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Biophysiologic and Social Stress Relationships with Breast Milk Feeding Pre and Post Discharge from the Neonatal Intensive Care Unit

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Abstract

Objective—To determine influences on incidence of breast milk feeding (BMF) at time of discharge and 6 months later among infants cared for in the neonatal intensive care unit (NICU).

Design—A 2-year prospective descriptive NICU hospital-based cohort design.

Setting—Academic Center Level III–IV NICU.

Participants—Five hundred and thirty-five infants cared for in NICU and a subgroup of one hundred twenty-nine participant mothers who answered questionnaires.

Methods—Pre-discharge data were collected using maternal and infant medical records. Post discharge data were collected from maternal questionnaires.

Results—At NICU discharge, biophysiologic stressors predictive of not receiving BMF included birth weight < 1500 grams ($p < 0.035$), heart surgery ($p = 0.014$), and inhaled nitric oxide treatment ($p = .002$). Teenage mothers were less likely to BMF ($p = 0.022$). After discharge, BMF duration correlated with BMF duration of a prior infant ($p < 0.009$). Most mothers reported BMF > 4 months, 91% continued pumping, and 89% indicated an interest in a hospital support group. Logistic regression analysis ($R^2 0.45$) identified factors that significantly increased the likelihood of BMF > 4 months: BMF plan ($p < 0.001$), convenience ($p = 0.018$), and family as resource ($p = 0.025$). Negative associations were: awareness of immune benefits ($p = 0.025$), return to work ($p = 0.002$), and infants requiring surgical ligation of the patent ductus arteriosus ($p = 0.019$).

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Disclosure

The authors report no conflict of interest or relevant financial relationships.

Conclusions—Social and medical stressors contribute to BMF duration pre and post NICU discharge. We speculate that active NICU BMF support targeting vulnerable infants and their families and assisting with plans for BMF pre and post discharge will help overcome barriers.

Keywords

NICU; breastfeeding duration; biophysiologic stress; social stress; neonates

The need for breast milk feeding (BMF) as the norm for nutrition for all infants, including those who require admission to the neonatal intensive care unit (NICU), is well-documented. More attention has been focused over the past decade on improving the quality of all newborn diets through optimal nutritional management from the start. The American Academy of Pediatrics (AAP) (2004, 2005) demonstrated its unwavering advocacy of BMF in a policy statement recommending it as the optimal form of infant nutrition for healthy, premature and at-risk infants in the NICU barring any specific contraindication.

Breast milk is one of the most crucial physiologic benefits a mother can supply her sick newborn. The majority of research has focused on the trends in breastfeeding in the normal newborn population. While BMF beyond 4 months of age (BMF > 4 months) is a national priority, many barriers exist that are unique to infants cared for in the NICU. These critically ill infants may receive breast milk that is pumped and given via bottle, tube feedings, by breastfeeding, or a combination of these methods. Earlier literature reviews discussed how breastfeeding provides psychoneuroimmunologic benefits to preterm infants, yet questioned why the incidence and duration of receiving breast milk in this population did not match that of full-term infants (Callen, Pinelli, Zukowsky, & Greenspan, 2005). While Callen et al. and others reported that differences in preterm infants in NICU are likely related to problems establishing and maintaining a milk supply and transitioning from gavage feeding to breastfeeding, they overlooked the fact that full term infants in NICU also struggle with these same issues. Although breast milk provides natural protein, fats and immuno-protective properties for neonates, the initial breastfeeding experience is often disrupted by essential medical interventions, making BMF challenging for mothers of sick infants (Lauwers & Shinkskie, 2000).

In order to identify and address common issues with all infants in NICU, researchers must examine NICU breastfeeding experiences longitudinally. In that way, researchers and clinicians can better understand the barriers to providing breast milk at various time periods and to begin implementing appropriate strategies to decrease potential barriers at the time of NICU admission or as soon after. Research that examines NICU healthcare practices and outcomes related to the provision of BMF can add to the body of science in this area to further promote optimal health and development of this vulnerable population. However, no research had been conducted to evaluate the incidence of BMF at time of NICU discharge or maternal perceptions of BMF barriers and benefits beyond NICU discharge. Therefore, we asked the following research questions: 1) What perinatal factors are associated with BMF versus formula feeding at time of NICU discharge at our institution? 2) Who were the mothers' primary sources of information on BMF? 3) What BMF support did mothers need and recommend? 4) What do mothers of NICU infants identify as benefits and barriers to continuing BMF post discharge? This study was undertaken to identify perinatal and biophysiological stress factors as well as maternal opinions of influences on BMF duration.

