ORIGINAL RESEARCH

# The effects of skin-to-skin holding on caloric composition of expressed breast milk

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## ABSTRACT

**Objective:** Mothers of premature infants express breast milk for early infant feedings, however problems arise with changes in physiologic stability of the infant. This pilot study examines the relationship of skin-to-skin holding to the caloric composition of maternal breast milk expressed by mothers of premature infants immediately after holding their infants.

**Methods:** Twelve dyads of first-time mothers with medically stable neonates weighing 1,500 grams or less at birth participated in this study. Mothers pumped breast milk on their personal, regular schedules over a 4-day study enrollment, skin-to-skin held their premature infants during the study, and pumped following holding their infants. All expressed breast milk was measured for caloric composition using a Creamatocrit Plus centrifuge. The expressed milk compositions over a four day period were compared using repeated measures ANOVA.

**Results and conclusions:** Four sequential days of pumped breast milk data was collected and tested from each mother. There was a significant increase in caloric composition for every sample of breast milk expressed after skin-to-skin holding as compared to non-holding conditions ($p$ = .000) in this pilot study. These findings demonstrate clinical importance in that skin-to-skin holding has the potential to improve premature infant growth over time.

**Key Words:** Neonate, Skin-to-skin holding, Maternal breast milk, Premature

## 1. INTRODUCTION

Research evidence guides the approach to improve nutrition of premature infants in the Neonatal Intensive Care Unit (NICU). The nutritional needs of these infants differ vastly from that of term infants, as described in the Cochrane Review of human milk studies.[1] This review reported that maternal expressed breast milk provides the best nutritional support for optimal growth of premature infants. The clinical findings with pumped breast milk are equally reassuring; it is thought that expressed milk matches the exact nutritional needs of the neonate at the time it is pumped making maternal breast milk the perfect nutritional match for the neonate regardless of gestational age. With close to 70% of all mothers choosing to express breast milk for their infant in the NICU, the role of nurses to support the efforts of the mothers and facilitate breast feeding has enlarged in recent years.

### 1.1 Relevant literature

The benefits of providing early maternal breast milk feedings for the compromised preterm infant have been well described in the literature. Because premature infants have immature immune and digestive systems, early breast milk feedings have been found to support digestive maturation and the milk itself is easier for the smallest premature infants to digest.[2]

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Research further correlates early breast milk feedings to a decreased incidence of late-onset sepsis, less necrotizing enterocolitis, improved digestive maturation, and a lower incidence of retinopathy of prematurity.[3] Moreover, it is reported that premature infants who are fed breast milk for at least two months have significantly better brain growth which correlates to better cognitive outcome.[4] The fact that one third of the neonate's brain growth occurs in the last 6-8 weeks of gestation is just one of the many compelling reasons for judicious nutritional support in the NICU, and, when merged with early breast milk feeding research, provides the rationale for nurses to encourage all mothers to initiate lactation through pumping.

Although there are a number of studies to date that findings support early feedings of maternal breast milk to the smallest of preterm infants, mothers are not always encouraged to initiate lactation through pumping in the NICU. The decision to provide breast milk through regular pumping for women who had not planned to breastfeed can be daunting, not to mention emotional. In addition, maternal breast milk supplies are frequently less than sufficient over time to meet the nutritional needs of the infant, leaving the mother at risk for feelings of inadequacy. In practice, mothers are encouraged to pump every 2-3 hours with a goal of 8-12 times in 24 hours to stimulate adequate milk production and pumping for a longer duration has been correlated to increased breast milk production.[5] Successful lactation and pumping a milk supply that meets the nutritional needs of the infant requires considerable effort, commitment, and a positive attitude on the part of the mother.

Initial feedings of premature infants are typically trophic feeds to promote gut mucosal development and increase the secretion of peptides to aid digestion.[6] Because initial feedings are small and feedings are increased very slowly for most premature infants, many mothers are successful in their effort to provide breast milk in the first few weeks after birth. Regardless of the efforts, there are a number of factors that can inhibit milk supplies including emotions, stress, and fatigue from sleep deprivation as well as postpartum depression. Many NICU mothers have difficulty sustaining their supply amidst the ongoing stress of their experiences in the NICU. Although mothers express breast milk successfully for the early NICU feedings, milk production tends to diminish at three to four weeks post-delivery.[6] Interventions to improve breast milk production over time have had limited and varied success. When reviewing evidence based practice literature, herbal galactagogues and relaxation therapies were considered to be the state of the science when paired with attention to diet, sleep and pumping schedule to help inadequate milk supplies.[7] Clearly, choosing to provide breast milk for feeding in the NICU is a challenge for mothers and has become a priority of care for NICU nurses.

