Newly born low birthweight infants stabilise better in skin-to-skin contact than when separated from their mothers: a randomised controlled trial

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ABSTRACT

Aim: Routine care of low birthweight (LBW) neonates relies on incubators for stabilisation. An earlier study suggested that skin-to-skin contact achieves better physiological stability in the transition period when compared to incubator care. The aim of this study was to replicate that study with a larger sample.

Methods: A randomised controlled trial with LBW infants (1500–2500 g) randomised at birth, 50 to routine care and 50 to skin-to-skin contact, with stabilisation using the Stability of Cardio-Respiratory system in Preterms (SCRIP) score measured repeatedly over the first six hours of life as the primary outcome.

Results: Newly born infants in skin-to-skin contact showed better transition to extra-uterine life (p < 0.02), with the SCRIP score at 360 minutes in skin-to-skin contact being 5.82 (SD 0.66) and in maternal infant separation 5.24 (SD 0.72), p < 0.0001. In extended skin-to-skin contact care, infants had significantly less need for respiratory support, intravenous fluids and antibiotic use during the remainder of the hospital stay.

Conclusion: Skin-to-skin contact was likely to be an optimal environment for neonates without life-threatening conditions who weighed 1500–2500 g at birth. By preventing instability that requires subsequent medical treatment, it may be life-saving in low-income countries.

INTRODUCTION

There is significant stress during the birth process (1) which is necessary to activate the brain and the lungs (2,3). Maternal–neonate skin-to-skin contact can be regarded as providing regulation through maternal sensory inputs that enhance autonomic nervous function (4), all the more important for the newly born (5) in the period of transition to extra-uterine life. Immediate maternal infant skin-to-skin contact is therefore hypothesised to be a fundamental regulator of the newly born autonomic nervous system, essential to stabilisation during transition (6). In the context of preterm birth, such a stabilising support would enhance adaptation to extra-uterine life by preventing instability (7). Early maternal infant interactions are also important in bonding processes (8), and early skin-to-skin contact is known to increase breastfeeding (9).

Current Western care is premised on the idea that instability can be recognised quickly and treated as appropriate with technology including incubators. However, primate studies suggest that the observed instability may actually be caused by the separation (10,11), described as dysregulation prompting cortisol release to restore homeostasis (4). Preterm infants in incubators have hypercortisolaemia (12) and incubator care may be treating instability while also exacerbating it.

Key notes
- The existing evidence base for the use of skin-to-skin contact in newly born low birthweight infants is inadequate.
- Skin-to-skin contact from birth maintained stability of low birthweight infants during transition. Separation in the first six hours of life resulted in delayed physiological stabilisation with subsequent increased need for medical interventions.
- Maintaining physiological stability during transition by skin-to-skin contact may be life-saving in low-income countries.
Skin-to-skin contact is the first component of Kangaroo mother care (KMC) (13). As defined, and as generally practised, the small newly born should be stable to qualify for skin-to-skin contact (14). However, unstable babies are at risk of mortality and may therefore never get the potential benefit of skin-to-skin contact. One randomised controlled trial (RCT) has been published in which the primary outcome was infant stabilisation in newly born infants weighing between 1200 and 2199 g (7). This showed that skin-to-skin contact accomplished stability in six hours in all subjects, compared to less than half of subjects in incubator care. That preventing instability should lead to decreased mortality is supported by one other RCT (15) which reported a 40% reduction of mortality when skin-to-skin contact was started in the first day of life regardless of stability status. Although these infants were randomised, only half of cases had mothers available to provide skin-to-skin contact and these initiated skin-to-skin contact at variable times in the first 24 hours of life. Two observational studies report similar reductions in mortality from early skin-to-skin contact: 45% in Zimbabwe (16) and 50% in Mozambique (17).

The purpose of this study was to replicate the earlier RCT by Bergman et al. (7) in a different context with larger numbers. Vietnam is a lower middle-income country; it has a 9% low birthweight (LBW) rate and skin-to-skin contact and KMC are not widely practised. The aim was to compare the effects of skin-to-skin contact and the conventional method of care involving maternal infant separation on the stabilisation of newly born LBW infants. This study tests the hypothesis that the maternal–infant milieu provided by skin-to-skin contact improves neonatal thermal and cardiorespiratory physiology during the transition to extrauterine life when compared to incubator care.

