RESEARCH ARTICLE

Outcomes of Implementation of a NICU-Based Late Preterm Infant Feeding Guideline

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ABSTRACT

BACKGROUND AND OBJECTIVES: Late preterm (LPT) infants are at risk for feeding difficulties. Our objectives were to reduce the use of intravenous (IV) fluids and increase breastfeeding at discharge among LPT infants admitted to our NICU.

METHODS: We implemented a feeding guideline and evaluated its effect using a pre-post design. We examined rates of our main outcomes, IV fluid use, and any or exclusive breastfeeding at discharge, as well as several secondary outcomes, including hypoglycemia (glucose <50 mg/dL) at >8 hours of life, by using χ^2 and t tests. We excluded infants that were <2000 g, admitted to the NICU at >8 hours of life, or needed IV fluids at ≤8 hours of life for a medical reason. We used multivariable logistic regression to examine odds ratios and 95% confidence intervals of our main outcomes.

RESULTS: Fifty percent of infants were eligible. Of those eligible, 18 of 52 (35%) vs 14 of 65 (22%) received IV fluids at >8 hours of life ($P = .06$). In the 24 hours before discharge, 35 of 52 (75%) vs 46 of 65 (78%) received any breast milk ($P = .67$), and 10 of 52 (30%) vs 10 of 65 (21%) received exclusive breast milk ($P = .43$). More infants had hypoglycemia in the posttime period (16 of 65 [25%]) compared with the pretime period (3 of 52 [6%]; $P = .01$).

CONCLUSIONS: After implementation of a LPT feeding guideline in our NICU that defined specific expected feeding volumes, we did not find changes in IV fluid use or breastfeeding.

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Late preterm (LPT) births, those at 34 0/7 to 36 6/7 weeks' gestation, constitute 7% of US births.[1] A population-based study revealed that hospital-based morbidities, such as hypoglycemia, respiratory distress, apnea, hyperbilirubinemia, hypothermia, and feeding difficulties, occur 7 times more often among LPT infants compared with term infants,[2] leading to prolonged hospitalization and higher health care costs.[3] For this reason, professional organizations, such as the National Perinatal Association,[4] the American Academy of Pediatrics,[5] and the Academy of Breastfeeding Medicine,[6] have published guidelines outlining optimal hospital-based management of LPT infants. Feeding care recommendations, which address the high rate of breastfeeding difficulties, immature oral feeding skills, and dehydration, are core components of these guidelines.

Regarding the hospital care of LPT infants, criteria for admission to level 1 vs level 2 or 3 neonatal care areas[7] and feeding care practices[8] vary widely. In our own hospital, an urban, academic medical center with a level 3 NICU, we noted considerably different feeding practices among LPT infants cared for in our level 3 NICU compared with our level 1 nursery. We noted that LPT infants cared for in our level 3 NICU were expected to consume far larger quantities of breast milk, donor milk, or formula in the first 4 days of life (~60–140 mL/kg per day) compared with LPT infants cared for in our level 1 nursery (~0–40 mL/kg per day). We believe this difference in expected feeding volumes was largely because of the NICU staff's fear of dehydration, hypoglycemia, and possible readmission. We were concerned that these practices were contributing to the unnecessary use of intravenous (IV) fluids because IV fluids were routinely started when a LPT infant was not reaching his or her feeding goals, regardless of weight loss' and that existing feeding practices were impairing establishment of breastfeeding because LPT infants were immediately supplemented with bottles or nasogastric feedings when not reaching our relatively high-targeted feeding volumes. For this reason, we developed a LPT infant feeding guideline and implemented this guideline in our NICU in June 2012. The expected feeding volumes specified in our guideline were similar to recommendations later published by the National Perinatal Association in 2013[4] and the Academy of Breastfeeding Medicine in 2016.[6] In these guidelines, small volumes of feedings are recommended because of the small capacity of the newborn stomach in the first days of life.[9] Our main objectives were to determine the extent to which implementation of our LPT infant feeding guideline led to a change in (1) the use of IV fluids during the hospitalization and (2) any and exclusive breastfeeding during the 24 hours before discharge. Our secondary objectives were to examine the extent to which implementation of our feeding guideline affected secondary outcomes related to LPT infant health, which included hypoglycemia, weight loss, hyperbilirubinemia requiring phototherapy, caloric supplementation >22 kcal/oz at discharge, and length of stay.

