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Goals for Human Milk Feeding in Mothers of Very Low Birth Weight Infants: How Do Goals Change and Are They Achieved During the NICU Hospitalization?

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Abstract

Background: Little is known about human milk (HM) feeding goals for mothers of very low birth weight (VLBW) (<1,500 g birth weight) infants, especially for black mothers, for whom rates of VLBW birth are higher and lactation rates lower. This study examined the establishment, modification, and achievement of HM feeding goals during neonatal intensive care unit (NICU) hospitalization for mothers of VLBW infants and the influence of maternal race and income.

Materials and Methods: A prospective cohort study measured maternal HM feeding goals (exclusive [EHM], partial, none) predelivery and during three time intervals: day of life (DOL) 1–14, 15–28, and 29–72. Goal achievement compared the goal for the time interval with the proportion of HM feedings received by the infant. Goal establishment, modification, and achievement were examined using chi-squared and contingency tables.

Results: Three hundred fifty-two mother–infant dyads (53% black; 70% low-income; mean birth weight, 1,048 g) were studied. Predelivery, 55% of mothers planned to provide EHM; fewer black and low-income mothers chose EHM. During DOL 1–14, 63% of mothers chose EHM, and predelivery racial differences disappeared. Only 10% of mothers chose exclusive at-breast EHM feedings. EHM feeding goals decreased during NICU hospitalization, especially for black mothers. Whereas most mothers met their HM feeding goals initially, achievement rates declined during hospitalization. Mothers' EHM goal achievement was not influenced by race or income.

Conclusions: Mothers changed their predelivery HM feeding goals after birth of a VLBW infant. Longitudinally, HM feeding goals and achievement reflected less HM use, highlighting the need to target lactation maintenance in this population.

Introduction

Human milk (HM) from the infant's own mother reduces costly morbidities such as necrotizing enterocolitis and late-onset sepsis in very low birth weight (VLBW) (<1,500 g birth weight) infants during neonatal intensive care unit (NICU) hospitalization.[1–6] Such morbidities can result in lifelong complications, leading care providers to encourage mothers of VLBW infants to provide HM for their infants.[7,8] For undecided mothers or those who planned to feed formula, the message is often to initiate pumping, deferring decisions regarding duration and method of HM feeding (e.g., directly at-breast versus bottle feeding expressed HM) until later in NICU hospitalization.[9–12]

Aside from studies examining maternal decision-making processes about changing predelivery (PD) feeding choices from formula to HM for their VLBW infants,[11–13] virtually no published research has focused on how these mothers establish, modify, and achieve HM feeding goals during NICU hospitalization. Although it is well established that prenatal maternal intent predicts breastfeeding initiation and duration in healthy mothers and infants,[14–16] these findings cannot be generalized to mothers of VLBW infants who may deliver prior to making a feeding decision and frequently change their decision after premature birth.[8,11–13] Related studies in this population have addressed maternal attitudes about providing HM,[17] barriers and facilitators,[18,19] and milk expression experiences.[17,20] However, these studies shed

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little light on the establishment, modification, and achievement of HM feeding goals. This paucity of data is especially troublesome because mothers of VLBW infants in the United States are disproportionately black and low income.[8,21] These vulnerable women are also most likely to have a prenatal intent to feed formula and to provide less HM during NICU hospitalization.[6,8,11–13] Thus, it is likely that racial and socioeconomic factors impact HM feeding goals for this population, but published studies are lacking.

The purpose of this study was to examine the establishment, modification, and achievement of HM feeding goals during NICU hospitalization for mothers of VLBW infants. Additionally, we sought to examine differences in these parameters as a function of race and income status.

Materials and Methods

Sample

This analysis is part of a National Institutes of Health–funded prospective cohort study examining health outcomes and cost of HM feedings for VLBW infants born between 2008 and 2012 and admitted to a 57-bed Level III NICU in Chicago, IL.[1] All eligible infants and mothers were offered enrollment, and data were collected from NICU admission through discharge. Eligibility criteria included the following: birth weight of <1,500 g; gestational age of ≤35 weeks; absence of severe congenital anomalies; negative maternal drug screen (except marijuana); admitted to the NICU within 24 hours of birth; and feedings initiated before day of life (DOL) 14. Maternal lactation initiation was not an inclusion criterion in order to measure outcomes at all levels of HM intake. For multiple births, one infant was selected randomly for inclusion. Infants who died were declared ineligible; those transferred to another institution before DOL 14 were excluded. Figure 1 details the sample. This study was approved by the Rush University Institutional Review Board, and signed informed consent was obtained from all subjects or parents of infant subjects.