Methods

This longitudinal exploratory study was designed to prospectively describe medical and social factors that may be associated with infant receipt of BMF at NICU discharge and to

examine maternal perceptions of the barriers, benefits and duration of BMF after these infants reach 6 months of age. Internal Review Board approval was obtained from the Office of Protection of Research Subjects for the conduct of this NICU hospital-based study.

Setting

This study was conducted at two academic affiliated NICUs between December 2005 and January 2007. One NICU was a level III and the other a level IV. Parent education and evidence-based BMF guidelines for newborns in these NICUs and nurseries were examined and promoted by a group of nurses two years prior to the study. A shared designated lactation specialist was available part-time (20 hours per week) during the data collection period for the level IV NICU and the nursery.

Sample

NICU sample—All infants admitted to the two institutional NICUs and all live infants discharged from these NICUs during the study period were included. There were no exclusion criteria. During the study period, there were 605 infants admitted to these NICUs. Maternal and infant medical and background data including type of feeding (partial or exclusive BMF or formula) were available on 535 families. The maternal age for the NICU sample overall ranged from 14 to 45 years with an average of 29.8 years ($SD \pm 6.7$), 53% were identified as advanced maternal age. Pregnancy induced hypertension was reported in 12.7 %. Prenatal care was identified in 90%. Ethnic breakdown was noted to be Hispanic 56% and non-Hispanic 44% and races were as follows: Caucasian 64%, African American 8%, Asian-Pacific Islander 12%, Native American 5%, Other 9%, and missing 2%. Infant background demographics included congenital birth defects (40%), chronic lung disease (12%), mortality (9%), necrotizing enterocolitis (5%), patent ductus arteriosus (25%), seizures (9%), ventilation > 4 hours (46%), any surgery (33%), cardiac surgery (7%), length of stay > 7 days (62%), low birth weight < 1500 grams (42%), infants of diabetic mothers (17%), cesarean births (52%) and transferred in from another hospital (39%).

Subgroup post-NICU maternal survey—All mothers of infants in the NICU who were able to read English or Spanish and who were identified in the NICU clinical research database as providing partial or exclusive breast milk feeding (NICU-BMF) to their infants at time of discharge were considered eligible. Of the total 605 infants admitted to NICU, 347 (57%) were identified who went home on some form of BMF. We targeted this subgroup of mothers who were providing breast milk to their infants to receive the survey by mail near the time the child reached 6 months of age (adjusted for prematurity as needed).

Protocols/Procedures

Medical record data abstraction of background characteristics prior to NICU hospital discharge was obtained by two trained neonatal nurse data analysts with well-established inter-rater reliability. These data were checked weekly by data entry personnel and monthly by the director of the institutional clinical research database center. Data were entered into a California statewide data base and also into our institutional administrative NICU clinical data base. Waiver of consent was granted by the IRB for access to data from the clinical database. Data obtained at time of NICU discharge included infant feeding type at discharge (i.e. partial BMF, exclusive BMF, or Formula only), history of perinatal diagnoses, maternal age and race. NICU infant background data included birth and discharge weights, gestational age at birth, perinatal and neonatal medical history, Neurobiologic Risk Score, and length of NICU stay.

Additionally, we examined post NICU discharge data on a subset of this population that was identified as receiving BMF at time of NICU discharge. The post NICU subset included

those infants whose mothers responded to the mailed Newborn Nutrition Survey of Mother's perceptions of BMF support, barriers and benefits, and infant age and weight at the time the mother filled in the survey. The surveys were mailed when infants reached approximately 6 months of age (adjusted for prematurity as needed). Surveys were mailed a second time for surveys that were not returned within two months. Trained research assistants mailed the surveys along with a self-addressed stamped envelope and \$1 dollar gratuity to the family's address identified in the electronic medical records.

