CLINICAL REPORT Guidance for the Clinician in Rendering Pediatric Care

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Promoting Human Milk and Breastfeeding for the Very Low Birth Weight Infant

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Provision of mother's own milk for hospitalized very low birth weight (VLBW) (≤1500 g) infants in the NICU provides short- and long-term health benefits. Mother's own milk, appropriately fortified, is the optimal nutrition source for VLBW infants. Every mother should receive information about the critical importance of mother's own milk to the health of a VLBW infant. Pasteurized human donor milk is recommended when mother's own milk is not available or sufficient. Neonatal health care providers can support lactation in the NICU and potentially reduce disparities in the provision of mother's own milk by providing institutional supports for early and frequent milk expression and by promoting skin-to-skin contact and direct breastfeeding, when appropriate. Promotion of human milk and breastfeeding for VLBW infants requires multidisciplinary and system-wide adoption of lactation support practices.

STATEMENT OF PROBLEM

Provision of mother's own milk for hospitalized very low birth weight (VLBW) (≤1500 g) infants in the NICU provides short- and long-term health benefits. Mothers of very preterm infants face many challenges in the provision of breast milk. The goal of this clinical report is to provide neonatal clinicians up-to-date information regarding NICU lactation support for mothers of VLBW infants.

abstract

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BACKGROUND INFORMATION

Epidemiology

National data from more than 800 NICUs that participate in the Vermont Oxford Network Quality Collaborative showed that provision of human milk at discharge among VLBW infants has increased from 44% in 2008 to 52% in 2017, but disparities persist according to maternal race and ethnicity and US census region.[1] Human milk provision is lowest among non-Hispanic Black and American Indian/Alaska Native populations and within the southern region of the United States (Fig 1). Currently, there is no mechanism for national surveillance of hospital-based practices known to support breastfeeding among VLBW infants, although such surveillance has been conducted intermittently at the state[2,3] or individual NICU level.[4–7] Hereafter, breast milk terminology is used according to definitions in Table 1.

Health Outcomes

Mother's own milk contains macronutrients and micronutrients as well as active biological components, including immunoglobulins, cytokines, growth factors, hormones, antimicrobial agents, immune cells, stem cells, and prebiotic oligosaccharides.[8] A substantial portion of the breast milk microbiome comprises probiotic bacteria.[9] Mother's own milk has been associated with multiple health benefits for VLBW infants, including lower incidences of necrotizing enterocolitis (NEC), late-onset sepsis, chronic lung disease, retinopathy of prematurity, and neurodevelopmental impairment (Tables 2 and 3). Generally, higher doses of mother's own milk are associated with increased health benefits; however, exposures of human milk are highly variable among studies (Table 2) and there is a paucity of data comparing infants exclusively fed mother's own milk, pasteurized donor milk, or preterm formula.

Pasteurized donor milk is recommended for VLBW infants when mother's own milk is not available[10]; however, pasteurization, freeze-thaw cycles, multiple container changes, and prolonged storage times required for donor milk processing reduce bioactivity.[11] When provided as an exclusive diet or in combination with mother's own milk feeding, pasteurized donor milk is protective against NEC but does not appear to confer the additional health benefits that have been reported with mother's own milk, such as reduction in late-onset sepsis or improvements in neurodevelopment.[12] Pasteurized donor milk may be considered a "bridge" until a full supply of mother's own milk is available.

Although the benefits of a human milk-based diet for preterm infants are established, studies examining the impact of an exclusive human milk diet on the risk of NEC versus a diet with any bovine components (preterm formula or bovine-derived human milk fortifier [HMF]) have had mixed results (Table 3). Several randomized control trials (RCTs) and observational studies reported reductions in NEC when very preterm infants received an exclusive human milk diet versus a diet with any bovine formula or bovine-derived HMF.[13–16] These data are countered by the largest RCT of an exclusive human milk diet of 127 infants with birth weight <1250 g who received bovine- versus human-derived HMF as a supplement to mother's own milk or pasteurized donor milk, which found no difference between groups in feeding tolerance or NEC.[17] Studies comparing human-derived HMF with hydrolyzed bovine protein HMF are not available at the time of this report.