Measures

Maternal and infant characteristics. Maternal race and low-income status were obtained from medical records and maternal questionnaire shortly after delivery. Only mothers who reported their race as black (non-Hispanic), white (non-Hispanic), or Hispanic were included in this analysis. Low-income status was defined as Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) eligibility (2012 household income <$42,643 for a family of four).[22] Mothers who did not know their WIC eligibility were eliminated from analyses that addressed the impact of low-income status. Infant characteristics were collected from the study database and included body weight, gestational age, and length of hospitalization.

Maternal HM feeding goals. Maternal HM feeding goals were measured by verbal questionnaire administered by research assistants (breastfeeding peer counselors [BPCs]) weekly during NICU hospitalization.[1] This instrument, developed for this project, included categorical maternal choices for goals about *type* of milk (exclusive HM [EHM], formula (no HM [NHM]), or both HM and formula (partial HM [PHM]) and *method* of feeding (exclusive at-breast, exclusive HM bottle feeding, or HM via both breast and bottle). The number of measured maternal HM feeding goals per mother varied with duration of NICU hospitalization and mothers' weekly availability for questionnaire completion. For purposes of analysis, these longitudinally measured maternal HM feeding goals were grouped into four time intervals: PD; initial postbirth (DOL 1–14); mid-NICU hospitalization (DOL 15–28); and late NICU hospitalization (DOL 29–72).

PD maternal HM feeding goals were not measured prior to delivery but were collected during initial intake interviews by BPCs following infants' enrollment into the study. Mothers were asked which HM feeding goal they had established *prior to* birth. Measurement of the DOL 1–14 HM feeding goal was timed to capture whether the mother had changed the PD goal after giving birth. All goals were measured when the mother was visiting the NICU at weekly intervals if mothers were available this frequently. If more than one maternal HM feeding goal was recorded during a measured interval, the final goal within the interval was used for analysis. If a mother chose ''unsure'' as her only HM feeding type goal during a time interval, her measures were excluded from analysis for that time interval.

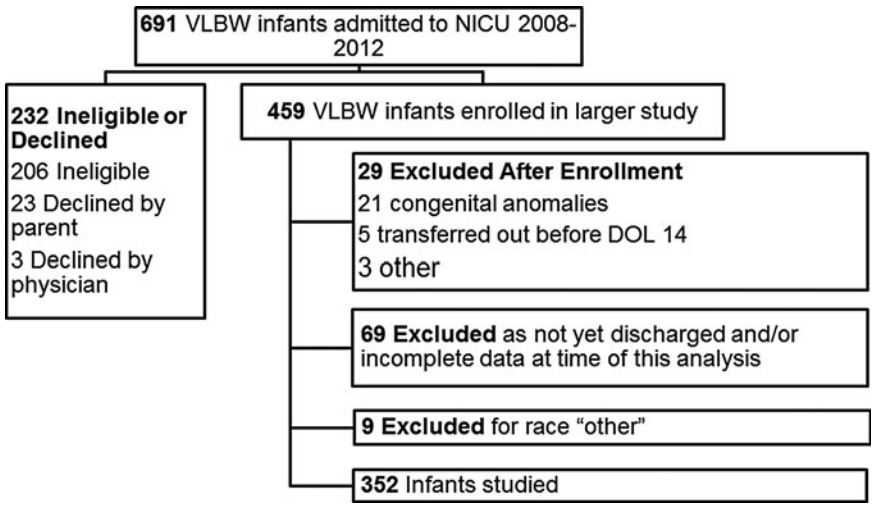

FIG. 1. Enrollment schematic. DOL, day of life; NICU, neonatal intensive care unit; VLBW, very low birth weight.