METHODS

Design, Setting, and Sample

We examined a cohort of mother-LPT infant dyads cared for at Boston Medical Center a large, urban, safety net hospital in Boston, Massachusetts with a 22-bed, level 3 NICU, from June 2010 to November 2014. The Boston University Medical Campus Institutional Review Board approved this analysis. During this time, any LPT infant born at <36 0/7 weeks' gestation was admitted within 2 hours after birth to the NICU for a minimum observation period of 6 hours, where infants were observed for cardiorespiratory stability, temperature and glucose regulation, and feeding ability. After NICU observation, if the medical team concluded that further observation or medical interventions were needed, such as an isolette to manage temperature regulation, IV fluids for hypoglycemia, respiratory support, further evaluation of feeding ability, or any other concern requiring intensive care, the infant remained in the NICU; otherwise, the infant was transferred to the level 1 nursery. LPT infants cared for in the nursery that required these interventions were transferred to the level 3 NICU.

Boston Medical Center has maintained Baby-Friendly designation since 1999. There were no specific changes to breastfeeding support practices in our NICU during the study time period, with the exception of the introduction of a pasteurized human donor milk program in June 2011, in which only infants at <35 weeks' gestation met criteria.

LPT Infant Feeding Guideline

Our feeding guideline was developed for infants deemed eligible to receive exclusive enteral feedings by the NICU medical team. It provided recommended total volumes of feedings in the first 4 days of life in addition to any direct breastfeeding (Table 1). Before the guideline, feeding decisions were made by the attending physician and not standardized. Our Boston Medical Center NICU guideline was similar to recommended supplemental volumes published by national organizations after the implementation of our guideline.[4,6] NICU nurses and physicians were trained in the use of the guideline only a few weeks before implementation, with ongoing training in the first 6 months after the rollout. We tracked our outcomes in the 2 years before implementation of our guideline from June 1, 2010, to May 31, 2010, and the 2 years after a 6-month "washout" period after the guideline was first implemented, when staff were continuing to receive training, from December 1, 2012, until November 30, 2014.

Inclusion Criteria

We tracked LPT infants who were born at and discharged from Boston Medical Center (did not die or were transferred out of our facility) and who were eligible for our guideline (birth weight ≥2.0 kg and did not require IV fluids at ≤8 hours of life for "medical indications" including (1) treatment of hypoglycemia, (2) nil per os (NPO) status for cardiorespiratory instability, or (3) NPO status for concern of gastrointestinal obstruction or severe cardiac defect requiring urgent surgery (Fig 1). We also restricted our analysis to LPT infants who were admitted to the NICU within 8 hours of life because the intent of the feeding guideline was to start as soon as possible, with the goal to reduce IV fluids soon after admission and support early breastfeeding. For our analysis of breastfeeding outcomes, we additionally

