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Human and Donor Milk Use Post NICU Discharge

Elaine Ellis, MD, Christine Aune, MD, Mario Fierro, MD, Cathleen Roberts, DO, Mary Allare, MD, Bradlee Drabant, MD, Amy S. Kelleher, MSHS, Christina Sanchez, Cheryl McDuffie, FNP

Abstract:

Background: The health benefits of feeding all infants human milk are well established but the use of human milk after infants are discharged from the Neonatal Intensive Care Unit (NICU) remains low.

Aims: Our aim was to investigate which infants were receiving human milk at discharge from the NICU and at varying times after discharge and to explore factors that foster or inhibit increasing human milk use in NICU graduates.

Methods: We conducted a prospective, observational study and collected data on the use of human milk at hospital discharge and during follow-up visits in five developmental follow-up programs. These follow up programs were in 5 different large cities in 3 different states in the United States.

Results: The overall rate of use of any human milk decreased from 841/1160 (72. 5%) at discharge to 233/791 (29.5%) in participants who were followed for >4 and ≤7 months after birth and this trend continued with later follow-up. In a multivariate logistic analysis, the factors found to be independently associated with the use of human milk at follow-up were: use of human milk at discharge (AOR=39.3, 14-162); White race compared to all other races/ethnicity (AOR= 2.97, 2.1-4.2); being reported preterm at birth (<=32 weeks) compared to more mature gestational age infants (AOR= 2.02, 1.4-2.9); and mother having received a breast pump within 12 hours of the birth of her infant (AOR=1.90, 1.2-3).

Conclusions: Health care practices within the NICU affect the continued use of human milk after infants are discharged from the hospital. These practices could be enhanced to increase human milk usage in NICU graduates.

Short title: Human and Donor Milk Feeding Use Post NICU Discharge

Keywords: Infant, neonate, premature, prematurity, human milk, breastmilk, follow-up

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Abbreviations: AOR - Adjusted Odds Ratio, CQI – Continuous Quality Improvement, IVH – Intraventricular hemorrhage, NICU – Neonatal Intensive Care Unit, ROP – Retinopathy of Prematurity, WIRB – Western Institutional Review Board.

Key Points

1. Human milk use drops dramatically after NICU discharge
2. NICU health care process impacts use of human milk at home
3. Important opportunities exist to improve human milk use

Address correspondence to: Amy S. Kelleher, The MEDNAX Center for Research, Education, Quality and Safety, 1301 Concord Terrace, Sunrise, FL, email: amy_kelleher@mednax.com, 800-243-3839 ext. 5206.

Introduction

Feeding of human milk in the NICU and after discharge is associated with improved outcomes, but rates of human milk provision after infants are discharged from the NICU remain low(1) despite the fact that the American Academy of Pediatrics endorses exclusive breastfeeding for the first 6 months with the recommendation that, ideally, breastfeeding continues for the first year of life. (2) The World Health Organization and UNICEF recommend initiation of breastfeeding within the first hour after birth, exclusive breastfeeding for the first six months, and continued breastfeeding for two years or more, together with safe, nutritionally adequate, age-appropriate, responsive complementary feeding starting in the sixth month. (https://www.who.int/elena/titles/early_breastfeeding/en/). Benefits to low birth weight infants have been demonstrated to include fewer re-hospitalizations, higher Bayley scores and better emotional regulation at 30 months. (3-5) Even though there are established benefits for providing human milk to infants requiring admission for intensive care, mothers face real challenges to accomplish this goal. (6;7)

NICUs have implemented programs to increase the use of human milk, and in some units, as many as 80 percent or more of infants receive at least some human milk at discharge. (8) Various studies have identified early milk expression, lactation support, kangaroo care, and breastfeeding as factors that contribute to increased human milk after NICU discharge. (6;9-14)

A MEDNAX Continuous Quality Improvement survey done in three NICU, follow-up clinic sites found that about 40-50 percent of NICU graduates were still receiving human milk at 1-3 months after discharge. As a result of the MEDNAX CQI survey, we designed a prospective study to investigate further factors influencing the use of human milk at the time of NICU discharge and during follow-up after discharge from the NICU. Our aim was to investigate which infants were receiving human milk, either expressed or breastfed at varying times after discharge, and explore NICU factors that foster or inhibit increasing human milk use in NICU graduates.

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Methods

Design

This is a prospective, observational study from the first follow up visit through 2 years post-discharge to capture information on infants after discharge in a variety of locations to determine factors contributing to longer human milk consumption. We prospectively collected data on a convenience sample of discharged infants seen in 5 developmental follow-up clinics. Our developmental teams participate in discharge planning and had access to the discharge summary of infants enrolled in the study. Participating clinics provided care to high-risk infants discharged from 20 NICUs and referred to a developmental follow-up program. The timing of this first recommended visit varied among sites, as did the timing that the family actually kept the visit. All patients who kept their first visit were included in our follow-up study cohort. Ongoing follow-up visit timing was individualized to the needs of each infant.

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Our study was a part of our ongoing quality improvement efforts, and signed consent and authorization forms were waived by the Western Institutional Review Board (WIRB). The WIRB required that an information sheet about our study be provided to the parents of each child seen in follow-up because we were prospectively collecting data and asking study specific questions. The information sheet was used to discuss our research efforts with the parent regarding the collection of routine care information on their child during follow-up. If the parent declined our request to collect prospective data, their child was not enrolled in the study.

Sample

Follow-up of infants after hospital discharge from the NICU is the standard of care. The NICUs included in this study are in 5 different metroplex locations in three different states. The majority of study participants were receiving Medicaid insurance. After discharge, office visits were coordinated by the developmental team and took place at individualized intervals at each site for up to two years corrected age. As the timing of visits was variable, we included ranges of follow up times as data points (Discharge; >1 and <=4 months; >4 and <=7 months; >7 and <=10 months; and >10 and <=13 months)

Measurement

Our primary outcome measure was family reported use of any human milk at NICU discharge and at specific time points after discharge from the hospital. All follow up visits included a discussion with the mother regarding their ability or inability to use human milk for their infant, including the method of feeding, fortification, formulas, and caloric density of all feedings. Our secondary outcomes included growth, readmission to the hospital, and continued use of medications after discharge from the hospital. We collected data on weight, length, and head circumference at each follow-up visit to assess the impact of breast milk use on growth.