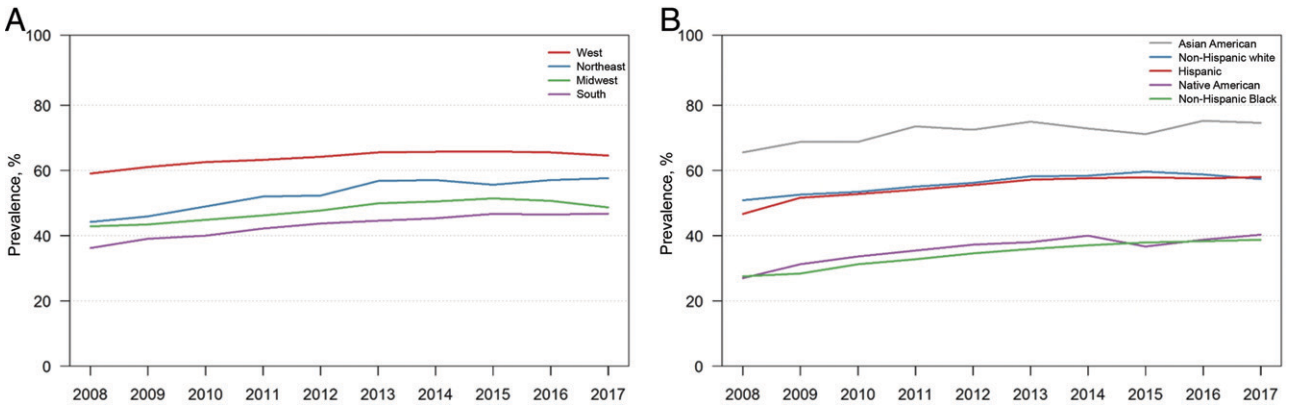

FIGURE 1 Any human milk at discharge among VLBW infants in the United States, 2008–2017. A, Any human milk at discharge among VLBW infants according to US region. B, any human milk at discharge according to maternal race/ethnicity. Adapted with permission from Parker et al.[1]

TABLE 1 Breast Milk Terms

Term	Definition
Mother's own milk	Milk from an infant's own mother
Pasteurized donor milk	Breast milk donated to a milk bank and pasteurized to eliminate pathogens
Informally shared milk	Unpasteurized milk from another infant's mother
Human milk	Mother's own milk or pasteurized donor milk
Bovine-derived HMF	Cow's milk protein–based nutritional fortifier for human milk
Human-derived HMF	Human milk protein–based nutritional fortifier for human milk
Exclusive human milk diet	Mother's own milk or pasteurized donor milk with a human-derived HMF

LACTATION CARE FOR THE VLBW INFANT

Institutional Lactation Supports

Mothers of very preterm infants are more likely to initiate lactation compared with mothers of term infants,[18] yet many of these mothers do not meet their intended feeding goals.[19] Mothers of VLBW infants face several challenges, including (1) preexisting and pregnancy-related medical morbidities that may contribute to delayed lactogenesis and/or reduced milk production[20–22]; (2) prolonged mother–infant separation; (3) dependence on pumping to maintain milk production, rather than direct breastfeeding; and (4) competing demands on their time that impede frequent milk expression and NICU visitation, such as requirements to return to work and care for other children and family members, among other factors.[23,24] Multidisciplinary NICU teams can play a critical role in ongoing lactation support by providing education, institutional supports for milk provision, and medical practices that support lactation.[4,5,25,26]