TABLE 1 Guidelines for the Expected Volume of Enteral Feedings for LPT Infants

	Boston Medical Center NICU Guidelines (June 2012)			National Perinatal Association (2013)	Academy of Breastfeeding Medicine (2016; Revision of 2011)
	Expected Volume per Feed (mL)	Expected mL/kg per d LPT Infants (~2.0–2.5 kg)	Expected mL/kg per d ≥37 wk or LPT infants ≥2.5 kg	Supplement Only if Medically Indicated With the Following Volumes, mL	Supplementation After Breastfeeding for the Following Volumes, mL
0–24 h after birth	~5–10	~20–30	~0–20	2–10	5–10
25–48 h after birth	~10–20	~60	~20–40	5–15	10–30 "thereafter"
49–72 h after birth	~20–30	~80	~60	15–30	
73–96 h after birth	~30–60	~100	~80	30–60	
Frequency of feeds	Offer ad lib every two hours to every three hours			10–12 breastfeeds or 8–10 formula feedings per d	8–12 breastfeeds per d
How to supplement	By orogastric or nasogastric tube if infant is unable to take sufficient feedings by bottle			Supplementation with feeding tube at breast feeding, cup feeding, finger feeding, or bottle-feeding	Supplemental nursing device at the breast, cup feeds, finger feeds, syringe feeds, or bottle depending on clinical situation or maternal preference
What to supplement	Mother's milk if available, then donor milk (with consent), then formula (Neosure 22 kcal/oz)			In order of preference: expressed breast milk, donor human milk, hydrolyzed formula, or formula	Expressed breast milk, donor milk, or formula
Monitoring dehydration	Use of IV fluids may be considered for significant wt loss, clinical concern for dehydration, hypoglycemia, or any other concern by an attending physician "Weight loss" not defined Stools and/or void frequency not specified			Wt loss of >3% per d or 7% by d 3 merits further evaluation Goal voids and stools = 3/3 by d 3, 4/4 by d 4, 6/4 by d 6, and beyond	Wt loss of >3% per d or 7% by d 3 merits further evaluation Goal of 6 stools by d 4

Comparing key elements of the LPT infant feeding guidelines at our own institution compared with those by professional organizations.

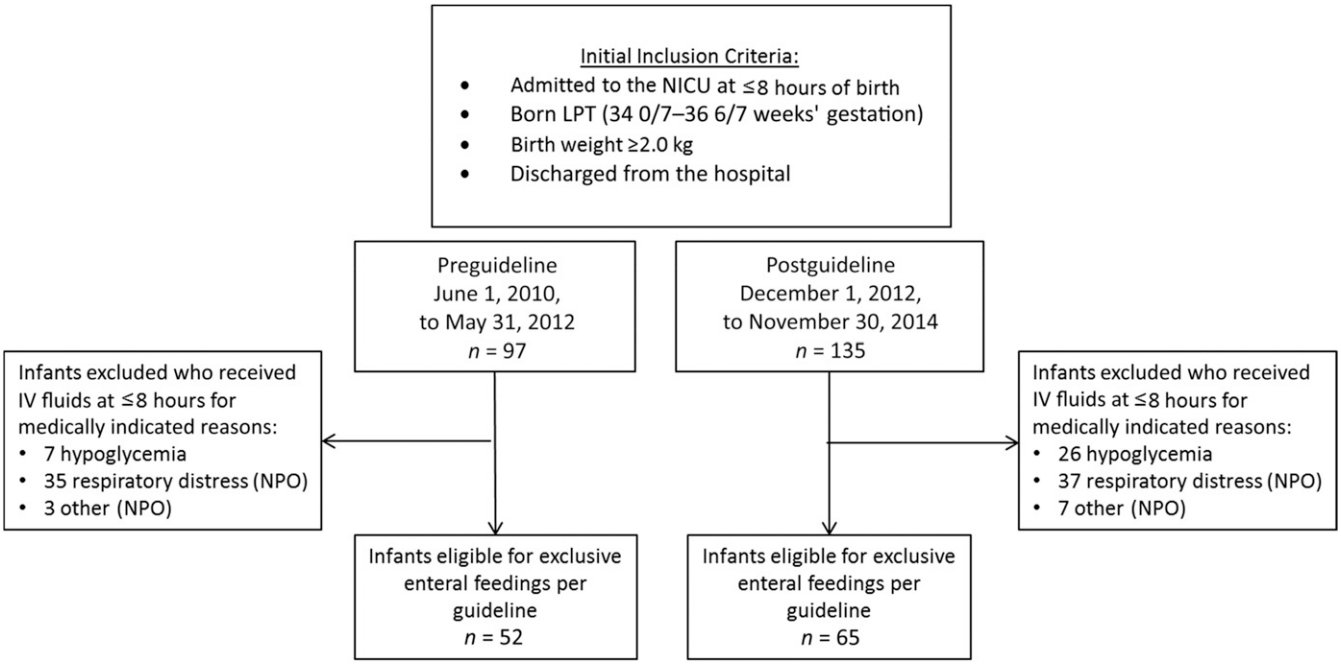

FIGURE 1 Participant flow diagram.

restricted our analysis to infants eligible to receive their mother's own milk per our hospital criteria, which is as follows: mothers without positive urine toxicology screens for nonprescribed opioids or illicit substances in the 10 weeks before or on the day of delivery, HIV, hepatitis C and cracked and bleeding nipples, open herpes lesions on the breast, taking medications contraindicated with breastfeeding, or in extreme social circumstances in which the infant would not be in the mother's care after hospital discharge.

