Investigating the Impact of Skin-to-Skin Care on Preterm Infant Heart Rate Variability

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Background

Kangaroo Mother Care (KMC), caring for newborns on their mother's chest 24 hours/day, has shown to be effective for thermal control, breastfeeding, and bonding in new borns and was initially used in resource limited countries to reduce mortality in low birthweight infants. For infants with a birthweight <2000g born in low- and middle-income countries, initiating KMC within the first week of postnatal life resulted in 51% reduction in mortality. KMC has also been found to decrease health care related sepsis and improve growth.

Skin-to-skin care in neonatal intensive care units (NICUs) in high-resource countries is usually performed as short-term placement on mother’s or father’s chest to enhance breastfeeding, attachment and parental self-esteem. Studies have shown that it is safe for both non-intubated and intubated preterm infants, and that 59% of NICU nurse managers, a survey of 12,448, intubated infants should not receive skin to skin care for multiple reasons including lack of criteria for infant selection, fear of dislodgement, stress on the infant, time involved for the nurse, temperature control concerns and bedside nursing fears of being blamed if something went wrong. Demonstration of potential benefit of skin-to-skin care for the infant could promote expansion of this practice. One potential benefit could be enhancement of the maturation of the autonomic nervous system.

The autonomic nervous system, comprised of sympathetic and parasympathetic innervations, is incomplete at birth. In premature infants the sympathetic tone is dominant. Improved parasympathetic tone promotes growth and restoration in addition to energy conservation.

Heart rate variability (HRV) measures the balance between sympathetic and parasympathetic mediators of heart rate. HRV increases with gestational age and has been shown to increase with skin-to-skin care. HRV is the temporal variation between sequences of consecutive heart beats, measured by the normal to normal (NN) interval which is the period between adjacent QRS complexes.

![Heart Rate Variability](image)

Figure 1. Heart rate variability between consecutive heart beats over a 2.5 second time period, the NN interval (Cousens 2015)

There are few reports evaluating HRV in preterm infants requiring respiratory support as well as assessing the impact of skin-to-skin care with fathers. Skin-to-skin care contributes to the father’s development of positive feelings of attachment and bonding. One study of HRV in 11 preterm infants showed a statistically significant difference in six of eight HRV domains monitored. Results of a crossover trial comparing physiologic measures in preterm infants before, during, and after skin-to-skin care showed no significant difference in body temperature, heart rate, respiratory rate, or neonatal stress score between care by the infant’s mother or father, although oxygen saturations were higher during skin-to-skin care with mothers. This study concluded that HRV measurements may be useful in capturing clinically relevant dynamic changes in autonomic regulation in response to skin-to-skin care.

Objectives

The objective of this study is to monitor heart rate variability in preterm infants requiring respiratory support during skin-to-skin care.

We hypothesize that skin-to-skin care is associated with a more mature pattern of parasympathetic activity as measured by various HRV indices of heart rate variability. Specifically, the standard deviation of the normal-to-normal interval (SDNN), the root mean squared of successive differences of normal-to-normal intervals (RMSSD), and the standard deviation of deceleration (SDDec) will decrease in infants that are receiving skin-to-skin care compared to isocare control.

In addition to the objectives presented above, an exploratory aim evaluates the differences in heart rate variability of preterm infants between mothers and fathers performing skin-to-skin care. The study collected the gender of the parent performing skin-to-skin with the infant for each session.

Methods

This prospective study was approved by the Institutional Review Board at the University of New Mexico Health Sciences Center, and written parental consent was obtained for all participants. The study sessions consisted of a 30-minute observation epoch prior to the skin-to-skin care, a 30-minute skin-to-skin care session, and a 30-minute observation epoch after completion of the skin-to-skin care, as described below.

During the skin-to-skin epoch, each infant was prone and upright on the parent’s chest, with the infant’s head turned towards one side. Heart rate variability data was collected by placing three ECG leads and a pneumogram on the infant and recorded using the BioPac Systems MP150 hardware (California, USA), the DA100c (pneumogram) and the EC100c (hardwired) equipment and AcqKnowledge 4.4.4 software. HRV processing and the pneumogram were removed following data collection completion, using massage oil to reduce skin irritation.

Selection of Patients:

The inclusion criteria are defined as:

1. ≤ 30 weeks gestational age at birth
2. ≤ 6 weeks postnatal age
3. Cranial ultrasound without severe intraventricular hemorrhage (Grade III or IV)
4. Receiving respiratory support at the time of the first session including:
   • Conventional mechanical ventilation
   • Noninvasive positive pressure ventilation (NPPV)
   • Continuous positive airway pressure (CPAP)
   • High flow nasal cannula (HFNC)
   • Low flow nasal cannula (LFNC)

Exclusion criteria are defined as failure to meet the above inclusion criteria and included:

1. Infants with known genetic disorders or known prenatal chromosomal anomalies
2. Infants with one or more major congenital anomaly
3. Infants undergoing active sepsis evaluation or treatment for infection
4. Infants on blood pressure or cardiac medications or infusions including inotropic medications
5. Mother <18 years old, incarcerated, requiring a legal representative or non-English speaking

Statistical Analysis

- The standard deviation of the normal-to-normal interval (SDNN), the root mean squared of successive differences of normal-to-normal intervals (RMSSD), and standard deviation of deceleration (SDDec) were used as the measures of heart rate variability (HRV).
- Kubios HRV Scientific was used to obtain SDNN and RMSSD from the raw EKG data, and SDDec was calculated from the RR intervals given by Kubios using the equation from C. Nasaré-Junior
- Measures were analyzed separately using Friedman's tests followed by post hoc Wilcoxon signed-rank tests for significant results; measurements were taken across the pre, during, and post skin to skin sessions
- A p-value of 0.05 was used to determine significance for the analyses
- All analyses were conducted in R software

Results

- Pre-, during-, and post- skin-to-skin sessions from 9 infants were analyzed
- SDNN and RMSSD were significantly different across the sessions when using the last five minutes of data from the during-skin-to-skin sessions, but not when using the first five minutes
- The post-hoc tests showed significant differences between the pre- and during- skin-to-skin sessions for both SDNN and RMSSD, and a significant difference between the during- and post-skin-to-skin session for RMSSD, indicating that skin-to-skin contact influences HRV

Conclusions

In this pilot study, the effects of skin-to-skin on three variables of HRV (SDNN, RMSSD, and SDDec) were analyzed during 22 skin-to-skin sessions in nine preterm infants.

- Statistical significance, using Friedman's tests, was found in two of three HRV domains when analyzing the end portion of a skin-to-skin session, but not the beginning portion, suggesting increased skin-to-skin contact increases autonomic regulation of the preterm infant
- Post-hoc Wilcoxon signed-rank test analysis of SDNN showed significance between pre-skin-to-skin and the end portion of during skin-to-skin, as well as between pre-skin-to-skin and post-skin-to-skin but not between the end portion of during skin to skin and post-skin-to-skin

- This suggests the variability in heart rate caused by changes in the autonomic nervous system last for at least 10 minutes after the baby has been placed back in their bed
- Data is still being analyzed to assess for any impact of the caregiver being the mother compared to the father during skin-to-skin sessions

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