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Early Feeding Factors Associated with Exclusive versus Partial Human Milk Feeding in Neonates Receiving Intensive Care

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Abstract

Objective—To evaluate early feeding factors associated with exclusive human milk (EHM) feeding at discharge in a cohort of human milk fed infants admitted to the neonatal intensive care unit (NICU).

Study Design—Retrospective cohort of consecutively discharged infants from two NICUs over a 12 month period who received any human milk during the 24 hours prior to hospital discharge. We used logistic regression to evaluate early feeding factors associated with EHM feeding at discharge.

Results—We evaluated a total of 264 infants. EHM-fed infants were twice as likely to receive human milk at the first feeding compared to partial human milk fed infants (65% vs. 32%; P<0.01). In multivariable analysis, including adjustment for race and type of maternal insurance, infants receiving human milk as the initial feeding, compared to formula, had a greater odds of EHM feeding at hospital discharge (adjusted OR 3.41; 95% CI 1.82–6.39; P<0.001).

Conclusion—Among infants admitted to the NICU whose mothers provide human milk, those receiving human milk as the first feeding were more likely to receive EHM feeding at discharge.

Keywords

breast milk; breast feeding; preterm infants; quality improvement; nutrition

INTRODUCTION

Human milk feeding has been shown to improve neurodevelopmental outcomes[1], decrease the incidence of gastrointestinal infections[2] and lower the risk of sudden infant death syndrome (SIDS)[3]. Exclusive human milk (EHM) feeding has benefits over partial human milk (PHM) feeding, including a decreased risk of gastrointestinal and upper respiratory infections[4]. In addition, the use of human milk in preterm infants, compared to formula, is

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associated with decreased short-term morbidity such as necrotizing enterocolitis[5], sepsis and meningitis[6] and improved long-term neurologic outcomes[7]. In extremely low birth weight infants, increases in the proportion of enteral feeding that is human milk are associated with an incremental improvement in mental and psychomotor developmental indices and a decreased risk of re-hospitalization[8].

The American Academy of Pediatrics (AAP) recommends exclusive breastfeeding until six months of age, followed by continued breastfeeding with complementary foods until one year of age[9]. Although breast feeding is initiated in 75% of all infants in the United States, only 50% of infants have any breast milk intake at 6 months of age and only 13% are meeting the guidelines of being exclusively breastfed until six months of age[10]. Infants born to mothers with lower socioeconomic status, African-American race, and younger age are less likely to initiate breastfeeding[11]. Characteristics of mothers who are able to provide exclusive rather than partial breast milk for term infants follow the same trends with older, Caucasian women of higher socioeconomic status being more likely to exclusively breastfeed[12]. Mothers of infants in the neonatal intensive care unit (NICU) face unique challenges to breastfeeding. Obstacles such as the necessity of a mechanical breast pump, decreased skin to skin contact, stress of a sick neonate and delayed initiation of enteral feeding are all factors that contribute to a lower rate of both exclusive and partial breastfeeding in infants discharged from the NICU[13, 14]. Identifying modifiable factors that are associated with EHM feeding among infants receiving any human milk may allow for the development of targeted quality improvement interventions. Strategies that focus on the population of infants whose mothers already provide some human milk are most likely to respond to interventions aimed at increasing EHM feeding.

The primary objective of this study was to compare early feeding factors, including the type of initial feeding and timing of initial feeding, as well as maternal and neonatal characteristics between infants receiving EHM feeding and PHM feeding at discharge from the NICU. We hypothesized that initial human milk feeding would be associated with EHM feeding at discharge from the NICU.

SUBJECTS AND METHODS

Sample

We evaluated a consecutive sample of all infants discharged from two Atlanta, Georgia level III NICUs (Emory University Hospital Midtown (EUHM) and Grady Memorial Hospital (GMH)). We evaluated infants over a 12 month period from December 1, 2010 to November 31, 2011 at EUHM and January 1, 2011 to December 31, 2011 at GMH. Inclusion criteria included: 1) admission to the NICU; 2) discharge to home and 3) receipt of any human milk in the 24 hours prior to discharge. Exclusion criteria included: 1) infants that were transferred to another facility or did not survive hospitalization and 2) incomplete data regarding type of feeding at hospital discharge. Patients were identified for eligibility by review of discharge logs. Further information was obtained by individual chart review. This study was approved by the Emory University Institutional Review Board and the GMH Research Oversight Committee.