Achievement of maternal HM feeding goals. To determine whether a mother achieved her HM feeding goal for the specific postbirth interval, the mother's goal (EHM, NHM, or PHM) was compared with the infant's HM intake. Specifically, we measured whether the infant received EHM (≥90% enteral feedings HM), NHM (<10% enteral feedings HM), or PHM (10–89.9% enteral feedings HM) for a 3-day period corresponding to the date of, as well as 24-hour periods before and after, maternal HM goal measurement. EHM was defined as ≥90% of enteral feedings received as HM based on previous work[23] by this research team because otherwise EHM-fed infants occasionally received a few milliliters of non-HM during NICU hospitalization due to scenarios such as a mother being late with a HM drop-off. If a mother had a goal of PHM but provided EHM or a goal of NHM but provided PHM or EHM, she was considered to have ''exceeded'' her goal. Methods for collection of prospective HM feeding data were previously published by this study team.[23]

For the first measured postbirth interval (DOL 1–14), infants were often nil per os (NPO) when the goal was recorded, so the first 3 days of enteral feedings, whenever they occurred, were used for analysis. For DOL 15–28 and DOL 29–72, if an infant was NPO for 1 of 3 measured days, 2 days of feeding data were used. If an infant was NPO for more than 1 of 3 days, the next 3 consecutive days of feedings after measurement of the maternal HM feeding goal were used for analysis. If an infant was NPO for an entire interval, the infant was excluded from the goal achievement analysis for that interval.

Data management and analysis

Data were previously checked for accuracy against original data collection instruments and entered into an electronic database by BPCs. Data relevant to this analysis were copied electronically from original databases and analyzed in Excel® (Microsoft, Redmond, WA) and SPSS version 21.0 (IBM, Armonk, NY) software. Descriptive statistics were used to summarize sample characteristics. Chi-squared analyses and contingency tables were used to evaluate differences in maternal HM feeding goals across time intervals and to determine the impact of race and income on maternal HM feeding goal establishment, modification, and achievement.

Results

Maternal and infant characteristics

In total, 352 mothers and their VLBW infants enrolled between February 2008 and April 2012. Their characteristics are displayed in Table 1.

Maternal HM feeding goals for type of milk. Table 2 shows maternal HM feeding goals for each of four time intervals for the sample and for subgroups of black, white, and Hispanic mothers. PD, statistically significant racial differences were seen. For DOL 1–14, significantly fewer mothers chose NHM than for PD ($p < 0.001$). As NICU hospitalization continued, the proportion of mothers who chose PHM feeding remained relatively stable, but more mothers chose NHM and fewer chose EHM. For example, compared with DOL 15–28, at DOL 29–72, over three times more mothers had an NHM feeding goal ($z = 3.53$, $p < 0.001$). No statistical differences were noted by maternal race for any postbirth time intervals.

Table 1. Characteristics of the Sample

Characteristic	*Total sample (n = 352 dyads)*[a]
Maternal age (years)	27.2 (6.5)
Maternal education (years completed)	13.1 (2.8)
Maternal race/ethnicity[a]	
Black	52.8%
White	19.9%
Hispanic	27.3%
Low income (WIC eligible)	69.8%
Primiparous	34.8%
Breastfeeding experience	28.7%
Multiple gestation	13.7%
Infant gestational age (weeks)	28.0 (2.4)
Infant birth weight (g)	1,048 (255)
Infant length of stay (days)	72.9 (42.3)

Data are mean (standard deviation) values or percentages as indicated.
[a]$n = 9$ excluded (from original $n = 361$) for race ''other.''
WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

The effects of low-income status on maternal HM feeding goals revealed a statistically significant difference between low-income and non–low-income women at all time intervals (Table 3). Low-income mothers were significantly less likely to choose EHM versus either PHM or NHM.

Maternal HM feeding goals for method of feeding EHM. For each time interval, mothers who chose EHM were asked which method(s) they wanted to use to provide HM. Mothers overwhelmingly chose a combination of at-breast and bottle feeding (81.2%), with small proportions choosing either exclusive breastfeeding (10.6%) or bottle feeding (8.3%).