Measures

The Neurobiologic Risk Score (NBRS) is a well developed tool that sums degree of severity of illnesses (e.g., intraventricular hemorrhage, ventilation, hypoxia, hypoglycemia and sepsis) during the NICU stay. The NBRS has good reliability and validity with scores greater than 5 being predictive of neuromorbidity (Brazy, Eckerman, Oehler, Goldstein, & O'Rand, 1991; Lefebvre, Gregoire, Dubois, & Glorieux, 1998).

Post NICU discharge, the Newborn Nutrition Survey of Mothers' perceptions was used to identify and describe BMF information. The single-page survey included fifteen multiple choice items with a Likert scale for responses about BMF and followed by three open-ended questions: 1) Can you identify any other barriers to breast milk feeding for you and your baby? 2) Can you identify any other benefits with breast milk feeding for you and your baby? 3) Can you write any suggestions for improving support of breast milk feeding for new mothers? The tool was peer-reviewed for content by one dozen NICU nurses and two lactation consultants. It was designed with one side in English and the other side in Spanish. It was pre-tested with a dozen bilingual mothers for clarity of content in both English and Spanish.

Analysis

A power analysis indicated that at least 100 participants were needed to achieve statistical significance using an alpha of 0.05 and a beta of 0.2. Data were analyzed with SAS 8.02 (1999–2001) and STATA 8 (2003). Mantel-Haenszel odds ratios and logistic regression models with goodness of fit were used to analyze dichotomized perinatal factors to determine any potential associations with BMF versus Formula feeding at time of NICU discharge. The data were first examined using descriptive statistics to identify frequency and percentages for the NICU background characteristics and for the post NICU survey of maternal responses to the study questions such as the following: 1) Who were the mothers' primary sources of information on BMF? 2) What BMF support did mothers need and recommended? 3) What do mothers of NICU infants identify as benefits and barriers to continuing BMF post discharge? Chi-squared tests were used to examine any potential linear associations between maternal responses and duration of current breastfeeding their infants.

Results

Maternal Characteristics and Feedings of Babies at Time of NICU Discharge

Statistically significant differences in maternal characteristics were noted at time of discharge between the formula fed and the NICU-BMF groups with several perinatal factors, including advanced maternal age > 35 years, prenatal care, outborn status, preterm birth at < 29 weeks gestation, and Hispanic ethnicity. No significant differences were noted between other variables of interest including Cesarean section, maternal hypertension, multiple birth, and intrauterine growth retardation. These findings are displayed on Table 1. More than 71% of inborn infants were discharged on some BMF. NICU-BMF infants were twice as likely to have mothers over 30 years of age ($p = 0.03$, OR 2.01) and with any prenatal care prior to delivery ($p = 0.02$). Of those mothers providing some BMF at time of discharge, Hispanic

and non-Hispanic Caucasian mothers were more likely to exclusively BMF while Asians and Blacks were more likely to supplement BMF with formula ($p=0.003$).

Infant Characteristics and Feedings of Babies Discharging from NICU

No significant differences were found between infant gender, high frequency ventilation, pneumothorax, or delivery room resuscitation, higher NBRS and type of feeding at discharge. However, significant differences were noted between receipt of formula versus BMF at NICU discharge and several interventional and biophysiological stressors listed in Table 2. NICU infants who were more likely to be discharged on formula included those with history of the following: 5 minute Apgar < 5, birth weight <1500 grams, seizures, birth defects or complications such as necrotizing enterocolitis, patent ductus arterious, retinopathy of prematurity, intraventricular hemorrhage, chronic lung disease or those treated with postnatal steroids, surgery, or ECMO.

Table 3 displays the results of logistic regression analyses of infants discharged on any BMF or no BMF and associated biophysiologic factors. Infants with early group B sepsis were five times as likely to be discharged on BMF ($p= 0.027$). Infants who were less likely to be discharged on NICU-BMF included those infants who were born to a teen mother ($p= 0.022$), weighed < 1500 grams at birth ($p<0.035$), required heart surgery ($p= 0.014$), and/or were treated with inhaled nitric oxide ($p= 0.002$).