Definitions

We determined feeding status at discharge by reviewing recorded enteral intake during the 24 hours prior to the day of discharge to home. EHM feeding was defined as the receipt of only human milk, with or without the addition of fortifiers. PHM feeding was defined as the receipt of at least one feeding of human milk, either mechanically expressed or directly from the breast, in addition to formula feeding, in the 24 hours prior to discharge. The use of donor human milk was uncommon at centers in this study and none of the infants evaluated received donor human milk at discharge. The date of initial feeding and whether human milk was provided during the initial feeding was recorded for all infants. In addition, neonatal and maternal variables that were thought to potentially influence human milk feeding were collected. As a measure of illness severity, we recorded the highest level of respiratory support the infant received in the first 3 days after birth.

Statistical Methods

We compared baseline neonatal and maternal variables between EHM and PHM fed infants. For normally distributed continuous variables, we described the sample using mean values with standard deviations and compared groups using the Student's t-test. For non-normally distributed variables, we described the sample using median values with interquartile ranges and compared the groups using the Wilcoxon rank sum test. We compared categorical variables between groups using the Chi-square or Fisher's exact tests.

We used logistic regression to further evaluate the independent association of the type of first feeding and the age at first feeding with EHM feeding at discharge after adjusting for known confounders and unbalanced variables between both groups. In addition to early feeding factors, two known confounders, maternal race and type of insurance, were included in the model. Additional baseline covariates were selected using stepwise logistic regression with selection and stay P-values of 0.1. The following maternal covariates were entered into the stepwise iteration of the model: maternal age, number of prior maternal children, method of delivery, maternal drug abuse, and receipt of prenatal care. In addition, the following neonatal covariates were entered into the model: gestational age, birthweight, center, Apgar score at 5 minutes, and type of respiratory support. We ran full and reduced models with and without the variable for age at first feeding to compare the effect of this variable on the estimate of the association between type of first feeding and EHM feeding at discharge. We evaluated for statistical interaction between type of first feeding and other covariates in the multivariable model on the odds of EHM feeding using interaction terms in our logistic model. We assessed how well the variables included in the model predicted EHM feeding at discharge using the area under a receiver operating curve (AUC or c-statistic) and the goodness-of-fit of the final model using the Hosmer-Lemeshow test. We used SAS Version 9.2 for all analysis (Cary, NC). We considered a $P < 0.05$ significant.

RESULTS

Over the 12 month period of study, 267 infants met inclusion criteria. After exclusion of three infants for lack of information regarding type of feeding at discharge, 264 infants were analyzed from the study sample. A total of 137 (52%) infants received EHM feeding and

127 (48%) received PHM feeding at discharge (Table 1). Mothers of EHM fed infants had more private insurance (48% vs. 19%) and less government insurance (50% vs. 69%) compared to PHM fed infants (P<0.01).

Prematurity was more common in EHM fed infants (66% vs. 51%, P = 0.01), with the mean gestational age for EHM fed infants of 35.2 weeks compared to 36.8 weeks for PHM fed infants (P=<0.01) (Table 1). Similarly, lower birthweight and higher levels of respiratory support were more common in EHM fed infants (P<0.01).

Both EHM and PHM fed infants had a similar frequency of any enteral feeding by 7 postnatal days (100% vs. 98.4%, P = 0.23) (Table 2). The mean age of initiation of enteral feeds was older in EHM fed infants compared to PHM fed infants (1.5 days vs. 0.9 days, P <0.01). EHM fed infants were significantly more likely to receive human milk at the first feeding compared to PHM fed infants (65% vs. 32%, P<0.01). Median length of stay was longer for those infants receiving EHM feeding (11 days vs. 7 days, P <0.01).