Lactation Education and Consultation

Family education has been shown to increase breastfeeding intent and reduce maternal anxiety.[27–30] Staff lactation education increases staff knowledge about breastfeeding and changes attitudes toward the use of human milk among preterm infants.[31] Readily available lactation consultants with NICU expertise improves maternal support in lacation.[25,32] However, bedside nurses also provide significant lactation education and education reinforcement.[4] Family education may include information on the health benefits of mother's own milk for VLBW infants, the need for early and frequent milk expression, the role of skin-to-skin contact (SSC), nonnutritive suckling and direct breastfeeding when physiologically appropriate, and technical information on proper milk handling, storage, and transport. NICU staff need familiarity with the technical skills of hand expression, pumping, and stepwise progression from enteral tube to oral feedings at the breast.[25,32] Family-centered care models promote family integration in medical care and improve duration of lactation.[33,34]

Milk Expression: Timing, Frequency, and Modality

Initiating milk expression soon after birth is important to stimulate milk production and provide early feedings with beneficial effects on the VLBW infant[35]; however, the optimal timing is unclear. A multisite observational study of 1157 mother-VLBW dyads found that first milk expression within 8 hours after birth predicted the highest likelihood of lactation until hospital discharge.[36] An RCT of 180 mothers who first expressed milk 1 to 60 minutes, 61 to 180 minutes, and 181 to 360 minutes after birth found no difference in lactation at 6 weeks or mother's milk feeding at discharge but found a greater volume of milk production over the first 6 weeks within the group expressing milk at 181 to 360 minutes.[35] It remains unclear whether hand expression or use of a breast pump is best for initial milk expression. One study of 11 mothers reported that hand expression in the first 48 hours was superior,[36] but a larger RCT of hand expression versus pumping for the first 7 days after birth reported that pumping was superior.[37]

Frequent milk expression is associated with a longer duration of milk production and greater milk volumes throughout the NICU hospitalization in observational studies[38–43]; however, the optimal frequency of milk expression is difficult to ascertain because studies differ in pumping frequency cut-points (≥4 to 7 times per day).[38–44] Frequent milk expression is needed to maintain ongoing milk supply. Milk production ≥500 mL per day by day 14 after birth has been shown to predict a longer duration of milk production during the NICU hospitalization among mothers of VLBW infants.[42,43] Mothers should pump with an effective and efficient double electric breast pump at home and in the hospital when possible because these pumps are superior to manual pumps.[37,45,46] It is useful

TABLE 2 Dose-Response Studies Examining Health Benefits of Human Milk for VLBW Infants