**METHODS**

**Trial setting**

The Tu Du Hospital was a major birthing unit in Ho Chi Minh City, Vietnam, with approximately 60 000 deliveries per year and 1200 obstetric beds. The neonatal unit had 180 beds and admitted 16 200 neonatal cases in 2012, the year of the study. The proportion of LBW babies was 12.5% in this hospital. Intensive care facilities were under severe pressure and incubators routinely held three small babies at a time. The hospital’s protocol required that all babies under 2.5 kg or <37-week gestation be transferred to the Neonatal Unit for observation of the adaptation process, with resulting separation from the mother.

**Study design and participants**

This was a RCT, using sealed opaque envelopes. All infants weighing between 1500 and 2490 g were screened for eligibility. The infants allocated to standard hospital care made up the control group. The infants allocated to skin-to-skin contact as a place of care rather than an incubator or cot made up the intervention group. Mothers testing positive for human immunodeficiency virus and hepatitis B were excluded, as the hospital’s policy was that these mothers should not breastfeed. Other exclusion criteria were severe malformation, chromosomal abnormality, life-threatening disorders requiring complex technology, severe asphyxia at birth (Apgar score <4 at five minutes necessitating prolonged resuscitation), neonatal convulsions, multiple births or mother in poor health.

The obstetric nurses on duty informed the research team whenever a mother would potentially be giving birth to a baby in the weight range of 1500–2490 g (predicted by ultrasound and an obstetrician). The study was conducted by two experienced neonatologists who provided standardised clinical care to both groups and collected all the data. One of the neonatologists would inform the mother (and father if required) and invite consent. After birth, if the mother and infant satisfied the eligibility requirements after weighing and assessment, an envelope with the group allocation was drawn. If the baby was allocated to skin-to-skin contact, the mother was asked to confirm her prior consent. If the baby was allocated to the control group, consent for use of information was confirmed. Adherence to the allocation was stringent and once treatment was started, there were no deviations from the approved protocol. Due to the nature of the intervention, blinding was not possible.

**Control group**

If the baby was allocated to the control group, the mother was informed and the infant was separated from her in accordance with the hospital’s protocol. After birth, the baby was taken to the resuscitaire for suctioning and drying with a sterile cloth, stimulation of breathing, evaluation of condition and general examination. If deemed to be stable, the baby was measured and weighed, dressed in diaper, clothes, cap, gloves and socks. A vitamin K1 injection and eye prophylaxis were given. The infant was then covered with a blanket and transferred to the neonatal department about 30 minutes after birth. Incubators set at 33°C or cots were used, depending on the need for care. Mothers would not see their infants until they were discharged from the neonatal department. Feeding was by bottle with artificial milk for prematures (Similac Neosure) or by feeding tube 5–7 mL/kg per two hours at 30 minutes, three hours and at five hours after birth, at which times all the vital sign data were collected.

**Intervention group**

If the baby was randomised to the intervention group, the infant was placed on a cloth on mother’s abdomen, cleaned gently, covered with a new cloth, and the cord was cut. The baby’s condition, gestational age and Apgar score were checked while the mother held the baby so that the nurse took care of both, first the baby and then the mother. The baby was then separated from the mother for about three minutes and taken to the resuscitaire to measure height and weight and to administer eye care and an injection of vitamin K1. A diaper, cap and open vest allowing skin-to-skin contact were put on the baby, but no gloves or socks.
The baby was then put back on the mother’s chest in direct skin contact, and the mother was given support regarding technique. Support was also given regarding self-attachment behaviours in infants showing such signs (18). Continued observations of the mother and infant took place in the after-birth room and nursing routines were carried out. Mothers were encouraged to breastfeed at 30 minutes, three hours and five hours after birth. If the baby could not be fed directly, the mother squeezed breastmilk into a 1-mL syringe for drop feeding or baby was fed through a gavage tube with the amount of 5–7 mL/kg per two hours; if the mother had no breastmilk, artificial milk for premature was used.

**Care common to both groups**

Time to cord clamping and management of symptoms of instability and complications were the same for both groups. Observations were made at identical time intervals.

