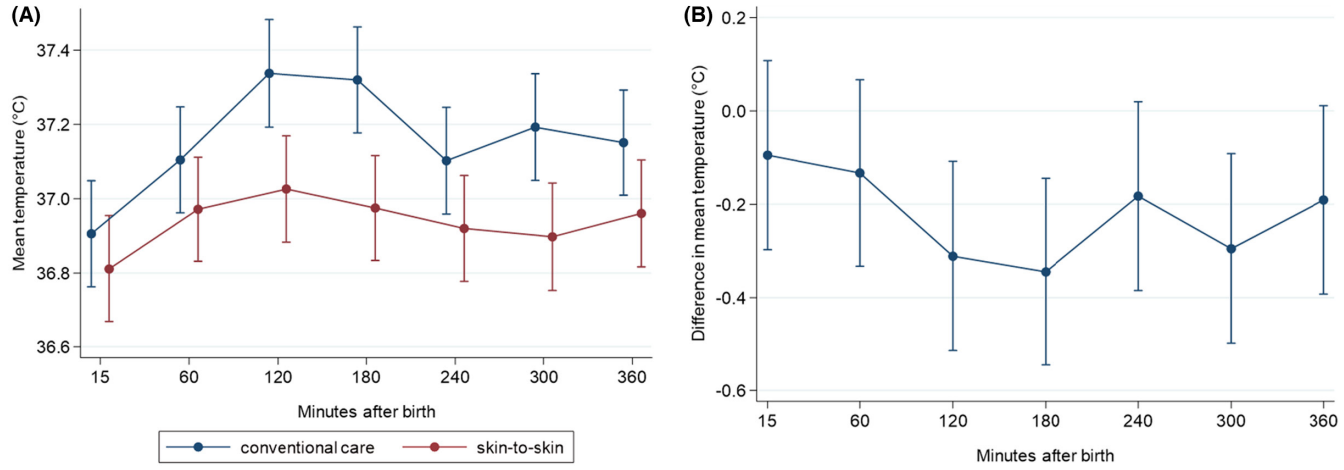

FIGURE 1 Mean infant axillary temperatures and differences in mean axillary temperature by randomisation group. (A) Mean (±SD) temperatures (°C) by randomisation group, data of the SSC group are presented in red, data of the control group infants are shown in blue. (B) Differences in mean (±SD) temperature. All at defined time-points during the study period of 360 min post-birth

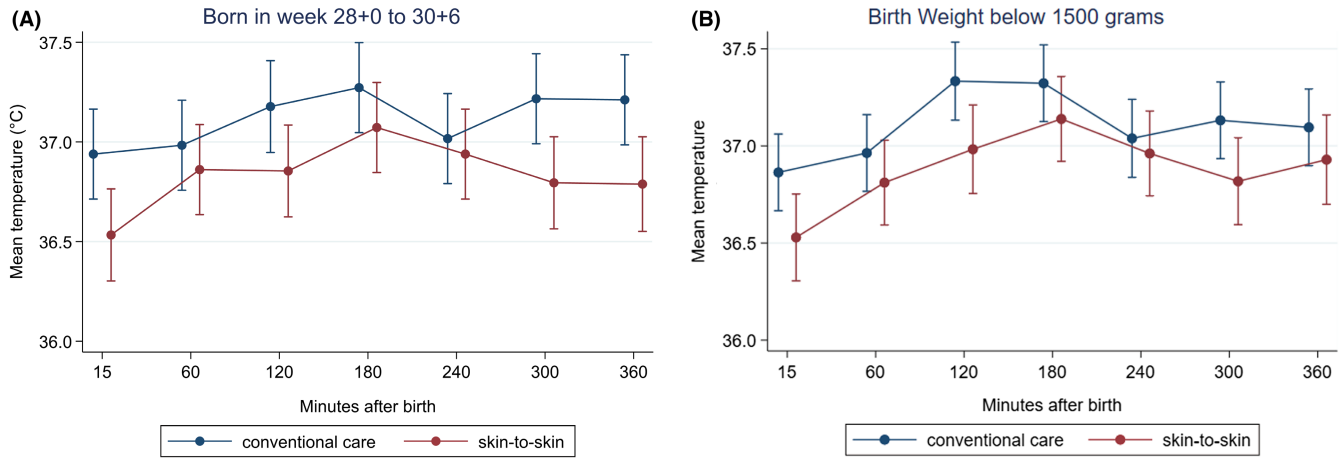

FIGURE 2 Mean infant axillary temperatures in subgroups of randomisation groups. Mean temperature, by randomisation group and subgroup at defined time-points. Skin-to-skin infants showed in red, conventional care infants in blue. (A) Born in week 28+ 0–30+ 6 and (B) Birth weight below 1500 grams

A lower mean temperature (95%CI) was also found for the subgroup of SSC infants born at GA 28+ 0–30+ 6, at 300 and 360 min, by 0.42°C (−0.66, −0.18, $p = 0.001$) and 0.42 °C (−0.73, −0.12, $p = 0.007$), respectively, and confirmed when corrected for sex, Table 2; Figure 2A.