		Outcomes					
Study	Exposure	NEC	Late-Onset Sepsis	Chronic Lung Disease	Retinopathy of Prematurity	Neurodevelopment	Hospital Growth
O'Connor et al, 2003 (n = 463)[127]	Mostly HM versus some HM versus mostly PF	—	—	—	—	Favors HM	Favors PF
Furman et al, 2003 (n = 119)[128]	1–24, 25–49, and ≥50 mL/kg of MM versus PF	—	Favors MM	—	—	—	—
Feldman et al, 2003 (n = 86)[129]	<25%, 25% to 75%, and >75% MM	—	—	—	—	Favors MM	—
Vohr et al, 2006 (n = 1035),[130] 2007 (n = 773)[131]	10 mL per day increments of MM	—	—	—	—	Favors MM	—
Meinzen-Derr et al, 2009 (n = 1272)[132]	10% of total diet increments of HM	Favors HM	—	—	—	—	—
Colaizy et al, 2012 (n = 171)[133]	>75% HM versus <75% HM	—	—	—	—	—	Favors less HM
Patel et al, 2013 (n = 175)[134]	Continuous mL/kg per day increments of HM	—	Favors HM	—	—	—	—
Belfort et al, 2016 (n = 180)[135]	Continuous days of >50% diet of MM	—	—	—	—	Favors MM	—
Assad et al, 2016 (n = 293)[16]	Exclusive HM versus MM + bovine HMF versus MM + PF + bovine HMF	Favors exclusive HM	—	Favors exclusive HM	Favors exclusive HM	—	—
Chowning et al, 2016 (n = 550)[136]	<50% days HM versus ≥50% days HM	Favors HM	—	—	—	—	Favors less HM
Hair et al, 2016 (n = 1587)[13]	Exclusive HM versus MM + PF + bovine HMF	Favors exclusive HM	Favors exclusive HM	Favors exclusive HM	Favors exclusive HM	—	—
Jacobi-Pollishook et al, 2016 (n = 611)[137]	25 mL/kg per day increments of MM	—	—	—	—	No difference	—
Patel et al, 2017 (n = 254)[138]	10% of total diet increments of MM	—	—	Favors MM	—	—	—
Sisk et al, 2017 (n = 551)[138]	≥50% MM versus ≥50% DM versus ≥50% PF	Favors HM	—	—	—	—	—
Madore et al, 2017 (n = 81)[139]	100% MM versus >50% DM versus >50% PF	—	—	—	—	Favors PF and MM	Favors PF and MM
Patra et al, 2017 (n = 430)[140]	10 mL per day increments of MM	—	—	—	—	Favors MM	—
Brownell et al, 2018 (n = 314)[77]	10% of total diet increments of MM versus DM versus PF	—	—	—	—	—	Favors PF and MM
Belfort et al, 2019 (n = 263 367)[141]	HM versus mixed HM and formula versus formula	—	—	—	—	—	Favors formula
Hoban et al, 2019 (n = 321)[142]	10% of total diet increments of DM and PF versus 100% MM diet	—	—	—	—	—	Favors PF versus MM; DM versus MM no difference
Miller et al, 2018,[143] meta-analysis of dose-response observational studies (risk ratio [95% confidence interval])	Varied	Favors HM (0.53 [0.42–0.67])	Favors HM (0.7 [0.56–0.90])	Favors HM (0.84 [0.73–0.96])	Favors HM (0.82 [0.70–0.96])	No difference in subcategories of childhood neurodevelopment	Not assessed

DM, donor milk; HM, human milk (combination of mother's milk and donor milk); MM, mother's milk; PF, preterm formula; —, not applicable.

for mothers to be trained in pump use by hospital staff before they are discharged, helping them navigate common technical issues such as suction strength, pain with pumping, and proper flange fit. Mothers may be encouraged to pump at the infants' bedside with accommodations to protect privacy, because greater milk volumes have been reported when mothers pump in close contact with their infants[47]; however, the design of certain centers may mean that a central lactation room is more comfortable for some women. A single-center observational study showed increased milk volume among mothers of infants born at <31 weeks' gestation after training in hand expression while pumping (ie, "hands on pumping"), but this finding has not been examined in an RCT.[39] Mothers need training in appropriate techniques for milk storage and transport and to be provided with rigid, food-grade