**Outcomes**

The Stability of Cardio-Respiratory system In Preterm infants (SCRIP) score is a composite measure of stability measured over five minutes (7) (Table 1). This was recorded from monitor readings (Philips VM1, Woodruff, WI, USA) during 5-minute epochs and recorded at 30 minute intervals. At the beginning of each epoch, heart rate and oxygen saturation were noted and temperature was recorded in the next minute. During the second and third minutes, respiratory rates were counted accurately; periodic breathing and the number and length of apnoeic episodes were counted in the fourth and fifth minutes. The period of full observation for primary outcome was six hours. Further patient data were collected until discharge. Blood glucose was measured at 180 and 360 minutes. For each subject, data were collected regarding the time breastfeeding started, the use of nasal continuous positive airways pressure (CPAP), ventilator support, the need for intravenous fluids during the first six hours and from 6 to 24 hours, any oxygen use in the first 24 hours, any use of antibiotics during the hospital stay and the length of stay in days.

The original SCRIP score described by Fischer et al. (19) was based on infants between 760 and 1610 g, and the mode of respiratory support was not factored in. As the infants in this study were larger and responding to oxygen by cannula, nasal CPAP or ventilation, the third component of the SCRIP did not contribute to interpreting instability. We therefore adapted the SCRIP score for late preterm infants (LPI), proposing a Stability of Cardio-Respiratory system In Late preterm infants (SCRIL) score. This also adjusts for appropriate heart and respiratory rates and is presented as a post facto secondary subanalysis (Table 2).

**Sample size, statistics and randomisation method**

The study was planned to compare two proportions of stabilisation, 60% in the maternal–infant separation group and 90% in the skin-to-skin contact group, where the ratio of maternal–infant separation to skin-to-skin contact was 1:1. It was estimated that 48 experimental subjects and 48 control subjects were required to be able to reject the null hypothesis that the stabilisation proportions for experimental and control subjects were equal, with probability (power) of 0.90. The type I error probability associated with this test of the null hypothesis was 0.05. This was estimated using PS Power and Sample Size Calculations (freeware software) (20). The total sample size was therefore 100.

The principal investigator (KCL) prepared 20 small pieces of paper indicating allocation to skin-to-skin contact, and 20 indicating allocation to the control group, folded them and sealed them in opaque envelopes. In this way, allocation could not be determined before the envelopes were opened. These envelopes were shuffled and placed in a drawer in the birthing room where they were accessible day and night. A second round of envelopes was prepared in the same way (20 skin-to-skin contact, 20 controls) and a final round completed the sample (10 skin-to-skin contact, 10 controls), that is block sizes of 20, 20 and 10 in each group. The researchers (KCL and TLN) determined eligibility of the infant; the caregivers on duty in the birthing room determined the eligibility of the mother and drew the allocation envelope. After the infants were assigned to intervention, blinding the researchers collecting data was not possible.

As these were potentially unstable infants and detailed clinical data were being collected, one of the two researchers stayed with the subjects for the full six hours of the primary observation period. The unit was extremely busy, and this research was conducted by two neonatologists (KCL and TLN) in their own time. For these reasons, data were collected continuously without interim analysis. Note that the intervention is essentially comparing two places of care, observations were the same in both groups,

| Table 2 SCRIL score (Stability of Cardio-Respiratory system In Late preterm infants) |
|-------------------|------|------|------|
| SCRIL             | 2    | 1    | 0    |
| Heart rate        |      |      |      |
| Respiratory rate  |      |      |      |
| Oxygen saturation |      |      |      |
| Apnoea < 80%      |      |      |      |
| Apnoea > 100%     |      |      |      |
| Apnoea > 200%     |      |      |      |
| Apnoea > 60%      |      |      |      |
| Any fall < 80%    |      |      |      |
| Any fall < 80%    |      |      |      |
| <100 bpm          |      |      |      |
| ≥170 bpm          |      |      |      |
| <29.9             |      |      |      |
| >70               |      |      |      |
| 94–97% oxygen     |      |      |      |
| ≥6 seconds        |      |      |      |
| <94% nCPAP, ventilation |      |      |      |

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and care as indicated by those observations was standardised for both groups.