Outcomes

One main outcome was any use of IV fluids at >8 hours of life during the hospitalization because the use of IV fluids at ≤8 hours of life was an exclusion criterion for analysis (see above). We categorized the use of IV fluids as "medically indicated" (as described above) and "not medically indicated" when no such reason could be found in our chart review. Our other main outcomes were any and exclusive breastfeeding in the 24 hours before discharge, in which "any breastfeeding" was provision of any expressed mother's milk or direct breastfeeding, and "exclusive breastfeeding" was provision of 100% expressed mother's milk or direct breastfeeding. Infants that received bovine-based fortifiers for caloric supplementation of mother's milk were not excluded in our definition of "exclusive" mother's milk at discharge.

As secondary outcomes, we examined the percent of LPT infants with hypoglycemia (defined as any glucose <50 mg/dL that occurred at >8 hours of life), any hyperbilirubinemia that required phototherapy, average maximum percent weight loss (defined as change in weight in grams from the day of birth until discharge), percent with caloric supplementation of >22 kcal/oz at discharge, and length of stay. A secondary breastfeeding outcome also included day of life the infant first received mother's breast milk, in which day of life 0 was 0 to 24 hours, day of life 1 was 25 to 48 hours, etc. We also examined average feeding volumes consumed by day (milliliters per kilogram per day; by bottle or nasogastric tube) and any direct breastfeeding in the first 4 days of life to assess compliance to recommended feeding volumes per our guideline.

Covariates

Covariates were abstracted from the medical record. Maternal characteristics included age, race and/or ethnicity, insurance type (Medicaid equivalent, private, or other), and mode of delivery (vaginal versus cesarean birth). Infant characteristics included gestational age, birth weight, sex, plurality, and discharge location.

Data Analysis

Data were analyzed by using SAS 9.4 (SAS Institute, Inc, Cary, NC) and Excel. We examined differences in maternal and infant characteristics and feeding volumes consumed in the first 4 days of life among LPT infants cared for in our NICU 2 years before and after implementation of our LPT feeding guideline. We used χ^2 and Fisher's exact tests for categorical variables and *t* tests for continuous variables and multivariable logistic regression to examine differences in our main outcomes in the pre- versus posttime periods. We used backward variable selection to fit our logistic regression models because we had a relatively large number of potential covariates and small number of subjects available for analysis ($n = 117$ for models in which any IV fluids were examined versus none, $n = 112$ for nonmedically indicated IV fluids only versus none, and $n = 106$ for any and exclusive breastfeeding at discharge versus none). By using this method, only gestational age was included as a covariate in our models. Additionally, in our models in which breastfeeding outcomes were examined, we included insurance status and mode of delivery (vaginal versus cesarean delivery) because these variables significantly differed in the pre- versus posttime periods in our bivariate analysis and, a priori, were factors known to be associated with breastfeeding. Unadjusted and adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were calculated.

RESULTS

In the pre- versus posttime period, 52 of 97 (54%) and 65 of 135 (48%) LPT infants were eligible for exclusive enteral feedings, respectively (Fig 1). The most common reasons infants did not receive exclusive enteral feedings was the need for IV fluids for hypoglycemia or for NPO status with respiratory distress. In our bivariate analysis, fewer mothers had Medicaid insurance in the pre- versus the posttime period (64% vs 85%; $P = .01$), and more gave birth vaginally instead of by cesarean delivery (75% vs 57%; $P = .04$). There were no differences in maternal age, race and/or ethnicity, or eligibility to breastfeed, nor were there differences in infant gestational age, birth weight, sex, or plurality in the pre- versus postguideline time periods (Table 2).