In multivariable analysis, infants receiving human milk as the initial feeding, compared to formula, had a significantly greater odds of EHM feeding at NICU discharge (adjusted odds ratio (aOR) 3.41; 95% Confidence Interval (CI) 1.82–6.39; P<0.001) (Table 3). The addition of the variable for age at first feeding was not significant (P=0.21) and, therefore, not included in the final model. Additionally, the inclusion of this variable in the multivariable analysis did not change the estimate for the association between human milk as the initial feeding and EHM feeding at discharge (aOR 3.32; 95% CI 1.77–6.23). Type of maternal insurance was independently associated with type of feeding and infants born to mothers who had private insurance were more likely to receive EHM feeding at discharge (aOR 10.1; 95% CI 1.74–58.2, P=0.01). After controlling for other factors, birthweight, number of prior living children, maternal race and length of stay were not significantly associated with EHM feeding. We found no evidence for statistical interaction between type of initial feeding and race, center or birthweight on the odds of EHM feeding at discharge (P>0.2 for each interaction). In subgroup analysis, initial human milk feeding was associated with EHM feeding at discharge in term, late-preterm (34 0/7 to 36 6/7 weeks), and moderate or extremely preterm (<34 0/7 weeks gestation) infants (P<0.01 for each subgroup) (Table 4). In addition, EHM feeding was more common among term infants admitted to the NICU (78.3%) than preterm infants <37 weeks gestation (58.2%).

DISCUSSION

We found that the receipt of human milk as the first feeding was highly associated with EHM feeding at discharge among human milk fed neonates receiving intensive care. Infants fed human milk for their first feeding were twice as likely to receive EHM feeding at the time of discharge, regardless of their gestational age. This association remained significant after adjusting for known and potential confounders, including center, birthweight, race and type of insurance. Our findings suggest that efforts focused on improving the use of human milk at the first feeding may have a large effect on EHM feeding by women who intend to breastfeed, regardless of the gestational age or birthweight of the infant receiving NICU care.

The Baby Friendly Hospital Initiative passed by UNICEF and WHO in 1991 recommends that the first feeding of all infants be human milk and no formula supplementation should be provided during the hospital stay[15]. The data supporting this policy suggests that term infants supplemented with formula during the nursery stay have an almost fourfold increase of being weaned off human milk by three months of age[16, 17]. NICUs that have implemented the Baby Friendly Hospital policy have seen a significant increase in the percentage of infants receiving EHM at discharge as well as prolongation of the duration of EHM feeding after discharge[18, 19]. Although there are many other important components of the initiative that aid in promoting breastfeeding, our data suggests that the use of human milk as the first feeding is an important contributor.

We speculate that the association between the first feeding of human milk and a higher incidence of EHM feeding at discharge may be related to the readiness of mothers to breast feed when the neonate is ready for the first enteral feed. Alternatively, it may be possible that certain caregivers wait until the mother has human milk to provide for the first feeding while other caregivers will substitute formula if no human milk is available. This is suggested by the finding that infants fed EHM at discharge had a later initiation of enteral feeding. The later initiation of enteral feeding could potentially lead to a prolonged length of hospital stay. However, our study did not detect a statistically significant association between EHM feeding and a longer length of stay after adjusting for other factors. Currently, there is conflicting evidence regarding the association between EHM feeding and prolonged hospital length of stay. A study by Schanler et al. reported a shorter hospital stay for very low birth weight (VLBW) infants fed exclusive human milk[20]. However, Parker et al. found that VLBW infants receiving EHM had an increase in average length of stay of 8 days compared with those receiving formula[21].

The independent association between private health insurance and a higher frequency of human milk feeding has been documented in previous studies[22,23] and was demonstrated in our study. Mothers with private health insurance are more likely to have a higher socioeconomic class and more advanced educational status, which are both associated with exclusive human milk feeding [24]. Of note, implementation of the Baby Friendly Hospital Initiative has been shown to increase exclusive breastfeeding rates across all demographic groups, including women of low socioeconomic status[25]. Promoting human milk as the first feeding as part of the Baby Friendly Initiative may help to reduce the socioeconomic disparities in exclusive human milk feeding.