Data collection

Participants were enrolled at the time of their first follow up visit by our developmental specialist and their clinical research team. We enrolled infants between September 2015 and June 2017 and entered data into an electronic case report form, which was used for monitoring, reporting, audit trail, and security. To protect our participant's privacy, we assigned a unique study code to each participant, and data was stored in a de-identified electronic database. Our follow up clinicians and research coordinators reviewed data from the NICU discharge summary and verified the information with the parents of infants who were enrolled in the study. We included growth parameters, types and route of feedings, presence of Intraventricular Hemorrhage (IVH), Retinopathy of Prematurity (ROP), surgeries, cardiopulmonary status, genetic anomalies, and equipment and medications use at discharge. Information was also collected from families at follow up visits and included: current feedings- human and/or donor milk with or without fortification, bottle or breastfed, for the formula used, type of formula used including caloric density. Families verified data in the discharge summary and provided information on in-hospital care, including timing and frequency of Kangaroo care, the timing of first human milk pumping, and any opportunity to breastfeed in the NICU. Data on medication use, readmissions, surgeries, and Emergency Department/Urgent Care visits were also collected at each follow-up visit.

We recorded growth measurements at each follow-up visit and collected data regarding specific therapies and interventions that each child was utilizing (e.g., speech and physical therapy, state versus private). New medical diagnoses were recorded, and any case positive for cerebral palsy was documented as to type and severity. Clinical Research Associates, independent of the developmental team, monitored each site for adherence to the protocol, data accuracy, and ensured that each site's conduct was in accordance with the International Conference on Harmonization Good Clinical Practice Guidelines and HIPPA Regulations.

Data Analysis

Our primary outcome measure was family reported use of any human milk at NICU discharge and at specific time points after discharge from the hospital. Our analytical approach to these data had two goals. The first was descriptive, and we report the changes over time in the use of human milk in our study cohort. The second was to better understand the factors associated with the use of human milk after discharge from the NICU. All statistical analyses were performed using JMP v. 11 (SAS Institute, Cary, NC). The available literature was reviewed to pinpoint factors associated with the use of human and/or donor milk, and these factors were included in the electronic case report form. We compared infants who received human/donor milk to those who did not receive human/donor milk using bivariate and multivariate analysis. During the bivariate analysis, all of the numeric data (birth weight, estimated gestational age, APGAR score, and length of hospital stay) were evaluated using both parametric (analysis of variance or two-sample *t*-test) and non-parametric tests (Kruskal–Wallis non-parametric test and Mann–Whitney test). When the data were non-parametric, we used the Kruskal–Wallis non- parametric test to make more than two comparisons and the Mann–Whitney test for two-sample comparisons. After bivariate analysis, multivariate logistic regression was used to identify factors independently associated with less human milk use. The model was developed by incorporating the variables that were found to have significant interactions ($P<0.1$) with the use of human milk being analyzed. APGAR score and birthweight were entered into the model as ordinal and continuous data, respectively. Variables were entered into the model using a stepwise selection (P-value for entry $P<0.1$ and $P<0.05$ for retention). Only variables with adjusted odds ratio (*AOR*) 95% CI that did not cross one were considered to have an independent and significant association with the use of human milk. Changes over time were evaluated using the Cochran- Armitage trend test, alpha value 0.05. To evaluate growth, we calculated gestational age and gender-specific z scores at birth, discharge, and follow-up at 4 to 7 months. Before 40 weeks postmenstrual age (PMA) we used the data from Olsen et al. .(15) and after 40 weeks, we used the World Health Organization growth data for comparison. (https://www.cdc.gov/growthcharts/who_charts.htm)

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Results

Study cohort

We enrolled 1160 infants at five high-risk follow-up clinics; these infants had survived to discharge and kept at least one follow up visit. The first patient was enrolled in September of 2015, and the last patient was enrolled in June of 2017. The median gestational age was 33 weeks with a 10-90th percentile of 26 to 38 weeks and the median birth weight was 1830 grams (10-90th percentile was 860- 2988 grams). Eighty-six percent of the infants were preterm, and 48% were female infants (Table 1). The median age at discharge from the hospital was 30 days (10-90th percentile was 9 to 100 days).

Use of human milk at discharge

Of 1160 participants, 841 (72.5%) were being fed at least some human milk at discharge, while eighty (10.1%) participants never received any human milk during hospitalization. The use of human milk at discharge from the hospital was similar for each of the follow-up clinics, with a range of 67 to 76% (Table 1). Factors associated with use of human milk at discharge from the hospital were: more mature gestational age at birth; heavier birth weight; earlier discharge from the hospital; non-Hispanic white (White-Hispanic participants were less likely to be sent home on human milk); any reported use of Kangaroo care (and when it was reported it was used more frequently and started at an earlier age; Table 1); and any reported use of a human milk pump. Participants who were on human milk at discharge and whose mothers received a human milk pump received a pump sooner after birth than those not on human milk at discharge. The use of human milk at discharge increased with increasing gestational age through 36 weeks and then dropped to lower levels for infants of 37-40 weeks gestation (Figure 1). The participants with the highest rate of human milk use at discharge were those born at 33, 34, and 35 weeks (all were above 80%; Figure 1). Infants born between 33, 34, and 35

Figure 1. Percent sent home on human milk feedings by gestational age at birth.