We found that use of IV fluids at >8 hours for any reason, medical or nonmedical, in the preguideline implementation time period was 35% (18 of 52) and was 22% (14 of 65) in the postguideline implementation time period ($P = .06$). Only 1 of 18 infants received medically indicated IV fluids (NPO for evaluation of intestinal obstruction) in the pretime period compared with 4 of 14 in the posttime period (2 for hypoglycemia, 1 for respiratory distress, and 1 for both hypoglycemia and respiratory distress). The percent of infants given IV fluids for nonmedical indications only was 33% in the pretime period compared with 15% in the posttime period. We also found that in the pre- versus posttime period, fewer infants had hypoglycemia (6% vs 25%; $P = .01$), more required phototherapy (42% vs 23%; $P = .03$), and more required caloric supplementation with >22 kcal/oz at discharge (31% vs 12%; $P = .02$). We found no difference in maximum percent weight loss during hospitalization, change in weight from birth until discharge, or length of stay (Table 2).

We found that average enteral feeding volumes did not significantly differ in the pre- versus posttime periods in the first 3 days of life, but at 73 to 96 hours of life (day 4), the average enteral feeding volume was higher during the 2 years before the guideline (122 mL/kg per day) versus the 2 years after the guideline (81 mL/kg per day; $P < .001$). Regarding compliance to the recommended enteral feeding volumes after the guideline, we found that on day 1, the

TABLE 2 Participant Characteristics and Outcomes

Characteristics	Pre (n = 52)	Post (n = 65)	P
Mother			
Age, y, mean (SD)	30.3 (5.7)	28.7 (7.1)	.17
Race and/or ethnicity, n (%)			.44
Non-Hispanic white	11 (21.2)	11 (16.9)	
Non-Hispanic black	21 (40.4)	25 (38.5)	
Hispanic	12 (23.1)	23 (35.4)	
Others	8 (15.4)	6 (9.2)	
Insurance type, n (%)			
Medicaid equivalent	33 (63.5)	55 (84.6)	.01
Private	15 (28.9)	10 (15.4)	
Other	4 (7.7)	0 (0.0)	
Mode of delivery, n (%)			.04
Vaginal	39 (75.0)	37 (56.9)	
Cesarean	13 (25.0)	28 (43.1)	
Eligible to breastfeed per hospital guidelines,[a] n (%)	47 (90.4)	59 (90.7)	.70
Infant			
Gestational age, wk, mean (SD)	35.3 (0.6)	35.3 (0.6)	.90
Birth wt, g, mean (SD)	2487.3 (418.7)	2553 (398.0)	.38
Female sex, n (%)	22 (42.3)	21 (32.3)	.26
Multiple birth, n (%)	8 (15.4)	16 (24.6)	.22
Direct NICU admission, n (%)	51 (98.1)	63 (96.9)	1.00
Discharge location, n (%)			.13
NICU	26 (50.0)	23 (35.9)	
Non-NICU (nursery, PICU, or pedi-floor)	26 (50.0)	41 (64.1)	
Main nonbreastfeeding outcomes			
IV fluids given at >8 h of life, n (%)			.06
Yes, per medical indications	1 (1.9)	4 (6.2)	
Yes, not per medical indications	17 (32.7)	10 (15.4)	
No	34 (65.4)	51 (78.5)	
Main breastfeeding outcomes[b]			
Initiation			
Day of life infant first received mother's milk, (direct breastfeed or expressed milk), mean (SD)	1.1 (1.0)	0.9 (0.9)	.07
Continuation until 24 h before discharge			
Any mother's milk at 24 h before discharge (direct breastfeed or expressed milk), n (%)	35 (74.5)	46 (78.0)	.67
Exclusive mother's milk at 24 h before discharge (direct breastfeed or expressed milk), n (%)	10 (30.3)	10 (21.3)	.44
Any direct breastfeeding, n (%)	24 (51.1)	31 (52.5)	.88
Secondary outcomes			
Any hypoglycemia (glucose <50 mg/dL) at >8 h of life, n (%)	3 (5.8)	16 (24.6)	.01
Any hyperbilirubinemia requiring phototherapy, n (%)	22 (42.3)	15 (23.1)	.03