Post NICU Discharge Duration of Breast milk Feeding and Maternal Characteristics

The characteristics of the mothers who responded to the survey did not differ significantly from the NICU maternal sample as a whole. Most mothers reported a pre-set BMF plan prior to hospital discharge. The majority of mothers reported they continued to pump milk (91%), required lactation support (52%) and wanted a hospital BMF support group (89%). Nearly half (48%) reported a need for more BMF education. Several reported receiving only anecdotal information. BMF duration, whether shorter or longer, was strongly associated with BMF duration of a prior infant ($\chi^2 20.2$, $p<0.009$).

Responses to Maternal Survey Regarding BMF Duration

We did not identify any significant differences in variables such as maternal age, diagnoses, and/or culture. Mothers who provided BMF > 4 months were nearly four times more likely to have a pre-set plan for duration of BMF and nearly three times more likely to suggest that a BMF support group at the hospital would be helpful ($p=0.05$). The BMF group was also nearly four times more likely to report receiving their information on breastfeeding from family or friends ($p= 0.004$). Only a few indicated that information came from healthcare professionals. Most mothers identified the pediatrician as their source of formula information. Mothers who provided BMF >4 months were nearly five times more likely to note BMF benefits to maternal stress ($p = 0.01$) or infant's stress ($p = 0.02$) but less likely to report benefits to infant immunity ($p = 0.01$).

Logistic Regression of Breast milk Feeding Duration to Beyond Four Months or Not

Mothers who identified that they provided BMF > 4 months were more than twice as likely to also report they had a BMF plan prior to discharge ($p = < 0.001$). They were also nearly four times more likely to report that they found BMF was convenient and that family/friends were a BMF information resource ($p =0.03$). Mothers not recognizing BMF benefits to infant immunity were over twice as likely to not provide BMF > 4 months ($p =0.03$).

Mothers who had infants with biophysiologic stressors of surgical PDA ligation ($p = 0.02$) were less likely to report provision of BMF beyond hospital discharge. Whereas mothers of

infants admitted for hyperbilirubinemia were nearly seven times as likely to report BMF > 4 months ($p = 0.011$). Table 4 displays the logistic regression results ($r^2 = 0.45$, $p < 0.0001$).

Discussion

In this study we focused on exploring factors associated with NICU infants' receipt of BMF at discharge and after reaching 6 months chronologic age. Exclusive BMF at NICU discharge was 63%, which was slightly higher than the California statewide rate reported at 61% among LBW infants (Lee & Gould, 2009). Similar to reports by Lee and Gould (2009), we observed a higher percentage of LBW infants who went home on formula. Infants with complex health issues are often too sick for the mother to hold during the first few hours and days of life. As mothers continue to express milk this delays the transition to direct breastfeeding and can affect milk supply (Smith, Durkin, Hinton, Bellinger, & Kuhn, 2003).

Our results align with prior research that reported low birth weight, low gestational age and admission to NICU were the strongest predictors for infants to not be receiving BMF at time of discharge (Scott, Binns, Graham, & Oddy, 2006). The overall low rate of NICU-BMF among the more complex infants highlights the challenges these infants, their family and the healthcare team face. Inborn and out-born infants are separated from their mothers as a result of admission to the NICU. When infants are transferred from other facilities for a higher level of care for surgical intervention or treatments, breastfeeding support may be lacking at the mother's hospital of origin and transportation issues may create barriers to visiting and bringing pumped milk. Because early and frequent contact with the infant is needed to stimulate and establish adequate milk production, the infant's transfer to another hospital can influence BMF (Powers, Bloom, Peabody, & Clark, 2003). All these challenges may delay or interrupt breast feeding and/or provision of BMF during a critical period. In this study, outborn infants admitted to the NICU were more likely to be discharged home on formula feeds.