TABLE 3 RCTs Examining Health Benefits of Human Milk for VLBW Infants

Study	Intervention	Control	Outcomes						
			NEC	Late-Onset Sepsis	Feeding Tolerance	Chronic Lung Disease	Retinopathy of Prematurity	Neurodevelopment	Hospital Growth
RCT of PF versus DM as a supplement to MM									
Schanler et al, 2005 ($n = 243$)[144]	MM + PF and MM + DM	MM	No difference	Favors MM	—	—	—	—	Varied[a]
RCTs of exclusive human milk versus not									
Cristofalo et al, 2013 ($n = 43$)[14]	DM + human HMF	PF + bovine HMF (powder)	Favors DM + human HMF	No difference	Favors DM + human HMF	—	No difference	—	Favors PF + bovine HMF
Sullivan et al, 2010 ($n = 207$)[15]	Exclusive HM (MM + DM + human HMF)	MM + PF + bovine HMF (powder)	Favors exclusive HM	No difference	No difference	No difference	No difference	—	No difference
Corpeleijn et al, 2016 ($n = 373$)[145]	MM + DM[b]	MM + PF[b]	No difference	No difference	—	No difference	No difference	—	—
O'Connor et al, 2016 ($n = 363$)[146]	MM + DM + bovine HMF (powder)	MM + PF + bovine HMF (powder)	Favors MM + DM + bovine HMF	No difference	—	No difference	No difference	No difference	No difference
RCTs of exclusive human milk examining fortifier types									
Moya[c,d] et al, 2012 ($n = 150$)[84]	MM + DM + bovine HMF (powder)	MM + DM + bovine HMF (liquid)	—	—	—	—	—	—	Favors bovine liquid HMF
Kim[c,e] et al, 2015 ($n = 147$)[82]	MM + DM + bovine HMF (powder)	MM + DM + bovine HMF (liquid)	—	—	No difference	—	—	—	No difference
O'Connor et al, 2018 ($n = 127$)[17]	MM + DM + human HMF	MM + DM + bovine HMF (powder)	No difference	No difference	No difference	No difference	Favors human HMF	—	No difference

DM, donor milk; MM, mother's milk; —, not applicable.

[a] Regarding wt gain, MM only was favorable over MM + DM; Regarding length gain, combined MM + PF and MM + was favorable over MM only.

[b] Intervention delivered in first 10 d of hospitalization before fortifier introduction.

[c] In this trial, intact protein was used for the powder fortifier and hydrolyzed protein was used for the liquid fortifier.

[d] In this trial, the powder HMF had 2.6 g per 100 mL and the liquid HMF had 3.2 g per 100 mL.

[e] In this trial, the powder HMF had 3 g per 100 mL and the liquid HMF had 3.6 g per 100 mL.

human milk collection containers.[32,48] Individualized plans for milk production after maternal hospital discharge may be developed with staff and lactation consultants.

NICU Practices Supporting Lactation

Recent reviews of studies examining SSC among mother-VLBW infant dyads found a positive effect of SSC on duration of mother's own milk production[49] as well as other important neonatal outcomes.[50] Early SSC has been associated with changes to the oral infant microbiome,[51] which may have implications for immune health. A previous American Academy of Pediatrics report provides guidance for SSC.[52] Family members can be encouraged to engage in SSC as often as possible and for as long as desired, depending on the infant's clinical condition. SSC can be safely performed among ventilated infants, infants receiving continuous positive airway pressure, and infants with securely placed central catheters. Facilitation of SSC may require the help of multiple hospital providers, including respiratory therapists. Continuous cardiovascular monitoring and monitoring for correct head positioning to maintain airway patency is needed.

Oral colostrum care consists of placing small amounts of colostrum on the infant buccal mucosa, often in the first hours after birth before beginning enteral feeding. Most mothers are able to provide colostrum for this purpose, even if the mother herself is significantly ill. Research in this area is emerging; a recent Cochrane meta-analysis of 6 small studies reported that oral colostrum care was associated with reduced days to enteral feedings (mean difference: −2.58 [95% confidence interval: −4.01 to −1.14]) but was not associated with reduction of NEC, late-onset sepsis, or mortality.[53] No adverse effects have been reported.[53] Research has not yet examined the impact of oral colostrum care in mother's own milk provision or family engagement later in the NICU hospitalization.

Transition to Direct Breastfeeding

Observational studies demonstrate that initial oral feedings at the breast, more frequent breastfeeding episodes, and earlier gestational age at the time of first breastfeeding attempt are associated with longer duration of breastfeeding during the hospital and postdischarge time periods.[54–58] Despite these potential benefits, significant barriers impede breastfeeding in the NICU, such as prolonged immature oromotor coordination, mother-infant separation, and the need for fortification of mother's own milk to optimize growth. Mothers can be encouraged to begin oral feeding at the breast as soon as the infant shows physiologic readiness (ie, feeding cues), and the infant's level of respiratory support allows for oral feeding. Oral feedings at the breast have been studied as early as 31 to 33 weeks' postmenstrual age.[54,55,57–59] Direct breastfeeding can occur as often as the infant's condition and mother's presence allows. Pre- and post-breastfeeding weight measurements may be used to monitor milk transfer.[60,61]