Stata version 13.1 (College Station, TX, USA) was employed for statistical analyses. Baseline demographic characteristics of the intervention (SSC) group and the standard care group were compared, using chi-squared or Fisher's exact tests to compare proportions. Continuous data were assessed for deviations from normality using the Shapiro–Wilk test and graphically by plotting histograms and were subsequently analysed using the two-sample Student’s t-test or Wilcoxon rank-sum (Mann–Whitney U-test) tests as appropriate. Primary and secondary objectives were analysed using time-dependent repeated-measures regression for continuous outcomes (xtreg procedure) and time-dependent repeated-measures logistic regression for binary outcomes (xtlogit) between the intervention and standard care groups. A single p-value was derived comparing the two groups, taking into account the repeated nature of the data collected at 30-minute intervals from 30 to 384 minutes.
360 minutes. SCRIL data were analysed in subgroups for birthweight and gestational age. Throughout, statistical significance was set at $p \leq 0.05$.

The protocol was approved by the Medical Ethics Council of Tu Du Hospital and Medical University of Ho Chi Minh City; there was no other trial registration. The trial protocol can be obtained from Dr Nils Bergman.

RESULTS

Baseline data
Recruitment started in Tu Du Hospital, Ho Chi Minh City, in December 2010 and continued to December 2011, when the last required subject was recruited. During the study period, 2738 babies weighing <2500 g were born. A total of 2230 of these babies weighed between 1500 and 2499 g (Fig. 1). The two researchers were only available for recruiting during their regular working hours. Only three beds were available to accommodate dyads allocated to skin-to-skin contact and this constrained randomisation. No new subjects could be enrolled in either the skin-to-skin contact group or the control group until a skin-to-skin contact dyad had been discharged. Recruitment continued until the target sample size was reached.

One subject in the skin-to-skin contact group required intensive care after four hours. The results of this case before and after separation from the mother are included in the analysis. Two others each had a period of interruption

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Figure 2 Stability of Cardio-Respiratory system in Preterms (SCRIP) score results, time series in minutes from birth: (A) total SCRIP score, (B) heart rate SCRIP score, (C) respiratory SCRIP score, (D) percentage of subjects achieving optimal scores on the full SCRIP, (E) the heart rate component of the SCRIP, and (F) the respiratory component of SCRIP. Oxygenation score not depicted. (Solid line = skin-to-skin contact; dashed line = maternal–infant separation.)
after the first six hours but continued thereafter in skin-to-skin contact until discharge. Their results are included in the analysis. The infants in the control group received standard care and none were excluded. All the assigned subjects were included in the analysis. No unintended or untoward effects were observed.

Baseline demographic and clinical characteristics of the mothers are shown in Table 3 and those of their infants are shown in Table 4. Groups were comparable. Approximately half the infants were <34-week gestation and over two-thirds were above 2000 g birthweight. Gestational age was based on first prenatal visit estimation, last menstrual period and ultrasound.

**Outcome data**
The total SCRIP score out of a maximum of six was $5.66 \pm 0.72$ in the skin-to-skin contact and $4.72 \pm 0.83$ in the maternal–infant separation study groups at 120 minutes ($p < 0.0001$), and $5.82 \pm 0.66$ (skin-to-skin contact) and $5.24 \pm 0.72$ (maternal–infant separation) at 360 minutes ($p = 0.0001$), with a significant temporal trend over the whole six hours ($p = 0.02$). The SCRIP score results during

![Figure 3](image-url)  
**Figure 3** Outcomes for specific parameters of the Stability of Cardio-Respiratory system in Preterms (SCRIP), time series in minutes from birth. (A) Proportion with stable heart rate, (B) proportion with heart rate <120 per minute, (C) proportion showing periodic breathing, (D) proportion with stable respiration, (E) proportion with respiration <40 per minute and (F) proportion with apnoeic episodes longer than 10 seconds. (Solid line = skin-to-skin contact; dashed line = maternal–infant separation.)
the first six hours of life are presented in their entirety in Figure 2, as means and as proportions of subjects achieving maximal scores. The individual parameters of the SCRIP score are presented graphically in Figure 3, with single p-values for time series comparing the two groups. Other secondary outcomes are presented graphically as time series in Figure 4 and as means or proportions in Table 5.