Factors that Influence BMF Pre and Post NICU Discharge

Human breast milk naturally adapts to satisfy and meet infant's physiological, psychological, nutritional and immunological needs. However, cultural and socio-economic issues today play a role in a multitude of reasons that influence whether a mother would choose to begin or continue BMF, for example, government programs such as Woman, Infant and Children (WIC) and early return to work (Matusiak, 2005). Recently the U.S Surgeon General (US DHHS, 2011), issued a national call for action to heighten awareness on decreasing factors that impede efforts to BMF (e.g., lack of support at home; absence of experienced family; and lack of information from health care clinicians). Cattaneo and Buzzetti (2001) reported that structured training sessions can increase health professionals' knowledge and exclusive BMF rates at discharge and at 6 months of age. However, cultural influences on the rates of initiation and duration of BMF are reportedly lower among African Americans in particular, and women supported by WIC programs (Colaizy & Morriss, 2008; Gross, 2003; Oliveira, 2003).

In our study, White mothers were more likely to exclusively BMF than Asian and Black mothers. However, Hispanic infants were more likely to be discharged from NICU on formula feeds. This is contrary to reports of BMF initiation rates that are high among Hispanics living in the United States (Gill, 2009). In our clinical experience, it is not uncommon for Hispanic mothers to initially feed their infants both breast milk and formula. Many Hispanic mothers switch to exclusive BMF once they reach full milk production. It is important to assess whether Spanish speaking families are receiving BMF education via bilingual staff or translators so they receive the same information as English speaking families.

Biophysiologic Stressors that Negatively Influenced Incidence of NICU BMF

Espy and Seens (2003) reported that maternal demographics and perinatal medical condition of the preterm infant are important predictors of NICU-BMF. Similarly, our research identified several biophysiologic stressors that influenced BMF pre discharge. Higher scores on the NBRBS were inversely associated with BMF duration. Mothers who give birth prior to term or who deliver a severely ill infant often have additional stressors that can affect BMF, including establishing milk supply and when the infant is unable to or has difficulty sucking from the breast. It is understandable that some suggest that mothers might intuitively BMF less as a result of fear over their infant's condition and survival. When extremely ill infants enter the NICU, these infants may undergo multiple surgeries and be supported for extensive periods on intravenous fluids rather than enteral feedings. In these circumstances, parents experience a rollercoaster of complicated issues related to infant morbidity and mortality.

As severity of illness increases, concerns about infant survival often supersede BMF issues. Babies with complex conditions are vulnerable to poor health outcomes based upon degree of risk factors and amount of resource availability (Purdy, 2004). Feeley et al. (2011) evaluated relationships between posttraumatic stress disorder (PTSD) symptoms and very low birth weight infant characteristics for 21 mothers at 6 months post NICU discharge. They found nearly a quarter of mothers were in the clinical PTSD range, that NICU infant severity of illness was related to maternal PTSD symptoms, and greater stress was related to decreased maternal sensitivity and effectiveness at structuring interactions with their infants. Mothers who are seriously stressed due to their infant's illness ultimately need more supportive resources, because the very infants who are the most ill and most stressed need BMF the most for its stress-relieving and immune boosting benefits but instead they are less likely to receive it.

The provision of BMF may be a vital resource for many of these infants. We identified higher percentages of infants on formula than BMF among those who required stressful interventions (e.g., bagging in delivery, extracorporeal membrane oxygenation (ECMO), inhaled nitric oxide, and surgery). Additionally, there were higher percentages of formula fed infants who had a variety of higher biophysiologic stressors, as shown in Table 3.

Maternal Factors and Benefits Associated with Overall Duration of BMF

Mothers whose infants were primarily admitted to NICU for diagnoses of hyperbilirubinemia were more likely to provide BMF beyond 4 months of age. Based upon recommendations from a large study examining newborn hyperbilirubinemia conducted by Chou and colleagues (2003), if the infant is feeding poorly, fluid intake should be monitored closely, breastfeeding continued with supplementation with formula, and phototherapy utilized as needed. The mothers of late preterm infants admitted for short stays in the NICU for hyperbilirubinemia may find that breastfeeding is more likely to be encouraged than the mothers of critically ill infants who are born at very low birth weight or any infant born with congenital heart defects or requiring nitric oxide or more invasive interventions.