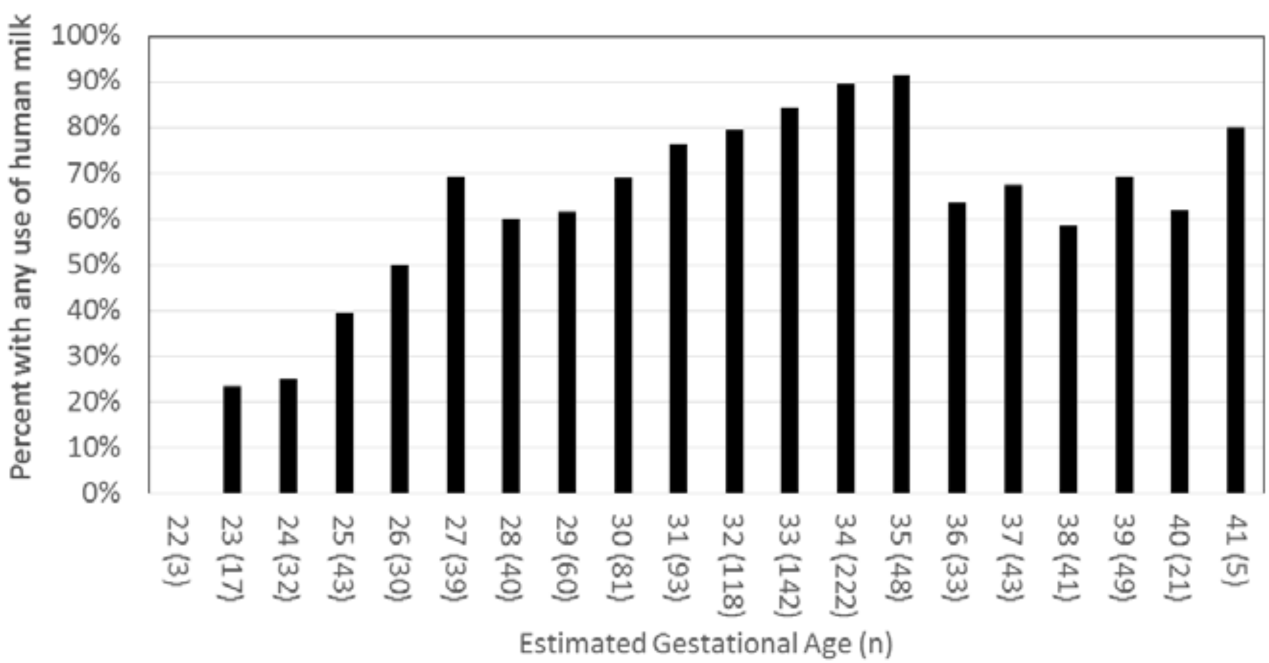


Table 1	Human milk At Discharge		All	p value
	No	**Yes**		
Total Numbers of Patients	319	841	1160	0.725
Gestational Age at Birth, median (10-90th percentile)	31 (24-38)	33 (28-37)	33 (26-37.9)	0.0001
EGA 3 Groups, n (%)				0.0001
<=32 weeks	203 (63.6)	353 (42)	556 (47.9)	
33 to 36	61 (19.1)	384 (45.7)	445 (38.4)	
>=37 weeks	55 (17.2)	104 (12.4)	159 (13.7)	
Birth Weight (grams), median (10-90th percentile)	1500 (664-3145)	1920 (1044-2866)	1830 (860-2988)	0.0001
Age at DC days, median (10-90th percentile)	48 (12-125)	25 (9-73)	30 (9-99.9)	0.0001
Discharge Weight (grams), median (10-90th percentile)	2880 (2177-4342)	2495 (2005-3581)	2583 (2035-3814)	0.0001
Sites, n (%)				0.1806
FTCT	57 (17.9)	142 (16.9)	199 (17.2)	
KID2	76 (23.8)	174 (20.7)	250 (21.6)	
MPDS	21 (6.6)	45 (5.4)	66 (5.7)	
PNSA	132 (41.4)	413 (49.1)	545 (47)	
PPHR	33 (10.3)	67 (8)	100 (8.6)	
Female, n (%)	151 (47.3)	407 (48.4)	558 (48.1)	0.9724
Congenital anomalies, n (%)	69 (21.6)	155 (18.4)	224 (19.3)	0.2434
Race Group, n (%)				0.0001
African American	53 (16.6)	85 (10.1)	138 (11.9)	
Asian	4 (1.3)	32 (3.8)	36 (3.1)	
Black Hispanic	2 (0.6)	17 (2)	19 (1.6)	
Native American	8 (2.5)	11 (1.3)	19 (1.6)	
Other	15 (4.7)	31 (3.7)	46 (4)	
Pacific Islander	1 (0.3)	5 (0.6)	6 (0.5)	
White	84 (26.3)	321 (38.2)	405 (34.9)	0.0001
White Hispanic	152 (47.6)	339 (40.3)	491 (42.3)	0.0335
Breast pump provided, n (%)	217 (68)	827 (98.3)	1044 (90)	0.0001
First able to use a breast pump, n (%)				0.0001
By 6 hours	106 (33.2)	518 (61.6)	624 (53.8)	
By 12 hours	36 (11.3)	116 (13.8)	152 (13.1)	
By 24 hours	29 (9.1)	99 (11.8)	128 (11)	
By 48 hours	22 (6.9)	62 (7.4)	84 (7.2)	
>48 Hours	17 (5.3)	23 (2.7)	40 (3.5)	
Kangaroo care at any time, n (%)	237 (74.3)	740 (88)	977 (84.2)	0.0001
Age at Kangaroo care <48 hours, median (10-90th percentile)	56 (17.6)	340 (40.5)	396 (34.2)	0.0001
Frequency of Kangaroo care almost daily, n (%)	149 (46.7)	603 (71.7)	752 (64.8)	0.0001
Type of human milk feeding during hospitalization, n (%)				0.0001
Donor milk only	9 (2.8)	0	9 (0.8)	
Donor's milk with formula supplement	17 (5.3)	0	17 (1.5)	
Mother's milk only	26 (8.2)	111 (13.2)	137 (11.8)	
Mother's milk with formula supplement	143 (44.8)	657 (78.1)	800 (69)	
Mother's milk/Donor milk	45 (14.1)	72 (8.6)	117 (10.1)	
Surgical Procedures, n (%)	61 (19.1)	79 (9.4)	140 (12.1)	0.0001
Medications at Discharge				
Diuretics	15 (4.7)	10 (1.2)	25 (2.2)	0.0009
Steroids	4 (1.3)	3 (0.4)	7 (0.6)	0.0953

