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Does skin-to-skin contact reduce stress during diaper change in preterm infants?☆,☆☆

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ABSTRACT

Background: Skin-to-skin contact reduces pain response in preterm infants subjected to minor painful procedures, such as heel lance. Diaper change is a procedure performed several times daily in hospitalized preterm infants. Routine care giving tasks such as diaper change may be stressful for the infant.
Aims: The purpose of this study was to investigate whether diaper change induces stress and if skin-to-skin contact could reduce such stress, measured by changes in skin conductance.
Study design: This was a randomized crossover pilot study in 19 preterm infants with gestational age between 28 and 34 weeks. The diaper change procedure was done twice in each infant, once during skin-to-skin contact, and once in incubator or bed with the mother present.
Outcome measures: During diaper change heart rate (HR), peripheral oxygen saturation (SpO_2), and changes in skin conductance (SC) peaks per sec, using the Skin Conductance Algesimeter (SCA), were registered.
Results: The mean SC peaks/sec increased/decreased significantly under/after change of diapers which thereby underpins that this is a stressful procedure for the preterm infant.
Skin-to-skin contact (SSC) entails significantly lower stress levels ($p < 0.05$) compared to diaper changed in an incubator/bed measured by the SCA.
Conclusions: Diaper change is a stressful procedure for preterm infants and may be ameliorated by skin-to-skin contact.

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1. Introduction

Hospitalized preterm infants may experience increased stress during care taking procedures such as diaper change [1–4]. Several studies report that skin-to-skin contact (SSC) reduces stress and discomfort compared to the same procedure carried out without skin-to-skin contact [5,6]. Preterm infants are exposed to a large number of potentially stressful procedures and stimuli during hospitalization in the high-tech NICU environment [1,7,8]. In addition to medical invasive procedures, routine care giving tasks may also increase stress. Excessive stress may cause long-term sequelae and sensitize the infant to pain and stress later in life [9]. Inadequate treatment of stressors in neonates has shown to influence short-term and long-term outcomes [10,11]. Changes in behavioral, hormonal and metabolic parameters occur in infants after exposure to noxious stimuli [12]. Unrelieved pain and stress are associated with detrimental physiologic and behavioral outcomes in adulthood [13,14]. The preterm infant is exposed to an accumulated amount of stress that may be disadvantageous both in a short and long perspective [15]. Animal research demonstrates that stress and the glucocorticoids secreted during stress can be neurotoxic to the hippocampus. However, this has not been empirically documented in human samples. A small study of 14 children reported that posttraumatic stress disorder symptoms and cortisol levels at baseline subsequently predicted hippocampal volume reduction over a 12–18 month period [16]. The aim of the study was to investigate diaper change as a possible stressor in neonatal intensive care, and second if skin-to-skin care could reduce stress due to diaper change.

1.1. Skin-to-skin contact

Skin-to-skin contact is operationally defined as the upright prone positioning of the diaper-clad infant skin-to-skin and chest-to-chest with the mother [5] Several studies have stated that mother–infant skin-to-skin contact has a significant effect in reducing procedural pain in preterm infants compared to standard incubator care [5,6,17,18]. Feldman and Eidelman found that skin-to-skin contact accelerates autonomic and neurobehavioral maturation in preterm infants [19]. Skin-to-skin contact between the preterm infant and the mother is an effective and

Abbreviations: SSC, Skin-to-skin contact; KMC, Kangaroo Mother Care; NICU, Neonatal intensive care unit; SCA, Skin Conductance Algesimeter; SC, Skin conductance.

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safe alternative to conventional bed or incubator neonatal intensive care and has been documented to decrease pain, has positive effects on infant sleep patterns and also improves parent–infant interactions [20].

2. Methods

2.1. Subjects

This was a randomized crossover clinical pilot study. All the preterm infants with GA between 28 and 34 weeks hospitalized in the NICU, Drammen Hospital Norway, between September 2011 and February 2012 were eligible for the study but were excluded if the following criteria were met: (1) birth weight below the 10-centile; (2) ventricular hemorrhage stage 3–4; (3) sepsis; (4) significant asphyxia; and (5) malformations. Nineteen preterm infants were included. All infants were respiratory and circulatory stable and one week or older at inclusion. Group assignments were made sequentially by a randomized series of sequential, sealed envelopes which randomized the preterm infants into two groups. Half of the infants were randomly selected to diaper change skin-to-skin as the first procedure. The other half had their diaper changed in the incubator/bed as the first procedure. The study was approved by the regional committee of ethics. Informed written consent was obtained from the parents in advance.