Multidisciplinary Team–Based Approaches

Multidisciplinary teams, including nursing, lactation, physicians, dietitians, and feeding therapists may best support lactating mothers.[4] Structured local and statewide quality improvement initiatives focused on adoption of hospital lactation support practices by multidisciplinary teams have successfully increased lactation rates.[3] Facilitators of effective multidisciplinary NICU lactation support teams include the following: consistent communication to families and among hospital staff members, physician buy-in, integration of lactation support practices into daily workflow, and ongoing data-driven feedback.[4,62]

Health Equity

Racial and ethnic disparities in the provision of mother's milk and pasteurized donor milk for VLBW infants are well-described; human milk use is lower among VLBW infants with non-Hispanic Black mothers, compared with those with non-Hispanic white mothers.[1,43,63,64] In addition to adherence to evidenced-based breastfeeding support practices described above for all mothers, several additional approaches have been shown to reduce Black and white disparities in breastfeeding in the NICU setting, including peer-counselor programs and support groups,[65,66] assistance with breast pump acquisition,[67] and transportation for mothers to visit the hospital.[28,30,64]

Growth and Fortification Needs for Human Milk–Fed VLBW Infants

The nutritional objective for hospitalized preterm infants is to match the fetal accretion of nutrients; nonetheless, poor growth continues to affect the majority of hospitalized VLBW infants.[68,69] Nutritional requirements cannot be met with human milk alone in the volumes of milk that are generally tolerated by VLBW infants because requirements exceed those of healthy term newborn infants in protein, energy, fatty acids, minerals, and micronutrients.[70] Multinutrient fortifiers are, therefore, added to human milk–fed to hospitalized VLBW infants.[71] It may be helpful to provide mothers with information on the use of HMFs, emphasizing the critical role of human milk despite

the need for fortification to optimize growth and development.

The macronutrient composition of preterm, term, and pasteurized donor milk is variable (Fig 2),[72–76] as are the needs of individual infants, and therefore, routine growth and nutrition monitoring is needed. Generally, the milk of mothers of preterm infants has higher protein content than the milk of mothers of term infants until about 10 to 12 weeks after birth[75] but still contains less than what is recommended for preterm infants (Fig 2).[70] The macronutrient content of pasteurized donor milk is often lower than that of milk provided by mothers of preterm infants,[74] such that infants supplemented with pasteurized donor milk, even with the addition of fortifiers, have a greater risk of growth failure.[77] Holder pasteurization used for donor milk processing results in a loss of lipase activity,[78] which reduces fat digestibility, which further adds to the risk of poor growth. Retort processing, another pasteurization method used to make shelf-stable donor milk, has been shown to significantly reduce lysozyme and secretory immunoglobulin A.[79] Overall, pasteurized donor milk is nutritionally suboptimal to a mother's own milk, reinforcing the importance of supporting mothers in maximal lactation.

Bovine- and human-derived HMFs are commercially available and vary in macronutrient content and degree to which proteins are hydrolyzed.[80–82] Bovine HMFs exist in powdered and liquid forms. In the United States, there has been a transition to use of liquid fortifier because of reports of bacterial contamination of infant formula powder and transmission of *Cronobacter (Enterobacter) sakazakii* during the hospital time period.[83] The liquid forms are supplied in sterile, single-use aliquots. Newer bovine HMFs provide hydrolyzed protein at higher protein concentrations than previous powder HMFs with intact proteins, which has been associated with improved growth.[80,84] Bovine liquid HMFs may be acidified as part of the sterilization process. A trial comparing acidified to nonacidified liquid HMFs showed similar growth but increased transient metabolic acidosis among VLBW infants receiving acidified liquid HMFs.[85] Optimal timing of fortification remains unclear, but several recent RCTs of fortification at feeding volumes less than 80 mL/kg per day showed no associations with feeding intolerance or NEC.[15,86,87] Adjustable fortification algorithms based on markers such as serum urea nitrogen may improve growth.[88,89] Rapid point-of-care milk analyzers that measure the macronutrient content of milk to facilitate individualized fortification strategies are emerging and have become available for clinical use.[90]