Inhalers	14 (4.4)	10 (1.2)	24 (2.1)	0.0017
Anticonvulsants	5 (1.6)	11 (1.3)	16 (1.4)	0.7791
Gastrointestinal medication	16 (5)	27 (3.2)	43 (3.7)	0.1637
Discharge equipment, n (%)	58 (18.2)	66 (7.9)	124 (10.7)	0.0001
Apnea Monitor	6 (1.9)	8 (1)	14 (1.2)	0.2282
Feeding pump	19 (6)	18 (2.1)	37 (3.2)	0.0022
Pulse ox	36 (11.3)	28 (3.3)	64 (5.5)	0.0001
Home on oxygen	41 (12.9)	31 (3.7)	72 (6.2)	0.0001
Any report of readmission, n (%)	65 (20.4)	118 (14)	183 (15.8)	0.009
<=32	43 (21.2)	53 (15)	96 (17.3)	0.0799
33-36	14 (23)	41 (10.7)	55 (12.4)	0.0112

Table 1. Characteristics of patients sent home on human milk

weeks gestational age were more likely to receive human milk at discharge than infants born at earlier or later gestational ages (based on Chi-square means of proportion test p<0.01).

In the 841 participants being fed some human milk at discharge, the most common feedings were breastfeeding with some bottle supplementation (504, 60%) and bottle feeding of expressed maternal milk (284, 34%). Only 27 (3%) of 841 were exclusively breastfeeding. Twenty-six (3%) were on tube feedings with maternal human milk (15 with gastrostomy tubes and 11 with nasogastric feedings). None of the 26 participants who were fed only donor milk (none of their mother's own milk) during hospitalization went home on human milk.

In the multivariate logistic analysis that includes data on all 1160 enrolled infants, the factors found to be independently associated with the use of human milk at discharge were: Non-Hispanic White race compared to all other races/ethnicity (*AOR*= 1.95, 1.52-2.51; *p*<0.0001); no report of surgical procedures (*AOR*= 1.96, 1.32-2.94; *p*=0.0007); any report of kangaroo care (*AOR*= 1.42, 1.0-2.01; *p*=0.0468) and being reported preterm compare to term (*AOR*= 1.86, 1.19-2.94; *p*=0.0066).

Participants sent home on human milk were healthier at discharge and less often were admitted during the first year of follow-up (Table 1). Participants fed human milk at discharge less often had a report of a surgical procedure and less often went home on diuretics, inhalers, feeding pumps, pulse oximeters, and home oxygen than participants who were not receiving human milk.

Reported use of Human Milk in Follow-Up for >4 and ≤7 months after birth.

There were 1160 participants referred for follow-up between September 2015 and June 2017 and kept one follow up visit, and 791 were followed for >4 and ≤7 months after birth (Table 2). The overall rate of use of any human milk decreased from 841/1160 (72.5%) at discharge to 233/791 (29.5%, p<0. 0001), who were