#### 1.1.1 *Breastfeeding practices and recommendations*

The Baby-Friendly Hospital initiative is a global strategy that recommends exclusive breastfeeding for a minimum of 6-month of age but preferably beyond 2-year of age.[8] The guidelines to promote and support breastfeeding over this critical neurodevelopmental period do not exclude the extremely premature infants of the NICU but do pose unique problems. In a recent systematic review of all published NICU feeding outcome studies (N = 339) over the last ten years, Ross and Browns examined infant growth and breastfeeding issues beyond the NICU discharge.[9] What these researchers found was a marked declining rate of breastfeeding after discharge despite the interventions implemented in the NICU to promote breastfeeding success. Although studies were fairly consistent in suggesting that the earlier the infant was born, the higher the prevalence of feeding difficulties over the first year of life, it was found that interventions used to improve breastfeeding while in the NICU also improve breastfeeding outcomes after discharge. This fact provides the necessary proof for nurses to focus efforts that support lactation in the NICU.

There are considerable challenges for mothers with premature infants in the NICU environment. In a prospective, longitudinal study examining breastfeeding outcomes of healthy infants (N = 92) compared to a cohort of sick premature infants (N = 87), maternal perception of the importance of breast feeding as it relates to infant wellbeing was the primary factor associated with the duration of breast feeding.[10] More importantly, the woman's first breast feeding experience had a major influence on her decision to breast feed beyond the first six months. That first experience in the NICU amidst the intensive, technology driven environment is yet another challenge for the mothers.

#### 1.1.2 *The relationship of skin-to-skin holding*

NICU nurses must anticipate the physiologic needs of the infant and intervene appropriately while assessing for opportunities for meaningful mother-infant interaction. Many nurses have noted in practice that skin-to-skin holding the very low birthweight infant appears to facilitate the mother's ability to produce increasing volumes of breast milk after holding, and there is some evidence that improved weight gain is a secondary advantage.[11] Interventions such as skin-to-skin holding that may support lactation and the physiologic needs of the neonate while offering meaningful mother-infant interaction play a major role in NICU settings.

Flacking and colleagues completed a prospective, longitudinal study of mother-infant dyads to examine breastfeeding

rates at one and six months of age after using skin-to-skin holding interventions in the NICU to guide relaxation and emotional fulfillment experiences for the mothers instead measuring breastfeeding success.[12] The findings of 103 extremely premature and 197 preterm demonstrated the empowering effect, however preterm infants were more likely to be breastfed than the extremely premature infants at one and six months ($p < .05$). In a second prospective study of 43 mother-infant dyads, breastfeeding rates at discharge from the NICU, 3 months, and six months were compared of mothers who skin-to-skin held and those who did not.[13] Breastfeeding rates were higher in the skin-to-skin holding group at discharge (82.6%) and 3 months of age (43.5% $p = .005$) as compared to those who did not skin-to-skin hold, however there was no discussion of sample differences or differences noted at six months.

Skin-to-skin holding gives mothers the opportunity to focus on the emotional fulfillment as a new mother instead of embracing the stressors associated with the NICU environment. This pilot study quantifies this maternal experience of skin-to-skin holding premature infants as it relates to breast milk while contributing one of the few empirical studies that measures an important physiologic effect of holding. Interventions to improve breast milk production when adhering to a pumping schedule in the NICU have had limited and varied success. NICU nurses continue to examine the evidence and try interventions at the bedside to facilitate successful lactation. This study describes the effect of skin-to-skin holding on maternal breast milk composition. The research question for this study is what is the relationship of skin-to-skin holding to breast milk composition?

### 1.2 Purpose of study

The purpose of this study was to examine the relationship of skin-to-skin holding to the caloric composition of maternal breast milk expressed by mothers of premature infants immediately after holding their infants.