There was no significant difference in mean temperature for the subgroup of SSC infants with BW below 1500 grams at different time-points, when corrected for sex, Figure 2B.

4.2 | Infants with events of hypo- or hyperthermia

4.2.1 | Infants with events of hypothermia

There was no significant difference in infants with events of mild or moderate hypothermia during the first 6 h after birth, when comparing the SSC and control group. For mild hypothermia, there were 15/46 versus 12/45 infants with events in the SSC and control group, respectively. This corresponds to a relative risk (95%CI) of developing mild hypothermia in the SSC group of 1.2 (0.65, 2.32, $p = 0.54$). For moderate hypothermia, there were 4/46 versus 1/45 infants with events in the SSC and control group, respectively. This corresponds to a relative risk (95%CI) of developing moderate hypothermia in the SSC compared to the control group of 3.9 (0.45, 33.68, $p = 0.21$). There were no events of temperatures below 35.0°C, Figure 3.

4.2.2 | Infants with events of hyperthermia

Infants presenting with events of hyperthermia during the first 6 h after birth was lower in the SSC group than in the control group, 23/46 50%, versus 32/45, 71%, corresponding to a relative risk (95% CI) in the SSC group of 0.70 (0.50, 0.99), $p = 0.04$. There was no significant difference between the two groups in number of infants with events of more severe hyperthermia above 38.0 °C or above 38.5 °C with a relative risk (95% CI) in the SSC group of 0.87 (0.37, 2.05, $p = 0.75$) and 0.24 (0.03, 2.10, $p = 0.20$), respectively. Figure 3.

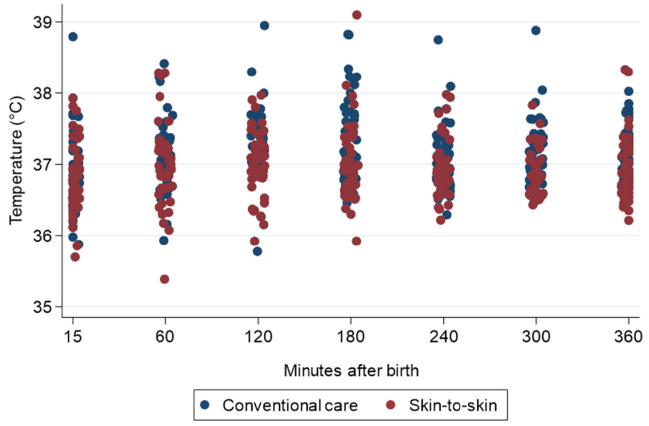

FIGURE 3 Individual infant axillary temperatures. Individual temperatures, by randomisation groups, at defined time points. Skin-to-skin infants showed in red dots, conventional care infants in blue dots

4.2.3 | Variance

The difference in variance between the groups were tested for each time-point, but we neither found significant difference at any time-point nor significant difference in changes over time between the groups ($p = 0.29$).

5 | MEAN TEMPERATURE BY AS-TREATED ANALYSIS

The intention for the SSC group was to initiate SSC immediately after birth. However, at 15 and 60 postnatal minutes 17/46 and 30/46 infants allocated to SSC were in SSC, respectively. At 15 postnatal minutes, in the subgroup of GA 28 + 0–30 + 6, one infant allocated to SSC was in SSC and in the subgroup of BW below 1500 grams three infants allocated to SSC were in SSC. At 60 min post-partum in the subgroup GA 28 + 0–30 + 6, 11 infants were in SSC and in the subgroup below 1500 grams also 11 infants were in SSC.

When analysed per intention-to-treat or randomisation group, the lowest mean temperatures occurred at 15 min post-partum in the SSC group. However, at this time point, most of the infants randomised SSC were not yet at this place of care. As-treated analyses showed no significant difference in mean temperatures (95%CI) between infants receiving SSC and the conventional care group at 15 min post-partum, −0.2°C (−0.50, 0.09, $p = 0.18$), nor at 60 min post-partum, −0.12°C (−0.12, 0.36, $p = 0.31$).