Figure 2. Proportion of infants being on breast milk during follow-up visits

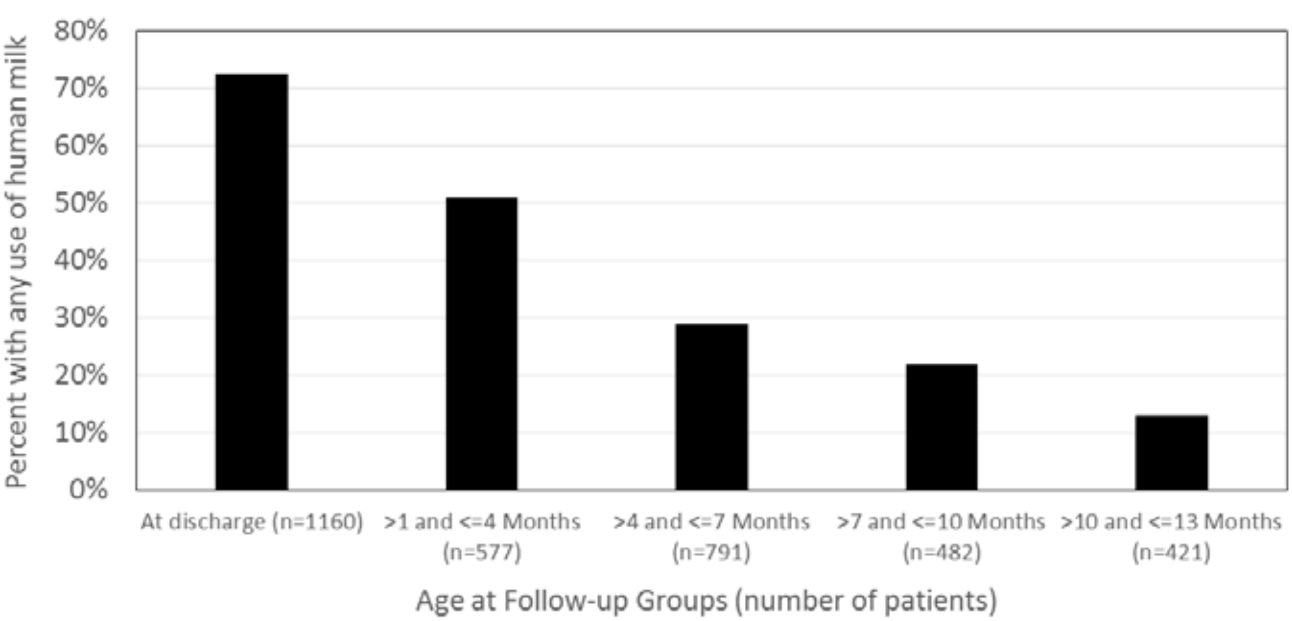


Table 2.	Human milk At Discharge		
On Breastmilk at Follow-up	**No**	**Yes**	
Total patients	558	233	
Gestational Age at birth	33 (27-38)	32 (27-36)	0.0352
<=32 weeks	244 (43.7)	124 (53.2)	
33 to 36	232 (41.6)	89 (38.2)	
>=37 weeks	82 (14.7)	20 (8.6)	
Birth Weight (grams)	1870 (900-2992)	1780 (862-2700)	0.0691
Age at DC days	29 (9-92)	30 (9-91.4)	0.3648
Female	268 (48)	119 (51.1)	0.4367
Congenital anomalies	112 (20.1)	44 (18.9)	0.7689
Race Group			0.0001
African American	58 (10.4)	18 (7.7)	
Asian	12 (2.2)	10 (4.3)	
Black Hispanic	11 (2)	3 (1.3)	
Native American	11 (2)	2 (0.9)	
Other	28 (5)	10 (4.3)	
Pacific Islander	1 (0.2)	3 (1.3)	
White	153 (27.4)	127 (54.5)	0.0001
White Hispanic	284 (50.9)	60 (25.8)	0.0001
Surgical Procedures	65 (11.6)	25 (10.7)	0.8061
Mother breastfed in NICU	348 (62.4)	207 (88.8)	0.0001
Breast pump provided	480 (86)	229 (98.3)	0.0001
Kangaroo care	456 (81.7)	209 (89.7)	0.0054
Frequency of Kangaroo care almost daily	342 (61.3)	176 (75.5)	0.0149

Table 2. Characteristics of patients on breast milk at follow up between 4 and 7 months.