Table 2. Maternal Human Milk Feeding Goals for Time Intervals by Race

Time interval (n), HM goal	*Total sample*[a]	*Race*			p[b]
		Black	*White*	*Hispanic*	
Predelivery	345	183	69	93	0.008
EHM	191 (55.4)	89 (48.6)	46 (66.7)	56 (60.2)	
NHM	36 (10.4)	27 (14.8)	6 (8.7)	3 (3.2)	
PHM	118 (34.2)	67 (36.6)	17 (24.6)	34 (36.6)	
DOL 1–14	315	163	64	88	0.06
EHM	198 (62.9)	93 (57.1)	49 (76.6)	56 (63.6)	
NHM	10 (3.2)	8 (4.9)	0 (0)	2 (2.3)	
PHM	107 (33.9)	62 (38.0)	15 (23.4)	30 (34.1)	
DOL 15–28	145	71	36	38	0.3
EHM	100 (69.0)	47 (66.2)	29 (80.5)	24 (63.2)	
NHM	8 (5.5)	6 (8.4)	1 (2.8)	1 (2.6)	
PHM	37 (25.5)	18 (25.4)	6 (16.7)	13 (34.2)	
DOL 29–72	182	85	43	54	0.1
EHM	101 (55.5)	38 (44.7)	27 (62.8)	36 (66.6)	
NHM	34 (18.7)	18 (21.2)	9 (20.9)	7 (13.0)	
PHM	47 (25.8)	29 (34.1)	7 (16.3)	11 (20.4)	

All data are reported as *n* (%).
[a]Variable *n* at each time interval reflects the variable number of mothers with recorded goals for that interval.
[b]*p* value for differences between races.
DOL, day of life; EHM, exclusive human milk; HM, human milk; NHM, no human milk; PHM, partial human milk.

Table 3. Feeding Goals by Women, Infants, and Children Program Eligibility and Time Interval

Time interval (n), HM goal[a]	*WIC*	*Non-WIC*	p
Predelivery (320)			0.02
n	238	82	
EHM	120 (50.4)	54 (65.9)	
NHM	29 (12.2)	3 (3.7)	
PHM	89 (37.4)	25 (30.5)	
DOL 1–14 (291)			0.02
n	216	75	
EHM	126 (58.3)	56 (74.7)	
NHM	9 (4.2)	0	
PHM	81 (37.5)	19 (25.3)	
DOL 15–28 (133)			0.01
n	88	45	
EHM	52 (59.1)	37 (82.2)	
NHM	8 (9.1)	0	
PHM	28 (31.8)	8 (17.8)	
DOL 29–72 (167)			0.006
n	114	53	
EHM	54 (47.4)	39 (73.6)	
NHM	26 (22.8)	5 (9.4)	
PHM	34 (29.8)	9 (17)	

All data are reported as *n* (%).

[a]Variable *n* at each time interval reflects the variable number of mothers with recorded goals for that interval. In addition, 23 mothers from the total sample were excluded for unknown Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) status.

DOL, day of life; EHM, exclusive human milk; HM, human milk; NHM, no human milk; PHM, partial human milk.

Racial differences in choice of HM feeding method were examined in detail at DOL 15–28. By this time, nearly all infants had achieved full enteral feedings, and the feeding method would have emerged as a greater reality for mothers. Of mothers who chose EHM, black women were less likely (2.2%) than either white (14.3%) or Hispanic (32%) women to choose feeding at-breast. Most mothers (93.5% of black, 85.7% of white, and 56% of Hispanic) anticipated using a combination of EHM feedings at breast and via bottle.

Achievement of maternal HM feeding goals. Mothers' achievement of HM feeding goals was measured for each time interval. No infants were NPO for an entire time interval, so none were excluded from analysis. Table 4 reveals that most mothers achieved their HM feeding goal for the DOL 1–14 and 15–28 time intervals, with mothers in the PHM and NHM categories exceeding their goals by providing EHM and PHM, respectively. During DOL 29–72, increasing numbers of mothers who chose EHM or PHM did not achieve these goals, and their infants received PHM and NHM, respectively. In particular, mothers who chose EHM as their DOL 1–14 HM feeding goal were more likely to achieve it compared with mothers who chose EHM later during NICU hospitalization (e.g., during DOL 15–28 [$p = 0.03$] or DOL 29–72 [$p = 0.003$]). For all time intervals, sizeable proportions of mothers who chose PHM as their HM feeding goal exceeded this goal. Mothers who chose PHM for the DOL 1–14 HM feeding goal were more likely to achieve or exceed this goal than mothers who chose PHM later in NICU hospitalization (e.g., during DOL 29–72 [$p < 0.005$]). No impact of race or low income was observed at any time with respect to HM goal achievement.