## 2. Methods

### 2.1 Study design

This pilot study was a repeated measures crossover design over a 4-day study enrollment designed to ascertain differences in breast milk pumped over time. The dependent variable of the study was maternal response measured in calories per milliliters of breast milk per pumping event. The independent variable of the study was the skin-to-skin holding intervention. The hypothesis tested was: There is a significant difference in the composition of maternal breast milk pumped after skin-to-skin holding premature infants as compared to maternal breast milk pumped after non-holding conditions.

### 2.2 Setting and sample

After obtaining hospital Institutional Review Board (IRB) approval to conduct the study, data was collected over a 15-month period at a 70-bed tertiary care, Level III NICU in a large suburban community hospital located in a South Atlantic State of the Mid-Atlantic region. After explaining the study, consent to participate was obtained from every mother invited to participate in the study. The sample of first-time mothers less than 35 years of age with neonates who weighed 1500 grams or less at birth, had a gestational age of 26-34 weeks at birth, were medically stable at the time of the study, and were not more than 14 days old were identified by the unit research nurse. The exclusion of mothers by age and/or with other children assured sample stability by limiting life experiences.

The maternal sample of primiparous mothers (N = 12) had a mean age of 26.2 years with 12+ years of education. In addition, 75% were married, no mother reported to have smoked, used alcohol, or any other substances during this pregnancy, and all mothers had at least five prenatal visits. The majority of the sample (68.3%) was Caucasian with 33.3% African American and 16.6% Asian American. The preterm infant sample (N = 12) had a mean gestational age of 28.3 weeks, weighed, on average, 1,172 grams at the time of the study, and were not more than 14 days of age. Nine infants were on ventilator support during the study; all infants were fed maternal breast milk via feeding tubes during the study.

### 2.3 Instruments

All expressed maternal breast milk was dated and timed by the mothers over the 4-day study enrollment. A single research assistant weighed all pumped milk in grams on a Navigator scale that digitally read to the hundredths of a measure. The scale was factory calibrated to all specifications of the United States National Bureau of Standards. Internal electrical calibration assured accuracy of measure to $\pm$ 0.1 grams.

All expressed milk was tested for caloric composition using a Creamatocrit Plus centrifuge. The Creamatocrit technique has been widely published in research and is especially useful to test breast milk lipid concentration and caloric density in mothers' milk.[14] The digital mechanism for measuring the lipid content and caloric concentration is internal; a software program converts findings to clinical application. The correlation between Creamatocrit Plus readings and actual lipid concentrations ($r = .95$) and caloric density ($r = .94$) has been shown to have high linear correlations.[15]

Additionally, a demographic survey was completed at study

enrollment to measure individual differences relating to pregnancy, birth, and socioeconomic status, along with potential intervening variables of medication, equipment, and environmental differences.

### 2.4 Procedure

After obtaining a signed informed consent from the infants' mother, a 4-day study schedule was set with the mother. Subjects were randomized to holding conditions by time and order of days to determine skin-to-skin holding effect on the expressed breast milk. Mothers were asked to maintain their own individual, regular pumping schedule over the study period. Each mother skin-to-skin held her infant for an hour in the NICU (holding condition) or did not hold her infant, but was present visiting the unit and observing her infant (non holding condition). Within 30 minutes after the holding or non-holding intervention, mothers expressed their breast milk by pumping for the dependent study measure. Each mother completed at least two skin-to-skin holding experiences over the study period. A single research assistant measured in grams, tested the composition, and recorded all expressed maternal breast milk during the study enrollment period on site in the NICU. Each measurement was recorded as an individual entry in a spreadsheet for ease of data entry and analysis purposes.

### 2.5 Data analysis

Data analysis was conducted to describe the sample, determine the relationship between holding and non-holding variables, and to test the hypotheses. The dependent variable of the study, maternal response measured in caloric composition of breast milk per pumping, was aggregated and then analyzed for each condition, skin-to-skin holding or non-holding and skin-to-skin holding and holding the dressed infant. The means across each treatment condition were then calculated. The hypothesis of this repeated measures design was tested using a mixed effect model with the level of significance set at $\alpha$ = .05.