Figure 3. Changes in use of human milk within Gestational Age Groups

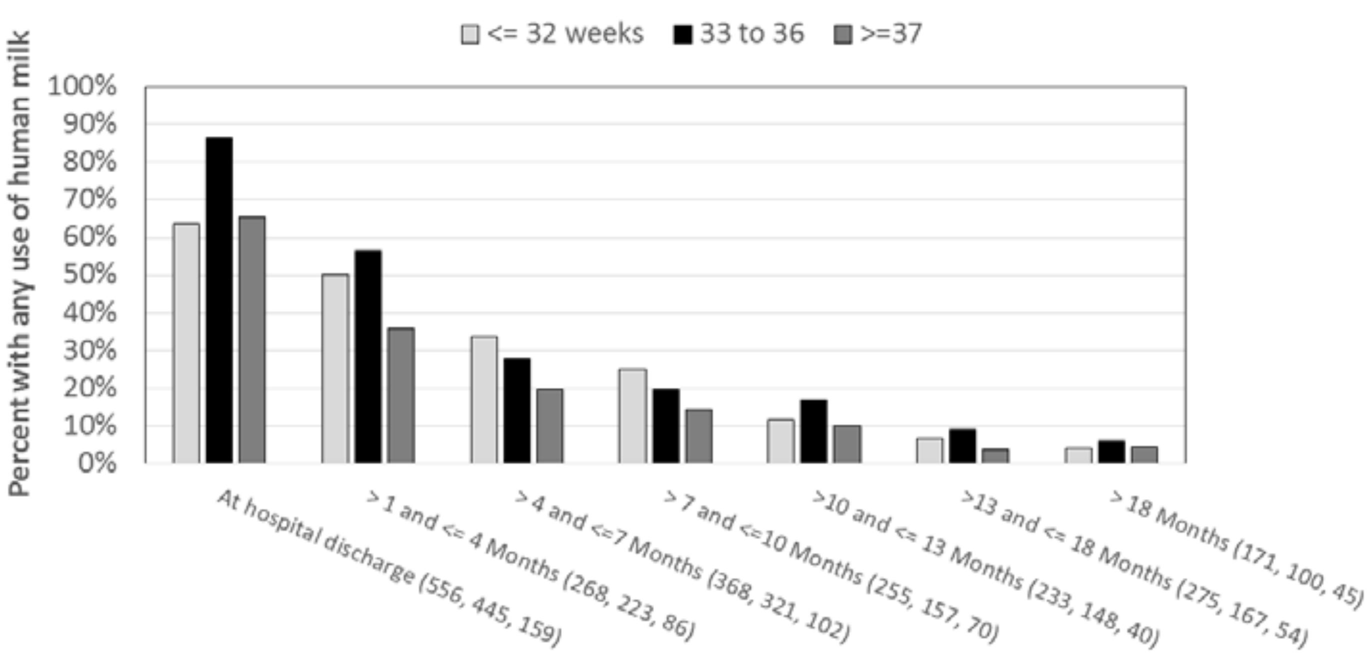


Table 3		Based on Use of Human Milk at Discharge				Based on continued use at Follow Up		
	EGA	Age group	No	Yes	P Value	No	Yes	P Value
z weight	<=32 wks	Birth	0.18 (-1.42-1.45)	0.14 (-1.5-1.42)	0.345	0.2 (-1.41-1.45)	0.08 (-1.52-1.5)	0.415
z weight	<=32 wks	Discharge	-0.61 (-1.87-0.45)	-0.63 (-1.66-0.36)	0.460	-0.6 (-1.78-0.33)	-0.48 (-1.81-0.52)	0.130
z weight	<=32 wks	>4 and <=7 months	-0.75 (-2.19-0.66)	-0.39 (-1.6-0.87)	0.003	-0.43 (-1.91-0.78)	-0.61 (-1.89-0.74)	0.183
z weight	33 to 36	Birth	0.17 (-1.33-2.31)	-0.18 (-1.58-1.07)	0.113	-0.24 (-1.55-1.04)	-0.03 (-1.31-1.3)	0.120
z weight	33 to 36	Discharge	-0.46 (-1.7-1.03)	-0.85 (-1.95-0.12)	0.005	-0.85 (-1.93-0.11)	-0.83 (-1.77-0.33)	0.240
z weight	33 to 36	>4 and <=7 months	-0.29 (-1.41-0.93)	-0.32 (-1.54-1)	0.851	-0.31 (-1.39-0.95)	-0.32 (-1.74-1.05)	0.911
z weight	>=37 wks	Birth	-0.5 (-1.6-1.2)	-0.24 (-1.78-1.38)	0.479	-0.29 (-1.63-1.67)	-0.33 (-2.32-1.34)	0.909
z weight	>=37 wks	Discharge	-0.75 (-1.77-0.78)	-0.77 (-2.07-0.78)	0.648	-0.75 (-2-1.02)	-1.3 (-2.6-0.83)	0.300
z weight	>=37 wks	>4 and <=7 months	-0.24 (-1.73-1.41)	-0.72 (-2.16-0.84)	0.185	-0.29 (-1.76-0.86)	-1.03 (-2.41-0.3)	0.019
z length	<=32 wks	Birth	0 (-1.49-1.09)	0.14 (-1.44-1.11)	0.238	0.12 (-1.37-1.14)	0.14 (-1.46-1.1)	0.905
z length	<=32 wks	Discharge	-1.19 (-2.96-0.28)	-0.85 (-2.52-0.32)	0.001	-0.96 (-2.85-0.32)	-0.83 (-2.32-0.49)	0.288
z length	<=32 wks	>4 and <=7 months	-1.3 (-3.37-0.37)	-0.72 (-2.73-1.01)	0.001	-0.89 (-3.11-1.07)	-0.98 (-3-0.4)	0.353
z length	33 to 36	Birth	0.23 (-1.81-1.6)	-0.07 (-1.42-1.15)	0.246	-0.08 (-1.55-1)	0 (-1.08-1.18)	0.160
z length	33 to 36	Discharge	-0.5 (-2.14-1.03)	-0.55 (-1.96-0.57)	0.448	-0.59 (-2.05-0.44)	-0.61 (-1.75-0.69)	0.567
z length	33 to 36	>4 and <=7 months	-0.67 (-2.12-1.02)	-0.37 (-2.01-1.07)	0.256	-0.45 (-2.12-1.09)	-0.44 (-1.91-0.9)	0.923
z length	>=37 wks	Birth	-0.44 (-1.68-1.38)	0 (-1.73-1.91)	0.063	0 (-1.43-1.75)	-0.25 (-2.2-2.11)	0.461
z length	>=37 wks	Discharge	-0.63 (-2.4-1.47)	-0.59 (-2.57-1.65)	0.780	-0.34 (-2.38-1.6)	-0.79 (-2.84-2.04)	0.331
z length	>=37 wks	>4 and <=7 months	-0.66 (-2.82-0.58)	-0.68 (-2.13-0.76)	0.512	-0.56 (-2.39-0.58)	-1.28 (-2.25-1.56)	0.322
z HC	<=32 wks	Birth	0 (-1.46-1.4)	0.07 (-1.33-1.33)	0.993	0.07 (-1.33-1.35)	0 (-1.54-1.3)	0.616
z HC	<=32 wks	Discharge	-0.71 (-2.06-0.56)	-0.56 (-1.73-0.38)	0.361	-0.71 (-1.94-0.47)	-0.53 (-1.62-0.41)	0.511
z HC	<=32 wks	>4 and <=7 months	-0.13 (-1.92-1.31)	0.14 (-1.23-1.58)	0.010	0.17 (-1.77-1.55)	-0.11 (-1.54-1.38)	0.107
z HC	33 to 36	Birth	-0.06 (-1.37-1.63)	-0.06 (-1.3-1.19)	0.847	-0.06 (-1.18-0.99)	-0.06 (-1.19-1.36)	0.516
z HC	33 to 36	Discharge	-0.26 (-1.68-0.7)	-0.71 (-1.69-0.2)	0.010	-0.56 (-1.62-0.38)	-0.53 (-1.56-0.38)	0.558
z HC	33 to 36	>4 and <=7 months	0.35 (-1.08-1.49)	0.38 (-0.99-1.78)	0.567	0.38 (-0.82-1.76)	0.32 (-1.38-1.86)	0.344
z HC	>=37 wks	Birth	-0.6 (-1.7-0.86)	-0.44 (-1.71-1.21)	0.279	-0.53 (-1.69-0.96)	-0.13 (-2.63-1.37)	0.960
z HC	>=37 wks	Discharge	-0.56 (-2.17-1.03)	-0.87 (-2.53-0.66)	0.188	-0.47 (-2.25-0.83)	-1.17 (-2.85-1.1)	0.090
z HC	>=37 wks	>4 and <=7 months	0.15 (-1.74-1.96)	-0.22 (-1.89-1.91)	0.300	-0.01 (-1.73-1.94)	-0.58 (-2.74-2.39)	0.051

Table 3. Supplement (z scores)

followed for >4 and ≤7 months after birth, and this trend continued with later follow-up (Figure 2). In 586 patients who were discharged home on human milk and who were followed for >4 and ≤7 months after birth, 230 (39.3%) continued to use human milk. In 205 patients who were not discharged home on human milk and who were followed for >4 and ≤7 months after birth, the rate of use of human milk increased from 0% to 3/205 (1.5%). At the follow-up visit that occurred >4 and ≤7 months, 233 infants were on human milk; 230 were those discharged on human milk, and 3 started human milk after discharge. In the 233 participants being fed some human milk at follow-up, the most common feedings were breastfeeding with some bottle supplementation of human milk (119/233, 51%). There were 32/233 (14%) participants who were exclusively breastfeeding.

Factors associated with continued use of human milk at follow-up (>4 and ≤7 months) from the hospital were similar to those associated with the use of human milk at discharge and included: more immature gestational age at birth; non-Hispanic white (White-Hispanic participants were less likely to be on human milk at follow-up and Non-Hispanic White participants were more likely to be on human milk at follow-up); any reported use of Kangaroo care (Table 2) and having had a human milk pump provided. The decrease in reported use of any human milk was independent of the site of care and gestational age group (Figures 3 and 4 Supplement).

In the multivariate logistic analysis that include only the 791 patients seen in follow-up, the factors found to be independently associated with the use of human milk at follow-up (>4 and ≤7 months) were: reported use of human milk at discharge (*AOR*=39.3, 14-162; *p*<0.0001); White race compared to all other races/ethnicity (*AOR*= 2.97, 2.1-4.2; *p*<0.0001); being reported preterm at birth

(<=32 weeks) compared to more mature gestational age participants (*AOR*= 2.02, 1.4-2.9; *p*<0.0001); and mother having received a human milk pump within 12 hours of the birth of her infant (*AOR*=1.90, 1.2-3; *p*=0.0037). We included the site as a variable in our logistic regression, and the site was not statistically associated with our outcome measures. Using a univariate analysis, the provision of a human milk pump was associated with the use of human milk at discharge and at follow-up between 4-7 months. (Tables 1 and 2). However, using multivariate analysis, the provision of a human milk pump was not independently associated with the use of human milk at discharge, but it was associated with continued use of human milk at follow-up between 4-7 months.