Table 4. Maternal Human Milk Feeding Goal Achievement

*Time interval (*n*), HM goal achievement*[a]	*Maternal goal*		
	EHM	*NHM*	*PHM*
DOL 1–14 (312)			
n	196	10	106
Met	85.2%	60.0%	19.8%
Exceeded	—	40.0%	72.6%
Not met	14.8%	—	7.5%
DOL 15–28 (142)			
n	98	7	37
Met	79.6%	71.4%	32.4%
Exceeded	—	28.6%	51.4%
Not met	20.4%	—	16.2%
DOL 29–72 (178)			
n	99	33	46
Met	73.7%	87.9%	26.1%
Exceeded	—	12.2%	34.8%
Not met	26.3%	—	39.1%

[a]Variable *n* at each time interval reflects the variable number of mothers with recorded goals for that interval.

DOL, day of life; EHM, exclusive human milk; HM, human milk; NHM, no human milk; PHM, partial human milk.

Discussion

To our knowledge, this is the first prospective study to report HM feeding goals for type of milk and method of feeding in mothers of hospitalized VLBW infants. In this urban, primarily minority low-income population, the majority of mothers had a goal of providing HM even prior to giving birth. However, mothers' HM feeding goals were not static during NICU hospitalization. In general, a greater proportion of mothers had goals for DOL 1–14 that reflected higher provision of HM (e.g., EHM or PHM) than PD, with a reversal of this trend as NICU hospitalization progressed. Concomitantly, as mothers' goals began to reflect less HM provision (e.g., EHM to PHM or PHM to NHM), the goals were more likely to be achieved or even exceeded. Only maternal low-income status was significantly associated with maternal HM feeding goals at all time intervals, with low-income women having significantly less ambitious HM feeding goals (Table 3).

Maternal race was significantly associated with maternal HM feeding goals for the PD time interval but not for later measurement periods. Specifically, PD, a higher proportion of black mothers reported a goal of NHM, whereas a higher proportion of white and Hispanic mothers reported a goal of EHM. These racial differences were no longer significant by DOL 1–14. The lack of differences by DOL 1–14 is likely a consequence of clinical practices in the study NICU. All mothers of infants admitted to the NICU are counseled by BPCs after delivery (irrespective of study participation) regarding the importance of HM feedings for VLBW infants, especially the reductions in late-onset sepsis,[2] necrotizing enterocolitis,[4] and other morbidities[8] with HM feedings. This scripted messaging includes statements such as ''Your milk is

a medicine'' and ''Pump now and make longer-term HM feeding decisions later.''[19] Consistent with our previous research,[12] this change in PD goals was most striking for black mothers, who were most highly represented in the NHM category PD. These data further underscore the efficacy of NICU healthcare provider messaging in increasing the proportion of mothers who begin providing HM for their VLBW infants, especially among black women.[11,24,25]

In contrast, later in NICU hospitalization, no statistically significant racial differences were noted in the proportions of women who chose EHM, NHM, or PHM. However, as is apparent in Table 2, there was a general trend among mothers of all races to provide a lower proportion of HM as NICU hospitalization progressed. These findings raise the possibility that mothers modified their HM feeding goals because of the common problem of decreased HM supply.[26] Thus, rather than retain an unrealistic goal, the goals were modified so they could be achieved. Alternatively, mothers may have decided that less ambitious HM feeding goals were acceptable as infants' conditions improved. Mothers may have felt HM ''did its job'' by protecting the infant from prematurity-related morbidities[17] and was no longer critical to care. Distinguishing between these potential explanations is a research priority so that appropriate interventions can be targeted to maintain established lactation in this population.

Table 4 sheds some light on these potential explanations. Although most mothers met or exceeded their HM feeding goals during NICU hospitalization, there was a trend to feed less HM (with respect both to less ambitious HM feeding goals and to lower achievement) as hospitalization progressed. From a pragmatic perspective, it is easier to achieve a goal for EHM feedings in a VLBW infant who needs very small amounts of HM during DOL 1–14 than when these same infants grow and consume up to 200 mL/kg/day during late NICU hospitalization. It is tempting to assume that mothers simply need ''more support'' to continue to provide HM. However, previously reported data from this cohort reveal that these mothers had significant medical risk factors (obesity, hypertension, diabetes, mental health diagnoses) that often negatively impact the initiation and maintenance of lactation.[27–31] It is conceivable that these medical problems, which are more prevalent in black and low-income populations,[32] compromise the maintenance of lactation despite the intensive ''lactation support'' received by study participants. Also relevant is the fact that long-term breast pump dependency translates into numerous barriers not experienced by mothers of healthy term infants.[18,33]