average enteral feeding volume was greater (41 mL/kg per day) than the recommendation of ~20 to 30 mL/kg per day. On days 2 and 3, the average enteral feeding volume was similar to the guideline (day 2: 57 mL/kg per day [recommendation ~60 mL/kg per day]; day 3: 82 mL/kg per day [recommendation 80 mL/kg per day]). On day 4, the average enteral feeding volume (81 mL/kg per day) was lower than the recommendation of ~100 mL/kg per day). Any direct breastfeeding was low in both the pre- and posttime periods in the first 4 days of life, with rates ranging from 35% to 56%, and there were no significant differences between pre- and posttime periods (Table 3).

In our adjusted model in which any IV fluid use was examined, we found no difference in IV fluid use in the pre- versus posttime periods (aOR 0.51; 95% CI 0.22–1.18); however, in our model restricted to infants with nonmedically indicated IV fluids versus none, we found that infants in the posttime period had lower odds of nonmedically indicated IV fluids compared with the pretime period (aOR 0.34; 95% CI 0.13–0.87). We did not find associations in our models in which any and exclusive breastfeeding were examined (aOR 1.40, 95% CI 0.54–3.68; aOR 0.58, 95% CI 0.19–1.81, respectively).

DISCUSSION

We developed a simple, easy-to-follow feeding guideline for LPT infants deemed eligible to receive exclusive enteral feedings admitted to our level 3 NICU and found no change in overall IV fluid use or breastfeeding. However, in our adjusted analysis, the use of nonmedically indicated IV fluid was significantly lower in the postguideline period compared with the preguideline period. We also found that after implementation of the guideline, LPT infants had higher rates of hypoglycemia after 8 hours of life, lower rates of phototherapy for hyperbilirubinemia, and lower rates of caloric supplementation >22 kcal/oz at discharge, but no change in maximum weight loss or length of stay.

LPT infants have immature feeding skills.[10,11] They are less coordinated in their ability to suck, swallow, and breathe, and they transfer less milk during feedings because

TABLE 2 Continued

Characteristics	Pre (n = 52)	Post (n = 65)	P
Maximum % wt loss during the hospitalization, g, mean (SD)	0.06 (0.03)	0.06 (0.05)	.86
Change in wt per d from birth until discharge, g, mean (SD)	−5.1 (25.8)	−12.6 (30.8)	.16
Caloric supplementation of >22 kcal/oz at discharge, n (%)	16 (31.4)	8 (12.3)	.02
Length of stay, d, mean (SD)	11.9 (8.8)	9.3 (7.5)	.09

[a] Infants did not receive mother's milk if their mother had positive urine toxicology results for nonprescribed opioids or other illicit substances in the preceding 10 wk before delivery, HIV, hepatitis C with cracked and bleeding nipples, open herpes lesions on the breast. Infants did not receive mother's milk from mothers who took medications contraindicated for breastfeeding or from mothers in extreme social circumstances in which mothers were not expected to care for the infant after delivery.

[b] Analysis for breastfeeding outcomes was restricted to infants eligible to receive mother's milk.

of weaker sucking pressures.[10,12] Mothers of LPT infants often have risk factors for delayed onset of lactogenesis, including cesarean delivery, obesity, hypertension, and diabetes.[13–15] Taken together, these issues put LPT infants at high risk for excessive weight loss and dehydration, which can lead to readmission.[16,17] We found that in our NICU, before the implementation of the guidelines, the fear of these conditions coupled with the "NICU culture" of tracking strict fluid intake and output led to drastically different feeding expectations among LPT infants cared for in our NICU compared with our level 1 nursery. For instance, in the first 24 hours of life, breastfeeding LPT infants cared for in our NICU were often expected to take much larger feeding volumes (as much as 30 mL per feed), with or without a previous breastfeeding episode, compared with no supplementation at all after a breastfeeding episode in the nursery. The use of non–breast milk supplements and reduced breastfeeding episodes during the establishment of breastfeeding are known to contribute to early breastfeeding cessation.[13] We suspect that this scenario is common among other NICUs, even among those that exist in Baby-Friendly designated hospitals like ours.