Unlike some researchers, we found the maternal BMF plan, recognition of the convenience, and prior experience were significantly associated with duration of BMF. Furman, Minich, and Hack (2002) found that 73% of mothers they surveyed intended to provide BMF, but only 16% supplied any BMF to their infants at 4 months of age. Most mothers in our study continued to pump milk. Smith and colleagues (2003) reported that among mothers providing breast milk through pumping, the rate of infants actually progressing to direct breastfeeding during hospitalization or after NICU discharge was less than 50% for term infants and only 27% for low birth weight preterm infants.

More than half of mothers surveyed needed lactation support and wanted a hospital BMF support group. One of the goals of Healthy People 2010 was to increase BMF at 6 months of age from 16% to 50%, but even in 2007 Bonuck warned that BMF remained a challenge for many mothers during that time period. One of the current breastfeeding goals for Healthy People 2020 is increase the percentage of infants who are breastfed at six months to 60.6% (United States Breastfeeding Committee, 2011). The tenth step of the Baby Friendly Hospital Initiative (2011) is to foster establishment of BMF support groups and referral to support on hospital discharge.

Post NICU Maternal Perceptions of Barriers Associated with Duration of BMF

We identified that a lack of family BMF support was significantly associated with lower BMF duration. The majority of mothers surveyed reported they received information about BMF from family and friends. Family and friends can be a valuable resource for BMF, as one study reported that teaching fathers how to manage the most common lactation difficulties was associated with higher rates of exclusive BMF at 6 months (Pisacane, Continisio, Aldinucci, D'Amora, & Continisio, 2005).

Surprisingly, few mothers in our study cited healthcare professionals as a source of BMF support. In contrast, most mothers reported that pediatricians were their source of formula information. One study surveyed mothers of healthy newborns at 12 weeks post nursery discharge and found only 53% were exclusively BMF and there were strong associations with health care providers recommending formula (Taveras et al., 2004).

Post NICU Maternal Perceptions of BMF Benefits for Infant Immunity

Ip et al. (2007) conducted a systematic review on maternal or infant breastfeeding outcomes in developed countries. Their literature search identified 43 primary studies on infant health outcomes, 43 primary studies on maternal health outcomes, and 29 systematic reviews or meta-analyses covering nearly 400 individual studies. They found BMF benefited term and preterm infant health, growth, immunity, and development. On the contrary, maternal recognition of these BMF benefits of infant immune status did not influence the duration of mothers' BMF decisions. Mothers who provided BMF < 4 months and who reported benefits to infant immunity may have had other competing issues that led to discontinuation of BMF earlier in spite of this awareness. Mothers may know about benefits to early infant immunity and not be educated about benefits to immunity in later infancy.

Post NICU Maternal Perceptions of BMF Benefits for Maternal and Infant Stress

Provision of BMF > 4 months and maternal recognition of BMF benefits to maternal stress and infant stress were interesting. Mothers who perceived their stress levels and those of their infants to be lower as a result of BMF provided BMF longer. Liu and colleagues (1997) reported that women who breastfed produced less stress hormone (cortisol) than those who bottle-fed and that the maternal closeness provided decreased risk for elevated cortisol levels. Maternal stress impacts infant cortisol, immunity and mechanisms influencing long term behavioral development (Coe & Lubach, 2005; Lundy et al., 1999; McCormick, Kehoe, Mallinson, Cecchi, & Frye, 2005; Owen, Andrews, & Matthews, 2005). Strong evidence suggests that BMF plays a role in affecting an infant's health and in maternal-infant bonding. It is likely that as mothers feel more successful at bonding with their infant, their stress levels drop. However, there is a paucity of research specifically investigating maternal stress and decisions to initiate and/or continue breastfeeding in infants cared for in NICU. Perhaps parent education focusing on the potential stress-relieving aspects for mother and infant would offer another avenue in promoting longer BMF duration.

Limitations

This study conducted across only two NICUs cannot be generalized across all NICUs. Due to the limited sample size these findings cannot be generalized beyond this study population. Although thirty-seven percent is not atypical for a survey response rate, selection bias cannot be ruled out based upon the fact this was a convenience sample and the low response may include more mothers who chose to participate because they breastfed longer. There may be potential bias due to non-response as a result of limited examination of potential variable differences between the respondents and non-respondents. We did not assess whether mothers received support from WIC programs or the influence of socio-economic status on BMF trends.