"However, using multivariate analysis, the provision of a human milk pump was not independently associated with the use of human milk at discharge, but it was associated with continued use of human milk at follow-up between 4-7 months. "

Growth Data

There were no consistent trends in growth patterns for participants discharged home on human milk compared to those who were not sent home on human milk (Table 3 Supplement). Birth z-scores for weight, length, and head circumferences were not different for any subgroup we evaluated. At discharge, participants with a gestational age between 33 and 36 weeks who were sent home on human milk had slightly lower z scores for weight and head circumference but no differences in z scores for length. At follow-up, these differences were no longer significant. At follow-up (4-7 months), participants with gestational age < 32 weeks who were sent home on human milk had slightly higher z scores for weight, length, and head circumference than participants in the same gestational age group who were not sent home on human milk and there was a suggestion of higher z scores in the lowest gestational ages.

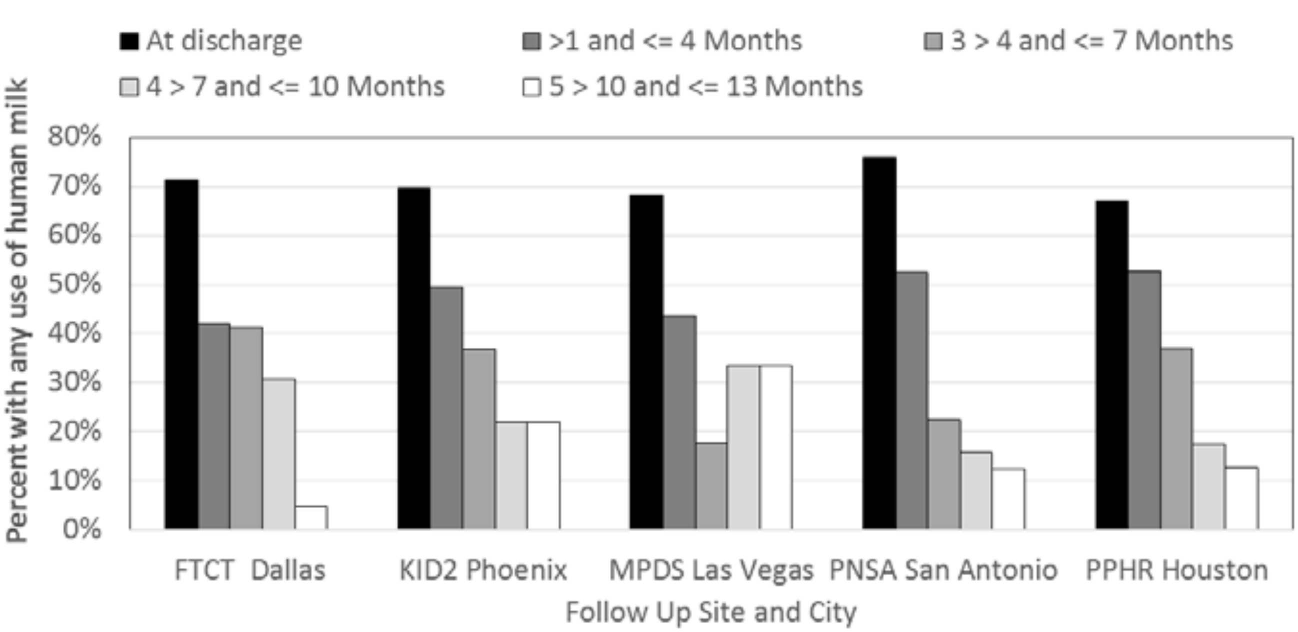
"There were no consistent trends in growth patterns for participants who remained on human milk at follow-up compared to those who were not on human milk at follow-up."

There were no consistent trends in growth patterns for participants who remained on human milk at follow-up compared to those who were not on human milk at follow-up. Infants >37 weeks gestational age who were still on breast milk at 4-7 month follow-up had lower z-scores for weight at follow-up; length and head circumference were not statistically different.

Discussion

In our study of high-risk participants seen in follow-up after NICU discharge, the most important factor associated with the continued use of human milk was being discharged on human or donor milk. We identified Kangaroo care as an important independent factor associated with human milk use. This has been emphasized in a recent randomized Kangaroo care trial, which found

Figure 4. Change in use of human milk from discharge to 1 year follow-up by site.



Supplemental Table	FTCT	KID2	MPDS	PNSA	PPHR	p value
Total enrolled	199	250	66	545	100	
EGA group, n (%)						
Preterm <37 weeks	178 (89.4)	208 (83.2)	60 (90.9)	472 (86.6)	83 (83)	0.2109
Term >=37 weeks	21 (10.6)	42 (16.8)	6 (9.1)	73 (13.4)	17 (17)	
Gestational Age at Birth, median (10-90th %tile)	31 (25-37)	32 (25-38)	32 (26.7-36.6)	33 (28-37)	33 (25-38)	<0.01
Birth Weight (grams), median (10-90th %tile)	1490 (700-2920)	1610 (766-3126)	1720 (972-2728)	2013 (1076-2928)	2060 (812-3378)	
Race Group, n (%)						
African American	52 (26.1)	22 (8.8)	15 (22.7)	36 (6.6)	13 (13)	<0.01
Asian	12 (6)	9 (3.6)	5 (7.6)	8 (1.5)	2 (2)	
Black Hispanic	1 (0.5)	1 (0.4)	0 (0)	16 (2.9)	1 (1)	
Native American	1 (0.5)	14 (5.6)	0 (0)	4 (0.7)	0 (0)	
Other	10 (5)	18 (7.2)	0 (0)	13 (2.4)	5 (5)	
Pacific Islander	2 (1)	2 (0.8)	2 (3)	0 (0)	0 (0)	
White	78 (39.2)	112 (44.8)	31 (47)	128 (23.5)	56 (56)	
White Hispanic	43 (21.6)	72 (28.8)	13 (19.7)	340 (62.4)	23 (23)	
Male, n (%)	103 (51.8)	136 (54.4)	32 (48.5)	283 (51.9)	48 (48)	0.8
Receiving human milk at discharge, n (%)	142 (71.4)	174 (69.6)	45 (68.2)	413 (75.8)	67 (67)	0.1806