TABLE 3 Enteral Feeding Volumes in the First 4 Days of Life

	Pre (n = 52)	Goal Volume per Guideline, mL/kg per d	Post (n = 65)	P
0–24 h		~20–30		
Enteral feeding volumes consumed, mL/kg per d, mean (SD)	41.5 (20.7)		41.2 (17.9)	.95
Any direct breastfeeding,[a] n (%)	20 (47.6)		18 (35.3)	.23
25–48 h		~60		
Enteral feeding volumes consumed, mL/kg per d, mean (SD)	71.0 (28.2)		57.0 (28.0)	.14
Any direct breastfeeding, n (%)	16 (45.7)		16 (47.1)	.91
49–72 h		~80		
Enteral feeding volumes consumed, mL/kg per d, mean (SD)	94.6 (38.1)		81.7 (38.0)	.32
Any direct breastfeeding,[a] n (%)	12 (36.4)		13 (44.8)	.61
73–96 h		~100		
Enteral feeding volumes consumed, mL/kg per d, mean (SD)	122.3 (20.8)		80.7 (32.2)	<.001
Any direct breastfeeding,[a] n (%)	18 (56.3)		8 (34.8)	.17

[a] Analysis for breastfeeding outcomes was restricted to infants eligible to receive mother's milk.

Soon after we implemented our guidelines, recommended supplemental feeding volumes in the first days of life were published by the National Perinatal Association[4] and Academy of Breastfeeding Medicine.[6] It is important to note that these national guidelines recommend direct breastfeeding at least 8 or more times per day first, followed by supplementation with mother's milk or other milk substitutes, only in the setting of excessive weight loss. In the guideline we developed, we did not specifically address the issue of supplementation and found that infants continued to receive a relatively large volume of feedings by bottle or nasogastric tube. While still at the hospital, all breastfeeding mothers of LPT infants admitted to the NICU receive lactation specialist support on site. Lactation visits in the first 4 days after delivery usually occur in the mother's postpartum room. There were no systematic changes to lactation specialist support during the study time period. At our center, only 35% to 56% of LPT infants received any direct breastfeeding in the first 4 days of life during the 4 years we tracked data. We hypothesize that this is the key reason why we found no change in breastfeeding outcomes. These data suggest that mothers came to the NICU to directly feed their infants, an important predictor of breastfeeding success, relatively infrequently. However, contributions to breastfeeding success in the hospital setting among LPT infants are multifactorial, and it is possible that other factors that we did not track also influenced breastfeeding outcomes. These may have occurred outside the NICU setting because the majority of LPT infants were transferred out of the NICU to other areas of the hospital before discharge.

LPT infants can have immature sucking abilities, which contribute to decreased breast stimulation and insufficient breast emptying. This process leads to inadequate breast milk production.[18] This can be prevented by maternal pumping after each direct breastfeeding episode until the oral feeding skills of LPT infants mature, which occurs at approximately term equivalent. Proper positioning to maximize LPT latch and sucking ability can also improve breast

stimulation and emptying.[6,11,18] It is imperative that mothers receive appropriate support by lactation specialists to guide mothers of LPT infants through this process. Our feeding guideline was well received, especially among the nursing staff. Although we did not see a statistically significant decrease in overall IV fluid use, which may have been due to our small sample size, our nursing staff reported anecdotally that they were pleased to not insert IVs in LPT infants. Physicians liked the guideline because there were clear medical indications that allowed for discretion for deviation. The entire NICU staff felt it was simple and easy to follow and fit within our NICU culture to closely track enteral feeding volumes. We believe this finding is important because few NICUs have any feeding guidelines for LPT infants and medical decisions are "provider-dependent," which leads to frustration for NICU teams.