Our study has several strengths. We used a consecutive sample of all infants receiving neonatal intensive care, rather than certain subpopulations of term or preterm infants. This increases the generalizability of our findings to the whole population of infants cared for in NICUs and may also reduce selection bias. In addition, we were able to determine the discharge feeding status based on actual measured intake of human milk rather than parental or clinician report. Finally, we were able to adjust for known and potential confounders of EHM feeding, including both maternal and neonatal characteristics.

Our study has several limitations. EHM feeding at discharge may not be indicative of continued EHM feeding at home. However, studies have shown that infants discharged on

EHM feeding from the hospital are more likely to continue EHM feeding at home and also receive any human milk for a longer period of time[26, 27]. Second, we could not assess the frequency or intensity of lactation consultation, which is another modifiable factor that influences exclusive breast feeding[28]. Third, this study may not be applicable to centers that have readily available donor human milk for the initial enteral feed. Finally, our observational study design limits inferences regarding causality between early feeding factors and EHM feeding at discharge.

Initiation and continuation of breast feeding for infants in the NICU can be especially challenging. The number of infants that are discharged from NICUs receiving EHM feeding has been reported to be around 30%[14, 29], only half of the reported exclusive breast feeding rate at discharge for all newborn infants[30, 31]. Increasing the rate of EHM feeding is important in promoting the health of both the neonate and the mother and remains an important quality indicator for neonatal intensive care units[32]. The findings from our study highlight an important modifiable factor that may guide targeted strategies for quality improvement efforts to increase the proportion of EHM fed neonates receiving neonatal intensive care. Further studies are needed to determine if improvement projects aimed at increasing the use of human milk as the first feeding, including the allowance of a reasonable amount of time for the mother to provide human milk, would increase the number of infants discharged home from the NICU receiving EHM feeding. In conclusion, among infants admitted to the NICU whose mothers provided any human milk at discharge, those receiving human milk as the first feeding were more likely to receive EHM feeding at hospital discharge.

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TABLE 1

Baseline Maternal and Neonatal Characteristics

Maternal Characteristics	Exclusive Human Milk n=137	Partial Human Milk n=127	P Value
Maternal age - mean years (SD)	29.0 (6.1)	27.6 (6.1)	0.08
Number of living children - median (IQR)	0 (0–2)	0 (0–2)	0.86
Type of Insurance			
Government	69 (50.4%)	88 (69.3%)	<0.01
Private	66 (48.2%)	24 (18.9%)	
None	2 (1.5%)	15 (11.8%)	
Any prenatal care	132 (96.4%)	122 (96.1%)	0.90
Substance Abuse	7 (5.1%)	12 (9.4%)	0.17
Mode of Delivery			
Vaginal	86 (62.8%)	82 (64.6%)	0.76
Cesarean	51 (37.2%)	45 (35.4%)	
Neonatal Characteristics			
Gestational Age – mean weeks (SD)	35.2 (4.0)	36.8 (3.3)	<0.01
Birthweight – mean grams (SD)	2380 (896)	2811 (844)	<0.01
Preterm (<37 weeks gestation)	91 (66.4%)	65 (51.2%)	0.01
Sex			
Male	79 (57.7%)	74 (58.3%)	0.92
Female	58 (42.3%)	53 (41.7%)	
Race			
Black	82 (59.9%)	71 (55.9%)	0.01
White	37 (27.0%)	21 (16.5%)	
Hispanic	11 (8.0%)	18 (14.2%)	
Other	7 (5.1%)	17 (13.4%)	
Inborn	128 (93.4%)	120 (94.5%)	0.72
Apgar at 1 min - median (IQR)	7 (4–8)	8 (6–8)	<0.01
Apgar at 5 min - median (IQR)	9 (8–9)	9 (8–9)	0.11
Singleton birth	110 (80.3%)	113 (89.0%)	0.05
Respiratory Support			
NC or Room Air	63 (46.0%)	85 (66.9%)	<0.01
CPAP	49 (35.8%)	34 (26.8%)	
Ventilation	25 (18.2%)	8 (6.3%)	
Hypoglycemia upon admission, n (%)	22 (16.1%)	21 (16.5%)	0.92

Data are displayed as n (%) unless indicated otherwise.