Equally important to consider is the impact of early messaging used by this research team and many NICUs that focuses on the unique impact of HM on the reduction in risk of early-onset NICU morbidities. We speculate that although this information is a powerful motivator for changing the PD goal from NHM to either PHM or EHM and initiating lactation, it may be inadequate for maintenance of lactation in this vulnerable population. This speculation is supported by a study[17] conducted with a subset of mothers enrolled into this cohort, in which mothers described that they had ''faith in my milk'' to prevent and/or mitigate prematurity-specific complications but became ''OK'' with PHM or NHM later in NICU hospitalization because their HM had been successful in mitigating these complications. These findings suggest that initial HM messaging may need to segue into carefully scripted talking points about the longer-term health benefits of continued HM feedings once the immediate risks of necrotizing enterocolitis and sepsis have lessened. The data from our study suggest that this messaging should begin prior to the DOL 29–72 period, when maternal goals became less ambitious.

To our knowledge, this is the first study to report maternal HM feeding goals for method of feeding in mothers with VLBW infants. The overwhelming majority of mothers who chose EHM as the feeding type chose a combination of at-breast and bottle feedings (81.8%), with only 2% of black mothers choosing exclusive feedings at breast. Although the rationale for mothers' HM feeding method goals was beyond the scope of this study, our previous studies[11,34] and anecdotal reports suggest that mothers want to ''share'' the experience of feeding their VLBW infants with fathers and grandmothers. Others cite the convenience of providing HM by bottle due to competing employment and school commitments. These findings have enormous implications for international NICU-based initiatives that prioritize exclusive feedings at-breast and discourage bottles.[35] These initiatives appear be out of step with the majority of NICU mothers' feeding preferences, even when the mothers want their infants to have only HM. In the NICU where this study was conducted, mothers receive state-of-the-art lactation care that includes one-on-one assistance with feeding at-breast by nurses and BPCs.[19,25] Furthermore, nurses do not introduce bottles to breastfeeding infants routinely—mothers are asked to provide permission for bottle feedings if they are unable to be present for feedings at-breast as discharge approaches.[19] Thus, these findings reflect an NICU culture of respecting parent decision-making on method of feeding, rather than a culture of promoting bottle feeding. Further studies in other NICUs will be of assistance in determining the prevalence of the use of both breast and bottles to feed HM in this population.

The strengths of our study include prospectively collected measures for maternal HM feeding goals that differentiated between type of milk and method for feeding the milk, the use of actual infant HM feeding data to measure achievement of maternal HM feeding goals, and the large sample of ethnically and income diverse mothers of VLBW infants. An acknowledged limitation is that not all mothers had recorded HM feeding goals at all study time intervals. There were fewer mothers with recorded goals later in NICU hospitalization compared with PD or DOL 1–14. Therefore, it is possible that the results are due to a skewed subset of mothers who happened to have lower EHM goals later in NICU hospitalization. However, the racial and WIC eligibility characteristics of the mothers at various time intervals are similar, so this seems unlikely. An additional potential limitation is that PD goals were collected at the first postdelivery study visit and may have been subject to recall bias. However, as mothers who deliver VLBW infants are technically ''PD'' from when they should have delivered (at term), recall bias may be different from that of term mothers. Another limitation is that this study was conducted in a single NICU that prioritizes lactation support, with maternal access to salaried BPCs, evidence-based lactation care specific to breast pump–dependent mothers, and discounted rental of hospital-grade breast pumps.[25]

Conclusions

After birth of a VLBW infant, more mothers chose EHM or PHM, and fewer chose NHM than PD. Our findings that maternal HM feeding goals reflect more ambitious HM use during DOL 1–14 but become less ambitious thereafter require additional research as to why established lactation is not maintained in this population. Strategies that call for additional ''lactation support'' may be ineffective in the absence of data about the specific factors that inform the changes in maternal HM feeding goals and their achievement over the NICU hospitalization. Additionally, the fact that the majority of mothers who chose EHM feedings did not plan to feed exclusively at-breast raises questions about a ''one size fits all'' approach to lactation priorities in the NICU.

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Disclosure Statement

No competing financial interests exist.

All authors made substantial contributions to the study design, analysis and interpretation of data, and drafting and revising the article. All approved the final version to be published.

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