2.2. The Skin Conductance Algesimeter

To measure stress during diaper change the MED-Storm's Skin Conductance Algesimeter (SCA) monitor was used [21]. The SCA is a non-invasive method for evaluating pain and stress. The SCA-monitor register bursts in the skin sympathetic innervation mirrored and shown as SC peaks/sec. Changes in SC peaks/sec reflect emotional sweating (different from temperature dependent sweating) and are mediated through cholinergic muscarinic receptors. The system measures conductance values between 1 and 200 micro-siemens. The device is approved for medical use and complied by safety regulations IEC 60601. The measuring (M) electrode was placed under the foot, the current counter electrode(C) on the dorsal side of the foot and the reference voltage electrode(R) directly beneath the ankle, which ensures a constant applied voltage across the stratum corneum beneath the M-electrode. The SCA measures the real-time changes in SC peaks/sec and has been tested and validated in term and preterm infants during painful or stressful procedures [22–28]. Different studies have shown a valid correlation between variation in SC peaks/sec and pain assessed by the behavioral assessment scales of premature infant pain profile (PIPP) and neonatal infant pain score (NIPS) [24,26].

2.3. Heart rate and oxygen saturation to monitor stress

Heart rate and oxygen saturation were registered 5 min before, during and 5 min after the diaper change. During the procedure the highest pulse rate and lowest score of saturation were registered (Table 2).

2.4. Procedure

The maximum time between the two diaper change events was 48 h. The infant had to be calm and satisfied during the diaper change. All infants were fed 30 min prior to the diaper change, in order to minimize SC variation due to hunger. There should only be urine in the diaper. Pacifier was not allowed. All procedures were performed in a large room with other infants, staff and parents present. The light and sound levels were reduced to a minimum. Electrodes for SC measurement were attached to the infant's foot at least 15 min prior to the procedure. The infant's heart rate and peripheral oxygen saturation were registered 5 min before, during and 5 min after the diaper change. In these defined periods the maximum and minimum of the physiological variables were registered. The SC peaks/sec was averaged over 15 s, and the maximum number of peaks/sec was registered. All procedures were performed by the same nurse. The diaper change in incubator or bed was carried out with the infant positioned side wise. The mother held her hands at the infants head and body, and comforted the infant with a soothing voice. The nurse changed the diaper following standard NICU procedure (see illustration Ia in the Appendix). The diaper change skin-to-skin was performed in lateral kangaroo position. The mother held her hands at the infants head and body and comforted the infant with a soothing voice. The nurse changed the diaper following standard NICU procedure (see illustration Ia in the Appendix).

Table 1
Study of infants' characteristics.

Male	9
Female	10
Number of twins	6
Birthweight (g)	1732 (464)
Weight during diaper change procedure	1867 (393)
Gestational age (weeks)	31.9 (1.4)
Post menstrual age during diaper change mean (SD)	37.7 (1.3)
Intraventricular hemorrhage, n (%)	0 (0)
Number ventilated during hospitalization, n (%)	
Number of ventilator	0 (0)
Number of CPAP	7 (36.8)
Number of "oxygen flow"	12 (63.2)
Number of infants ventilated during diaper change procedure, CPAP, n (%)	2 (10.5)
Length of stay (days) mean (SD)	31 (13.3)

Mean (SD) or number with percentage in parenthesis.

2.5. Statistics

The number of infants was based on previous studies performed on term and preterm infants before, during and after painful procedures and procedures anticipated to be stressful without pain. In these studies the number of infants was between 6 and 20 [22–30]. Statistical analyses were performed with SPSS software version 18.0 (SPSS Inc., Chicago, IL, USA). The effect of diaper change skin-to-skin or in bed on SpO_2, HR and Peaks/sec was performed as a crossover study and statistically assessed using a linear mixed model. This linear mixed model had a random intercept and fixed effect of observation time (i.e. before, during or after) and diaper change (i.e. skin-to-skin or bed). Any effect of modification, i.e. different effects of diaper change at different observation times, was assessed with an interaction term in the statistical model. If the interaction term was significant, the effect of diaper change was assessed separately at each observation time using paired sample t-tests. Adjustments for multiple comparisons with Bonferroni correction were done. A p-value < 0.05 was considered statistically significant.

Table 2
Saturation (SaO_2) and heart rate (HR) during diaper change.

		Diaper bed		Diaper breast	
		mean	SD	mean	SD
Variable	SpO_2				
Before change		96.7	2.4	97.2	2.5
During change		90.7	6.5	92.4	5.2
After change		97.1	2.2	97.9	1.9
Variable	HR				
Before change		154.2	10.6	155.7	12.0
During change		172.9	19.9	167.8	15.5
After change		156.6	14.0	155.6	12.5

In both groups there was a significant change in oxygen saturation and heart rate during the procedure ($p < 0.05$) but there was no significant difference between groups at any time point.

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