6 | DISCUSSION

This randomised controlled trial involving immediate SSC for very preterm infants conducted in high-resource settings showed that mean temperatures during the 6 h study period after birth were in the normal range also in infants born before 31 weeks and below 1500 grams. We found a lower number of infants with events of hyperthermia during the first 6 postnatal hours in the group of infants in SSC compared with infants in conventional care.

During the first min of life, when the wet infant is exposed to the relatively cold extrauterine environment, medical interventions may contribute to significant heat loss. In our study, we found mean axillary temperatures to be 0.2°C lower during the first 6 postnatal hours in immediate SSC when compared to conventional care. This was not considered clinically significant as all mean temperatures were within normal range. Conventional care in Scandinavia includes high levels of nursing care such as temperature monitoring, attention to room temperatures and servo-control temperature regulation in radiant heaters and incubators to prevent hypothermia. This may explain why there was an overall low incidence of hypothermia also in the conventional care group.

There was a higher number of infants presenting with events of hyperthermia during the first 6 postnatal hours in conventional care when compared to immediate SSC. In high-resource settings SSC with a parent during the first hours of life may prevent hyperthermia and its potential harmful effect in preterm infants.

The infant was immediately installed in SSC or first assessed on a heated resuscitaire when immediate medical intervention was needed, on the decision of the neonatologist in charge. Although the purpose of this study was to investigate the effect of immediate SSC, median time to SSC initiation was 0.4 h and for the subgroup of infants born in week 28 + 0–30 + 6 it was as late as 1 h. This was justified by earlier research published by our group while preparing for this trial, showing that temperature control could be a challenge for a very preterm infant in immediate SSC.[15] The SSC initiation time reflects the complexity of caring for a very preterm infant, and may also reveal hesitancy to a novel intervention by the medical and nursing teams in charge. The differences in temperature in infants born before 31 weeks is not explained by SSC since only one of these infants was actually in SSC at that time-point.

Importantly, the SSC providers in the study were mainly fathers. The thermal stability in the SSC group suggests that in the aspect of thermoregulation partners are suitable as substitutes for the mother for providing immediate SSC.[19] This has also been observed in healthy term infants.[20]

7 | STRENGTHS AND LIMITATIONS

IPISTOSS is one of few studies on immediate SSC in high-resource settings from GA 28–33, here showing the safety of this practice. For practical reasons, infant temperature was measured intermittently by an axillary thermometer and not continuously. This might have been disadvantageous for SSC infants since removing the covering may have led to temperature loss. In addition, continuous measurements would have picked up trends more accurately. We did not measure the body temperature of the parent providing SSC.

8 | CONCLUSIONS

Infants born very preterm cared for in SSC with a parent during the first hours of life showed normal thermoregulation. Immediate SSC may protect the newborn preterm infant from hyperthermia. Concerns about thermoregulation should not limit the use of immediate SSC in high-resource settings.

ACKNOWLEDGEMENTS

The authors thank the participating infants, parents and the staff at the birth units and NICUs at the Stavanger University Hospital and the Danderyd and Huddinge units of Karolinska University Hospital; in particular, research nurses Kerstin Andersson and Kirsten Engevik.

FUNDING INFORMATION

This study was funded by BabyBjörn, Barnforskningen at Astrid Lindgren Children's Hospital, the Doctoral School in Health Care Sciences (FiV) at the Karolinska Institutet (KI), the Kempe-Carlgrenska Fonden, the Kronprinsessan Lovisas Fond, the Laerdal Foundation, the Lilla barnets fond, Region Stockholm, The Samaritan Foundation for Paediatric Research, Strategic Area Health Care Science (SFO-V) at the Karolinska Institutet, Strategic Area Health Care Science (SFO-V) at the Karolinska Institutet, the Swedish Research Council, Sällskapet Barnavård and Helse Vest, Norway.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

ORCID

Karoline Lode-Kolz https://orcid.org/0000-0002-3240-5016
Agnes Linnér https://orcid.org/0000-0002-2934-2771
Björn Westrup https://orcid.org/0000-0002-3187-067X
Siren Rettedal https://orcid.org/0000-0002-4305-141X