Only the results of the SCRIL score subgroup analysis are shown in Figure 5. These results compare groups above and below 34-week gestation and above and below 2000 g birthweight. Continuing in their group allocation beyond six hours, infants in the skin-to-skin contact group required less intravenous fluid (9/50 vs 26/50, \( p < 0.001 \)), and there was less antibiotic use (9/50 vs 26/50, \( p = 0.004 \)) during the subsequent hospital stay. There was no significant reduction in the length of stay (7.0 vs 8.0 days).

CONCLUSIONS
The cardio-respiratory stability by the SCRIP score was significantly improved by skin-to-skin contact, consistent with the results reported by Bergman et al. (7). This study therefore supports the hypothesis that skin-to-skin contact provides autonomic support and regulation, and so

![Figure 4](image_url)

**Figure 4** Clinical outcomes presented as time series in minutes from birth. (A) Means of respiratory rate, (B) means of apnoeic episodes, (C) means of heart rates, (D) means of oxygen saturations, (E) means of apnoeic episode duration in seconds and (F) means of temperature celsius. (Solid line = skin-to-skin contact; dashed line = maternal–infant separation.)
protests newly born LBW infants from becoming unstable. The oxygen saturation was maximal in both groups: the parameters determining sensitivity for oxygen saturation were defined for neonates smaller than those studied. Even so, significant differences are apparent in stability of heart rate and respiration. The individual components comprising the SCRIP score show differentiated responses. In skin-to-skin contact, stability appears to be achieved in one hour. Separated newly born infants have respiratory instability during the first three or four hours, followed by heart rate instability up to six hours. The relative bradycardia, decreased respiratory rate and lower temperature are consistent with an dissociation stressor response (21,22).

The SCRIL score should be seen as a proposal for adapting a meaningful parameter to LBW infants and LPIs. Its significant outcomes are artefactual, as the cut-offs between the scores were selected post facto. Nevertheless, this creates a more sensitive instrument for stability, with fewer maximal scores and greater range. Note that in the subgroup analysis in Figure 5, smaller and younger infants in skin-to-skin contact are considerably more stable than larger and older infants in maternal–infant separation.

There were several real and potential study limitations. The constraints on recruiting prior to birth may bias for certain kinds of LBW infants. The limited number of beds available for skin-to-skin contact could potentially create bias but recruitment was halted in both groups when skin-to-skin contact beds were occupied. The improved outcomes after the first six hours in the skin-to-skin contact group could be due to improved breastfeeding, which was not allowed in the control group. The research site had an extremely large workload and in the neonatal department (control group), space precluded mothers from being present with their infants during the stay. This makes the results less generalisable to many places, where maternal presence may improve outcomes. On the other hand, given the hypothesis that separation may have adverse effects, the study site ensured full compliance with maternal absence.
Once subjects were deemed eligible, randomisation stringency was good. However, blinding was not possible and subsequent data were also managed by the clinical researchers, because the research was carried out without significant funding. The mothers and infants were comparable in both groups. Shuffling of envelopes could, but did not, pose a potential study limitation, in that shuffling does not ensure random (chance) allocation, as does computer generated randomisation. As the procedure did produce similar study groups, adjusted analyses were unnecessary. The attention given to ensuring standardised care for any symptoms of instability makes these findings applicable to most circumstances and settings.

This study suggests that mothers and LBW infants should not be separated, which may require changes in birthing routines (27). The early stabilisation period appears to predict the subsequent clinical course, as evidenced by the increased need for respiratory support, intravenous fluids and antibiotics in the control group. In this study, there was no decreased length of stay, as reported elsewhere (28), but this may be due to the fact that these were relatively larger infants who were mostly LPI, with discharge criteria determined by weight (29).

In conclusion, there was no mortality in the research sample, but there was evidence of decreased morbidity in the skin-to-skin contact (intervention) group relative to the maternal–infant separation (control) group. This study therefore supports the notion that skin-to-skin contact is the appropriate environment for early physiological transition for LBW infants and LPI. This study should be conducted in smaller infants and in low-income countries with significant neonatal mortality.

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CONFLICT OF INTEREST
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