Supplemental table showing site demographics

higher exclusive human milk feedings and direct breastfeedings at both discharge and one-month post-discharge in the earlier, more frequent Kangaroo care group (16). While the provision of a human milk pump was not independently associated with the use of human milk at discharge, it was associated with continued use of human milk at follow-up between 4-7 months. These data are encouraging in that they imply that attention and commitment to many health care practices may be associated with higher rates of long-term human/donor milk use. This study, which included diverse NICU graduates, not just preterm or infants below specific weight limits, reinforces information that kangaroo care, access to human milk pumps, and going home on human milk all contributed to participants receiving human/donor milk longer after discharge. We were encouraged that there were no clinically meaningful differences in growth between infants on human milk compared to those on formula, and there was a suggestion that in lowest gestational ages, being discharged home on human milk was associated with higher z-scores at 4-7 months follow-up. In contrast, infants >37 weeks gestational age who were still on breast milk at 4-7 month follow-up had lower z-scores for weight at follow-up, but the length and head growth were not different.

We showed that continued use of human milk after discharge from the NICU is low and decreases rapidly in all gestational age groups. In all of our sites, it appears that sicker infants—having surgery, going home on medications other than vitamins—were less likely to be on human milk at discharge. A quality improvement project targeting mothers of infants with complex cardiac and congenital anomalies utilized the strategy of human milk pumping (early and often) and were able to show some increases in human milk feedings at discharge.(17) Infants from our sites who did not receive their own mother's milk but were only receiving donor milk in the NICU were unlikely to go home on human milk at discharge. Thus a strategy to promote health while inpatient actually decreased support to this same health intervention after discharge.

With the information we report, there are potential opportunities for change. Higher human milk use among white mothers indicates that focusing information and developing more culturally specific and culturally sensitive education both prenatally and during NICU stay towards non-white mothers may have benefit, however, other studies have continued to document struggles in impacting rates of human milk feeding in Hispanic and non-Hispanic black mothers (18,19) Other target populations for focus during the NICU stay are mothers whose infants go home on more medications, have surgery and those mothers whose infants receive donor milk only. Implementing, promoting, and strengthening evidenced-based strategies and developing additional strategies based on the identification of ongoing barriers to these strategies will continue to increase human milk use in this vulnerable population. (20,21)

> ***"We did not have information about absolute amounts of human milk as a proportion of total feedings, either total volume or total calories, only whether an infant was receiving any human milk at discharge, which could have impacted growth data. "***

Limitations

We did not have information about absolute amounts of human milk as a proportion of total feedings, either total volume or total calories, only whether an infant was receiving any human milk at discharge, which could have impacted growth data. Human milk volumes at two-week post-delivery have been shown to predict feeding human milk at discharge, and this variable should be collected in future endeavors. (22) Supporting behavior change is a complex process, and there were many pieces of information that we did not investigate in this initial data gathering of the use of human milk. We did not collect socioeconomic status, maternal education level, or maternal age, and these factors have been shown to serve as mediators in racial and ethnic disparities in human milk feeding provision. (23) We also did not ask a question regarding the intent to breastfeed, which has been shown to also influence breastfeeding or the use of donor milk. We did not survey or collect information on various NICU policies regarding supporting breastfeeding, kangaroo care, nor on mother's memories of any support she received, nor did we survey medical care teams in the NICUs on their view of supporting breastfeeding. All of these are potential areas of future investigation. In addition, minimal information was obtained on support to mothers for human milk use after discharge.

> ***"Moving forward, we plan to investigate our data regarding utilization of intervention (therapies), both state-supported and private, and changes in medications between discharge and various follow-up times to work to identify gaps between inpatient care and post-discharge care."***

Moving forward, we plan to investigate our data regarding utilization of intervention (therapies), both state-supported and private, and changes in medications between discharge and various follow-up times to work to identify gaps between inpatient care and post-discharge care. We also plan to analyze the 2-year follow-up data.

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Contributors' Statements

Dr. Ellis conceptualized and designed the study, collected the data, drafted the initial manuscript, and critically analyzed, reviewed, and revised the manuscript for important intellectual content.

Drs. Aune, Fierro, Roberts, Allare, Drabant, Ms. McDuffie, and Christina Sanchez conceptualized and designed the study, collected the data, and critically analyzed, reviewed, and revised the manuscript for important intellectual content.

Mrs. Kelleher conceptualized and designed the study, drafted the initial manuscript, and critically analyzed, reviewed and revised the manuscript for important intellectual content.

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Elaine Ellis, MD,
Developmental Follow-up Clinical Scottsdale, Scottsdale, AZ

Christine Aune, MD
San Antonio Pediatric Developmental Services

Mario Fierro, MD
San Antonio Pediatric Developmental Services

Cathleen Roberts, DO
Neurodevelopmental Pediatrician
Medical Director Dallas Developmental Pediatric Services

Christina Eliza Sanchez, OMS II
Research Coordinator

Mary Allare, MD
Medical Director
Phoenix Perinatal Associates
Developmental Follow Up Clinic

Cheryl McDuffie, FNP
Preemie Place for High-Risk Follow-up Clinic

Bradlee Drabant, MD
Neonatologist
Neonatology Specialists of Las Vegas
MEDNAX Pediatric Developmental Services of Las Vegas

Corresponding Author:

Amy S. Kelleher, MSHS
The MEDNAX Center for Research, Education, Quality and Safety,
1301 Concord Terrace, Sunrise, FL,
email: amy_kelleher@mednax.com,
800-243-3839 ext. 5206.