REFERENCES

1. Bissinger RL, Annibale DJ. Thermoregulation in very low-birth-weight infants during the golden hour: results and implications. Adv Neonatal Care. 2010;10(5):230-238.
2. Organization WH. Thermal Protection of the Newborn: a Practical Guide. World Health Organization; 1997.
3. Croop SE, Thoyre SM, Aliaga S, McCaffrey MJ, Peter-Wohl S. The golden hour: a quality improvement initiative for extremely premature infants in the neonatal intensive care unit. J Perinatol. 2020;40(3):530-539.
4. Laptook A, Salhab W, Bhaskar B, Neonatal Research Network. Admission temperature of low birth weight infants: predictors and associated morbidities. Pediatrics. 2007;119(3):e643-e649.
5. Conde-Agudelo A, Diaz-Rossello JL. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. Cochrane Database Syst Rev. 2016;2016(8):Cd002771.
6. Arya S, Naburi H, Kawaza K, et al. Immediate "kangaroo mother care" and survival of infants with low birth weight. N Engl J Med. 2021;384(21):2028-2038.
7. Lyu Y, Shah PS, Ye XY, et al. Association between admission temperature and mortality and major morbidity in preterm infants born at fewer than 33 weeks' gestation. JAMA Pediatr. 2015;169(4):e150277.
8. Amadi HO, Olateju EK, Alabi P, Kawuwa MB, Ibadin MO, Osibogun AO. Neonatal hyperthermia and thermal stress in low- and middle-income countries: a hidden cause of death in extremely low-birthweight neonates. Paediatr Int Child Health. 2015;35(3):273-281.
9. Baley J. Skin-to-skin Care for Term and Preterm Infants in the neonatal ICU. Pediatrics. 2015;136(3):596-599.
10. Bergman NJ, Linley LL, Fawcus SR. Randomized controlled trial of skin-to-skin contact from birth versus conventional incubator for physiological stabilization in 1200- to 2199-gram newborns. Acta Paediatr. 2004;93(6):779-785.
11. McCall EM, Alderdice F, Halliday HL, Vohra S, Johnston L. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database Syst Rev. 2018;2(2):Cd004210.
12. Gupta N, Deierl A, Hills E, Banerjee J. Systematic review confirmed the benefits of early skin-to-skin contact but highlighted lack of studies on very and extremely preterm infants. Acta Paediatr. 2021;110(8):2310-2315.
13. Linnér A, Lilliesköld S, Jonas W, Skiöld B. Initiation and duration of skin-to-skin contact for extremely and very preterm infants: a register study. Acta Paediatr. 2022;111(9):1715-1721.
14. Kristoffersen L, Stoen R, Hansen LF, Wilhelmsen J, Bergseng H. Skin-to-skin care after birth for moderately preterm infants. J Obstet Gynecol Neonatal Nurs. 2016;45(3):339-345.
15. Linnér A, Klemming S, Sundberg B, et al. Immediate skin-to-skin contact is feasible for very preterm infants but thermal control remains a challenge. Acta Paediatr. 2020;109(4):697-704.
16. Linnér A, Lode Kolz K, Klemming S, et al. Immediate skin-to-skin contact may have beneficial effects on the cardiorespiratory stabilisation in very preterm infants. Acta Paediatr. 2022;111:1507-1514.
17. Linnér A, Westrup B, Lode-Kolz K, et al. Immediate parent-infant skin-to-skin study (IPISTOSS): study protocol of a randomised controlled trial on very preterm infants cared for in skin-to-skin contact immediately after birth and potential physiological, epigenetic, psychological and neurodevelopmental consequences. BMJ Open. 2020;10(7):e038938.
18. Sweet DG, Carnielli V, Greisen G, et al. European consensus guidelines on the management of respiratory distress syndrome–2019 update. Neonatology. 2019;115(4):432-450.
19. Maastrup R, Greisen G. Extremely preterm infants tolerate skin-to-skin contact during the first weeks of life. Acta Paediatr. 2010;99(8):1145-1149.
20. Ayala A, Christensson K, Christensson E, Cavada G, Erlandsson K, Velandia M. Newborn infants who received skin-to-skin contact with fathers after caesarean sections showed stable physiological patterns. Acta Paediatr. 2021;110(5):1461-1467.

How to cite this article: Lode-Kolz K, Hermansson C, Linnér A, Klemming S, Hetland HB, Bergman N, et al. Immediate skin-to-skin contact after birth ensures stable thermoregulation in very preterm infants in high-resource settings. Acta Paediatr. 2022;00:1–8. https://doi.org/10.1111/apa.16590