## 3. RESULTS

Four sequential days of pumped breast milk data for holding (skin-to-skin and dressed infant) and non-holding conditions was collected from each mother (N = 12). The within subjects skin-to-skin holding was completed at a consistent time of day for each individual mother. The between subject time of day for holding was random, ranging from 900 to 2,100, and determined by the individual mother and the mother's usual schedule in the NICU. All mothers maintained a consistent pumping schedule throughout the study period, although some pumped at more frequent intervals than others. Because of this difference, all pumped breast milk was then compared between the non-holding, holding and interacting with the dressed infant, and the skin-to-skin holding conditions for each individual mother to serve as the within subjects control.

### 3.1 Volume immediately after skin-to-skin hold

Breast milk volumes varied widely by time of day for every mother in this study, yet all with one exception expressed larger volumes after skin-to-skin holding experiences. Mean breast milk volumes for the skin-to-skin holding condition were 99.0 ml as compared to 73.2 ml for the non-holding condition. Although the skin-to-skin holding intervention demonstrated a significant difference in breast milk volumes over the non-holding condition, this was a finding that was unanticipated with this small sample size. Figure 1 demonstrates the expressed breast milk volume variation in milliliters for the non-holding and skin-to-skin holding conditions when controlled for time of day. Anecdotal notes of experiences by nurses at the bedside during the holding times did not disclose variations of environment, changes in physiologic stability of the infants, or nearby emergent events that would have negatively influenced the maternal experiences.

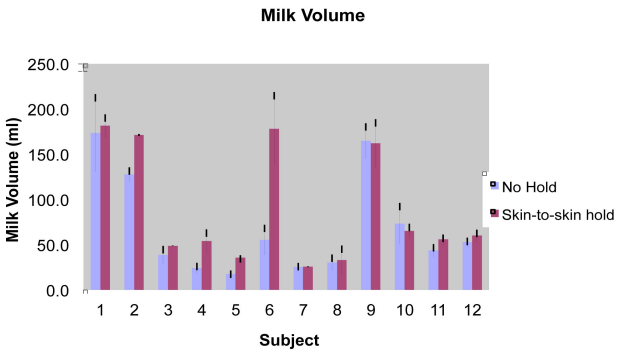


**Figure 1.** Mean expressed breast milk volume in milliliters by subject for non-holding and skin-to-skin holding conditions with control for time of day

### 3.2 Testing the hypothesis

The hypothesis of this repeated measures design was tested using a mixed effect model with the level of significance set at $\alpha$ = .05. A mixed effect model was selected to test for carry-over and order effects from the holding conditions while testing the hypothesis. With this model, skin-to-skin holding effects beyond the initial pumping were tested as well as the differences between the holding times of day in this study. The mixed effect model with log of milk composition in calories per milliliter being predicted by skin-to-skin holding condition and time of day indicated a statistically significant difference between holding conditions, thus supporting the hypothesis ($p < .000$). Moreover, the statistical anal-

ysis provides evidence that skin-to-skin holding increases expressed breast milk calorie composition ($p < .000$).

Although there were significant differences in composition as measured as caloric density of maternal breast milk between the holding and non-holding groups of mothers, every mother produced breast milk with higher caloric composition following skin-to-skin holding their infants. Figure 2 demonstrates the breast milk caloric composition for holding and non-holding conditions for every subject. Moreover, the composition data was consistent between subjects with a standard error = 0.003 for the skin-to-skin holding condition and 0.124 for the non-holding condition. This mixed effect model used to predict milk composition indicated a statistically significant difference between holding conditions, thus supporting the hypothesis ($p < .000$).

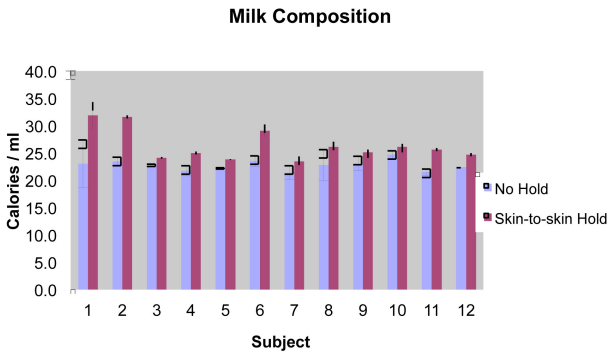


**Figure 2.** Mean expressed breast milk composition in calories per milliliter by subject for non-holding and skin-to-skin holding conditions with control for time of day