Clinical Implications

A primary goal of the study was to translate the research findings into practice and promote BMF for all infants. To overcome the clinical barriers identified in our study, internal dissemination of these findings in our NICU heightened awareness and revived the enthusiasm for BMF quality improvement. The research team enlisted medical, nursing and institutional leadership support to seek grant funding from the Birth and Beyond California (BBC) Training and Quality Improvement Project. Whether infants are inborn, outborn, sick, or healthy, adequate support of BMF during NICU hospitalization requires ongoing multi-disciplinary coordination of care, consistency and continuity for vulnerable infants and their extended families. It takes a team of professional change champions in the hospital and the community to support families who choose to provide BMF and to help establish BMF plans individualized to each infant.

Several clinically relevant findings were noted in this study. One finding was the need to highlight BMF benefits to mothers' and infants' stress, infant immunity and development, and incorporate this into bedside teaching. Another finding was that hospital based BMF support groups are welcomed and needed by families. Support groups that include trained neonatal nurses, discharge planners, social workers, and lactation consultants may enhance opportunities to identify nutrition choices, discuss benefits and challenges to BMF and help families set and meet long term plans. A third finding was the need to improve collaborative efforts to support BMF between hospital transfers. Discharge planners, bedside nurses, and physicians can play key roles in facilitating BMF support for patients transferred to and from outside hospitals by inquiring about BMF support for the mother at the other institution and plans for the safe transport of stored frozen milk if available. Discharge summaries should include written documentation of whether an infant is on BMF, the estimated amount, whether it is supplemented or calorie augmented, and the family's plan including follow-up with recommended referrals to the local community support groups.

Conclusion

The relationships identified in our study suggest that sicker infants and out-born infants were less likely to leave NICU on any BMFs. BMF duration tended to be linked to having a preset BMF plan, family support and awareness of BMF benefits for maternal and infant stress. We speculate that NICU interventions that increase awareness of these links between pre-set plans, family support, and maternal and infant stress may increase BMF duration post NICU discharge. These findings shed light on areas for future research and clinical practice initiatives that strive to improve BMF support for infants requiring NICU care. More research is needed to examine the significance of relationships between provision of breast milk feeds versus breastfeeding as well as associations with biophysiologic and emotional stress, immunity and child behavioral outcomes of this vulnerable population.

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Comparison of Maternal Characteristics Between Infants Receiving Formula Versus Any Human Breast Milk Feeds (BMF) at NICU Discharge (N =534)

Table 1

Maternal Characteristic	Sample Size of Mothers with Identified Characteristic	Formula		Any BMF		P value
		N	%	N	%	
Advanced Maternal Age *	(N = 286)	95	33	191	67	0.03 **
Teen Maternal Age	(N = 67)	45	67	22	33	< 0.0001 **
Transferred In - Not Inborn	(N = 217)	128	59	89	41	< 0.0001 **
Delivery 29 wks Post Conceptual Age	(N = 85)	49	58	36	42	< 0.0001 **
Hispanic	(N = 206)	88	43	118	57	0.04 **
PROM	(N = 92)	43	47	49	53	0.04 **
Chorioamnionitis (%)	(N = 34)	9	26	25	74	0.17
Prenatal Care (%)	(N = 472)	160	34	312	66	0.02 **
Cesarean	(N = 278)	109	39	169	61	0.46
Maternal Hypertension	(N = 66)	25	38	41	62	0.93
Multiple Births	(N = 68)	22	32	46	68	0.33
Intrauterine Growth Retardation	(N = 27)	11	41	16	59	0.71

Note. NICU = neonatal intensive care unit. PROM = premature rupture of membranes greater than 24 hours prior to time of delivery.

* = maternal age greater than 35 years at time of delivery of infant.