HUMAN MILK SAFETY

Milk Preparation and Storage

NICUs should optimally have institutional protocols and parent education addressing breast pump and pump kit cleaning as well as milk storage, handling, and transportation practices.[48,91,92] Guidelines for milk storage are provided in Table 4.[92–96] Fresh milk feedings maximize bioactive properties that are decreased with freezing.[97–99] Errors in administration of milk (feeding milk to an infant from an unrelated mother) are well-documented, and NICUs are best served by clear site-specific protocols for decreasing the risk of such errors. Two-provider verification as well as the use of systems similar to electronic medication administration bar coding are possible practices for preventing milk misadministration.[100,101] The Centers for Disease Control and Prevention provides guidance for instances when milk misadministration has occurred (https://www.cdc.gov/breastfeeding/recommendations/other_mothers_milk.htm).[102] Temperature-controlled milk warmers can be used to facilitate safe warming practices.[48]

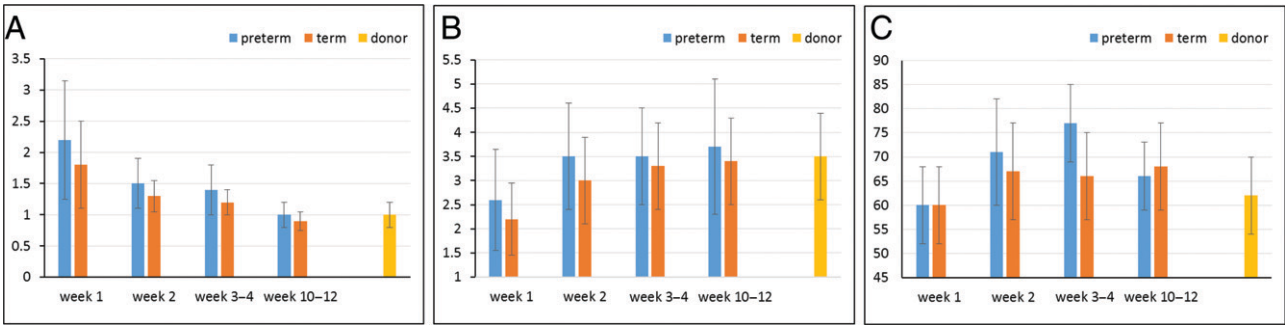

FIGURE 2 Comparison of macronutrient content of preterm, term, and pasteurized donor milk. Error bars indicated 1 SD. A, Protein content (g per 100 mL). B, Fat (g per 100 mL). C, Energy content (kcal per 100 mL). Preterm and term milk results modified from Gidrewicz et al.[75] Donor milk results modified from the mature donor milk category (milk from mothers obtained 4 to 52 weeks after birth) from John et al.[76]

Informal Milk Sharing

Informal milk sharing is the noncommercial sharing of human milk between mothers for the purpose of infant feeding. This practice is increasing in the United States.[103] Health care providers may choose to discourage families from direct milk sharing and the purchase of human milk from Internet-based sources. Both practices are associated with risks of bacterial or viral contamination of nonpasteurized milk and the possibility of exposure to medications and other substances.[10,104] Informal milk sharing may involve suboptimal milk handling and storage practices that may increase the likelihood of bacterial contamination.[103] Despite counseling, some mothers of VLBW infants will continue to plan on informal milk sharing; mothers are encouraged to discuss this openly with the infant's care team. Some institutions require parents to sign informed consent for hospital use of informally shared milk to document knowledge of the associated risks.