Abbreviations: SD, standard deviation; IQR, interquartile range; min, minute; NC, nasal cannula; CPAP, continuous positive airway pressure.

TABLE 2

Early Feeding Characteristics and Length of Stay

Variable	Exclusive Human Milk n=137	Partial Human Milk n=127	P Value
Enteral feeding on DOL 0-7	137 (100%)	125 (98.4%)	0.23
DOL at first feeding – mean (SD)	1.5 (1.1)	0.9 (1.2)	<0.01
Human milk as first feeding	89 (65.0%)	40 (31.5%)	<0.01
Length of stay - median d (IQR)	11 (7–26)	7 (4–14)	<0.01

Data are displayed as n (%) unless indicated otherwise.

Abbreviations: DOL, day of life; SD, standard deviation; d, days; IQR, interquartile range.

TABLE 3

Multivariable Analysis of Factors Associated with Exclusive Human Milk Feeding

Variable	OR	95% CI	P Value
Human milk as first feeding	3.41	1.82 – 6.39	<0.001
Birthweight[1]	0.96	0.92 – 1.01	0.08
Type of maternal insurance			
Government	4.23	0.84 – 21.19	0.08
Private	10.07	1.74 – 58.17	0.01
None	1.00	reference	
Number of prior living children	1.23	0.98 – 1.54	0.07
Race			
Black	1.63	0.69 – 3.86	0.27
Hispanic	1.58	0.48 – 5.18	0.45
Other	0.62	0.18 – 2.13	0.45
White	1.00	reference	
Length of stay[2]	1.50	0.98 – 2.29	0.06

Response category is EHM. Model includes center (not shown), C-statistic=0.82 and Hosmer & Lemeshow goodness-of-fit P=0.90. Testing for interaction between type of initial feeding with race, center and birthweight was not significant (P>0.2 for each comparison).

Abbreviations: NICU, neonatal intensive care unit; OR, odds ratio; CI, confidence interval; EHM, exclusive human milk.

[1] per increase in 100 grams of birthweight

[2] OR indicates effect for each doubling of length of stay due to natural log transformation

TABLE 4

Patient and Early Feeding Characteristics by Gestational Age Subgroups

Variable	Exclusive Human Milk	Partial Human Milk	P Value
Number of infants, n			
≥37wk	46	62	
34 0/7-36 6/7wk	44	43	
<34 0/7wk	47	22	
Birthweight, mean g (SD)			
≥37wk	3326 (588)	3428 (588)	0.37
34 0/7-36 6/7wk	2234 (449)	2470 (487)	0.02
<34 0/7wk	1591 (544)	1732 (463)	0.30
Gestational age, mean wk (SD)			
≥37wk	39.7 (1.3)	39.6 (1.3)	0.57
34 0/7-36 6/7wk	35.1 (0.8)	35.3 (0.9)	0.17
<34 0/7wk	30.9 (2.6)	31.6 (1.8)	0.28
Initial feeding, mean age (SD)			
≥37wk	1.4 (1.5)	0.8 (1.6)	0.04
34 0/7-36 6/7wk	1.2 (0.9)	0.9 (0.8)	0.17
<34 0/7wk	1.9 (0.9)	1.3 (0.9)	0.01
Human milk as first feeding, n (%)			
≥37wk	36 (78.3%)	25 (40.3%)	<0.01
34 0/7-36 6/7wk	26 (59.1%)	11 (25.6%)	<0.01
<34 0/7wk	27 (57.4%)	4 (18.2%)	<0.01

Abbreviations: g, grams; SD, standard deviation; wk, weeks.