With respect to guideline compliance in the posttime period, we found that, on average, infants received greater than recommended enteral feeding volumes on day 1 and similar to recommended enteral feedings on days 2 and 3. We speculate that medical teams may have felt the most nervous with the relatively lower recommended feeding volumes in the first 24 hours of life (20–30 mL/kg per day) compared with after the first 24 hours because this differed significantly from previous practice, and therefore infants were fed greater volumes in this time period. A limitation is that we did not assess reasons for noncompliance for each LPT infant. We also did not assess differences in nasogastric and orogastric versus oral feeds. It is possible that noncompliance varied by the route of feeding delivery.

After implementation of our guideline, we did find that hypoglycemia at >8 hours of life increased. This likely occurred because infants received smaller feeding volumes in the posttime period. However, because only 2 infants required IV fluids for treatment of hypoglycemia after guideline implementation and length of stay did not change, we do not conclude that our LPT feeding guideline led to any concerning patient outcomes at our hospital. Studies in which the authors report incidence of hypoglycemia among LPT infants (7%–48%) vary widely in the definitions of LPT birth and hypoglycemia, but are consistent in reports of elevated risk compared with term infants.[19–24] Although length of stay is longer among LPT infants, compared with term infants,[3] studies in which authors differentiate specific reasons for prolonged hospitalization, such as IV fluids for hypoglycemia, are lacking. Future assessments of feeding guidelines for LPT infants with larger sample sizes are additionally needed to further assess risks of hypoglycemia requiring IV glucose therapy and the subsequent impact on length of stay.

We were surprised that infants had lower rates of phototherapy for hyperbilirubinemia in the posttime period because the guideline was designed to deliver smaller volumes of feedings to LPT infants, and less enteral feeding can decrease the rate of bilirubin excretion, thereby leading to more elevated bilirubin levels and greater need for phototherapy. We did not change our phototherapy guidelines during the study time period. LPT infants in our cohort did not differ in the extent of weight loss in the pre- versus postperiod, indicating that those infants born during the postperiod likely received sufficient feedings to promote bilirubin excretion. We also found that fewer infants in the posttime period required caloric supplementation of >22 kcal/oz at discharge. We did not track specific reasons why infants were prescribed caloric supplementation at discharge. Further investigation regarding the need for phototherapy and caloric supplementation when implementing feeding guidelines for LPT infants is needed.

Going forward, we will alter our guideline to more closely match that of the National Perinatal Association. We will specify that direct breastfeeding is strongly encouraged when the mother is willing and available and that supplementation is only recommended for specific medical conditions, such as weight loss of >3% per day or 7% by day 3, or hypoglycemia. We will emphasize that supplemental volumes should be administered by a supplemental nursing system, cup, or finger, rather than a bottle or a nasogastric tube and that the supplemental volumes are "maximum," rather than "minimum" volumes to avoid overfeeding. We will elicit feedback from mothers of LPT infants on how best we can encourage them to come to the bedside for breastfeeding. Finally, this process of closely evaluating feeding plans for LPT infants deemed eligible to receive exclusive enteral feedings has made us consider appropriate feeding strategies for LPT infants who do require IV fluids at birth that allow for a short transition time off IV fluids once infants are stable to do so.

Strengths of our analysis are that we tracked detailed measures of breastfeeding and IV fluids and abstracted a variety of covariates that describe our population. Limitations include a relatively small sample size because our level 3 NICU has only 22 beds. We also did not track skin-to-skin, the use of breast pumps, lactation support, or other factors known to impact breastfeeding in the hospital setting among LPT infants.

CONCLUSIONS

Fear of dehydration and hospital readmission among LPT infants may lead to inadvertently high expectations for total fluid volumes among LPT infants cared for in the NICU. Assessments of feeding guidelines for LPT infants designed to reduce IV fluids and improve breastfeeding while tracking important secondary outcomes, such as hypoglycemia, weight loss, phototherapy, and length of stay, are lacking. The use of a NICU LPT infant feeding guideline that specified expected feeding volumes in the first 4 days of life was well received by NICU staff but did not lead to changes in IV fluid use or breastfeeding. More studies that contain reports on the implementation of feasible feeding guidelines for LPT infants and the impact on important health outcomes are needed to further optimize the care of this vulnerable population.

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