** =statistically significant at p value <.05.

Table 2
Comparison of Infant Biophysiologic Stressors Between Formula and Any Human Milk at Time of NICU Discharge

	Formula		Any BMF		P value
	N	%	N	%	
Bagged in Delivery Room	96	48	91	27	0.002 *
Cardiopulmonary Resuscitation Needed in Delivery Room	33	17	27	8	0.79
5 minute Apgar score <5 (%)	12	6	8	2	0.03 *
Low Birth Weight < 1500 grams	109	55	116	35	<0.0001 *
Hypoxic Ischemic Encephalopathy	7	4	3	1	0.01 *
Male (%)	183	52	104	56	0.58
Early Group B Strep	9	6	6	2	0.01 *
Inhaled Nitric Oxide	36	18	21	6	<0.0001 *
High Frequency Ventilation	66	33	31	10	0.17
Pneumothorax	20	10	18	5	0.12
CLD	26	18	28	8	0.001 *
Extracorporeal Membrane Oxygenation	8	4	3	1	0.02 *
Postnatal Steroids	30	15	19	6	0.003 *
ROP (%)	14	8	11	4	0.04 *
Patent Ductus Arteriosus	69	35	66	20	0.0004 *
NEC	15	8	6	2	0.003 *
IVH	45	22	27	8	0.001 *
Seizure	23	12	21	7	0.03 *
Any Birth Defect	104	52	110	33	<0.0001 *
Any Surgery	87	44	87	27	<0.0001 *
Late Sepsis	38	19	23	4	0.002 *
Length of Stay 3weeks	71	36	83	25	0.009 *

Note: NICU = neonatal intensive care unit. IVH = intraventricular hemorrhage. ROP = retinopathy of prematurity. NEC = necrotizing enterocolitis. CLD = chronic lung disease coded by greater than 28 days on oxygen.

* = statistically significant at p value <.05.

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Table 3

NICU Infant Predictors and Biophysiologic Stressors Associated with Breast Milk Feeding (BMF) at NICU Discharge

Model Predictors	Log-Odds Ratio (β)	Odds Ratios	(95% CI) Any NICU BMF at Discharge	P-value
Predictors At Time of Birth				
Teenage Mother	-1.74	0.18	0.08–0.37	0.00 [*]
Caesarean	-0.59	0.55	0.33–0.92	0.02 [*]
Inborn	0.99	2.55	1.66–3.91	0.000 [*]
Born at Low Birth Weight	-0.53	0.59	0.36–0.96	0.035 [*]
Endotracheal Tube at Delivery	-0.89	0.41	0.23–0.73	0.003 [*]
Biophysiologic Stressors				
Early Group B Strep Sepsis	1.68	5.35	1.21–23.70	0.03 [*]
Cardiac Surgery	-1.06	0.35	0.15–0.81	0.014 [*]
Inhaled Nitric Oxide	-1.16	0.31	0.15–0.64	0.002 [*]

Note. NICU = neonatal intensive care unit.

^{*} = statistically significant at p value <.05.

[†] = Logistic Regression Model Pseudo R-squared 0.19 (p<.0001).

Table 4

Results of Logistic Regression Analysis Model For Factors Associated with Breast Milk Feedings (BMF) Beyond 4 Months of Age

Model Predictors	Log-Odds Ratio (β)	Odds Ratios	(95% CI) BMF > 4 months	P-value
Maternal Reported Support				
Maternal Breastfeeding Plan	.96	2.59	(1.7–3.82)	<0.001 [*]
Family & Friends BMF Resource	1.32	3.78	(1.19–12.0)	0.025 [*]
Maternal Reported Barriers				
Barrier Return to Work	2.12	8.39	(2.0–35.1)	0.004 [*]
Barrier Baby Frustration	–1.44	–0.24	(0.57–0.99)	0.048 [*]
Maternal Reported Benefits				
BMF Convenient	1.42	4.15	(1.28–13.42)	0.018 [*]
BMF Beneficial to Immunity	–2.35	–2.24	(0.01–0.75)	0.025 [*]
NICU Biophysiologic Stress				
Patent Ductus Arterious Ligation	–4.86	–0.008	(0.0001–.045)	0.019 [*]
Hyperbilirubinemia	1.90	6.7	(1.53–29.39)	0.011 [*]

Note. NICU = neonatal intensive care unit.

^{*} = statistically significant at p value <.05.

[†] = Logistic Regression Model Pseudo R-squared 0.45 (p<.0001).