## 4. Discussion and Conclusion

The results of this study are encouraging in that breast milk volumes pumped after skin-to-skin holding increased after every hold for every mother participating in the study with one exception and, more importantly, the caloric composition increased after skin-to-skin holding for every mother. These findings are consistent with clinical reports of NICU nurses who relate skin-to-skin holding to letdown experiences for mothers less than three weeks post-delivery. In these reports, nurses have encouraged mothers to pump following holding and have found that even mothers with limited milk supplies pump greater than normal quantities after holding their infants. It is thought that skin-to-skin holding may enhance let-down through heat transfer between the mother and infant and/or by reducing maternal stress.[11,12] This pilot study was designed based on these reports and observational data obtained by this investigator while working as a NICU staff nurse.

Further examination of the results of skin-to-skin holding intervention on breast milk volumes and calories when compared to non-holding conditions in a graph yields a clinical picture for all who provide care for mothers in the NICU. Figures 1 and 2 provide graphic representation the findings of changes in breast milk volumes and composition with the skin-to-skin holding intervention when compared to the non-holding experiences of the lactating mother. Again, this is clinically significant in the NICU where every calorie contributes to growth, development, and early discharge.

These findings are supported in the review literature as well as in data synthesis studies. Ahmed and Sands examined 310 studies of breastfeeding outcomes including duration, exclusivity, maternal satisfaction, and weight gain among preterm infants. The results found that peer counseling and skin-to-skin holding, when paired with post-discharge lactation support, improved breastfeeding outcomes over time.[16] These investigators further clarified that early literature discussed the theoretical contributions of skin-to-skin holding to breastfeeding and that further study was indicated.

Although the results of this study demonstrated a significant difference in the caloric composition of maternal breast milk pumped after skin-to-skin holding premature infants as compared to maternal breast milk pumped after non-holding conditions ($p < .0000$), there were difficulties in the design and implementation of this study. It should be noted that while enrolling mothers into this study was relatively easy, many of the mothers had some difficulty pumping to a regular schedule for the entire study enrollment of four consecutive days and dropped from enrollment. Moreover, clinical control for the skin-to-skin holding condition was complicated by infant assessment of readiness for holding and overall unit activity. Not all study infants could be held at the same time on two separate days of the study. These factors need further consideration in replication of this study.

### 4.1 Significance of study

Over the last twenty years, skin-to-skin holding has been increasingly adopted as part of nursing practice in NICU's across the United States. Although there is a plethora of research that examines the positive physiologic effects on infants, few studies examine skin-to-skin holding from a maternal perspective. Results of this study serve to increase the understanding of the multifaceted advantages of skin-to-skin holding for infant developmental outcome and maternal lactation success. In addition, these results suggest there may be other differences in maternal breast milk pumped following skin-to-skin holding. Future studies should look further into the effects of skin-to-skin holding on milk composition whereas calories should be further analyzed by fat, protein, and carbohydrate compositions.

### 4.2 Limitations

The primary limitation of this study is the sample size. This pilot sample is representative of the unit, hospital, and geographic location and, although these findings may not be generalizable to other NICU populations without additional research, the data adds to the literature on benefits of skin-to-skin holding. In addition, the 4-day design with planned holding events was another limitation in this complex, intensive care environment. Stability of the enrolled premature infant and/or stability in the caregiving environment interfered with the methodology.

### 4.3 Implications to practice

Despite the limitations, the findings from this study add to the body of literature on the skin-to-skin holding experience in the NICU. There are several important implications to nursing practice and lactation that emerge from this research evidence. If skin-to-skin holding improves breast milk by increasing the calories per milliliter for mothers in the NICU, premature infant development can benefit with improved lactation and neurodevelopmental outcome. In a recent review of the literature, there are reports that the longer duration of breast milk feedings has positive effects on cognitive development of the preterm infants and that maternal breast milk for at least the first two months correlates to optimal brain growth. The effect of skin-to-skin holding on maintaining lactation success in the NICU is in itself perhaps the most important implication to neonatal nursing practice. Moreover, it appears that skin-to-skin holding experiences support maternal role definition with active mothering in the NICU while aiding maternal confidence development.

## CONFLICTS OF INTEREST DISCLOSURE

The author declares that there is no conflict of interest statement.

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