Contraindications

Contraindications to breastfeeding are described in detail in previous American Academy of Pediatrics publications related to breastfeeding.[104–107] Providers may use LactMed, a Web-based information source published by the National Library of Medicine and National Institutes of Health,[108] or other valid published sources of guidance in counseling mothers in provision of mother's own milk when receiving medications. Generally, studies examining effects of maternal medications in mother's own milk have not been performed among VLBW infants; thus, providers must weigh the risks of exposure to maternal medications with the benefits of the mother's own milk in clinical decision-making.

Cytomegalovirus

Cytomegalovirus (CMV) is a ubiquitous double-stranded DNA virus with which 60% to 70% of American women are infected before pregnancy.[109] Most CMV immunoglobulin G–positive women shed the virus in breast milk during lactation. Mother's own milk is the primary source of CMV transmission among term newborn infants, and nearly all term infants who acquire CMV during breastfeeding are infected without signs of illness.[110] In contrast, postnatally acquired cytomegalovirus (pCMV) infection in preterm infants can be associated with a sepsis-like illness, increased morbidity, and, rarely, mortality.[111–113] Manifestations of pCMV infection can include apnea, pneumonitis, leukopenia, thrombocytopenia, hepatitis, cholestasis, and colitis.[114] Health care providers caring for VLBW infants fed mother's own milk and presenting with signs suggestive of late-onset sepsis may consider CMV testing as well as evaluation for bacterial infection. The freeze-thawing cycle has been shown to reduce, but not eliminate, the viral load of CMV in mother's own milk[115] and is associated with loss of bioactive components.[97–99] A recent meta-analysis estimated that rates of postnatally acquired CMV infection from consumption of mother's own milk was 19% (11% to 32%) for asymptomatic CMV infection and 4% (2% to 7%) for CMV sepsis-like syndrome.[112] Although the overall rate of acquiring pCMV is decreased among infants fed frozen mother's own milk (13% [7% to 24%]), freezing is not associated with a decreased risk of CMV sepsis-like syndrome (5% [2% to 12%]), suggesting that minimal viral exposure is required to infect the extremely low birth weight infants at the highest risk for symptomatic pCMV sepsis-like syndrome.[112] Two studies have found higher rates of bronchopulmonary dysplasia among VLBW infants with pCMV infection.[114,116] The long-term neurodevelopmental effect of breast milk–acquired pCMV among VLBW infants is unclear, with some studies finding no effect on neurodevelopment and several others attributing varying degrees of cognitive delay to pCMV infection.[117–124] Additional studies are needed to determine the relative impact of breast milk–acquired pCMV infection, given the many benefits of mother's own milk among VLBW infants, particularly for decreasing the risk of NEC. At the current time, evidence is insufficient to support withholding mother's own milk because of the risk of pCMV.

TABLE 4 Maximum Human Milk NICU Storage Recommendations

Environment	Temperature	Freshly Expressed Mother's Milk	Frozen Mother's Milk	Frozen Pasteurized Donor Milk
Room temperature	60°–85°F or 16°–29°C	4 h	4 h[a]	4 h[a]
Refrigerator	39°F or 4°C	96 h	48 h[a,b]	48 h[a]
Freezer (2 door refrigerator and freezer)	0°F or −18°C	9 mo	9 mo	6–8 mo[c]
Deep freezer	0°F or −18°C	12 mo	12 mo	6–12 mo[c]
Laboratory freezer	−94°F or −70°C	12 mo	12 mo	6–12 mo[c]

[a] After thawing.
[b] Per expert opinion.
[c] Varies by milk bank; check expiration date.

Discharge Planning

Postdischarge plans must be individualized to consider the mother's goals for breastfeeding, bottle-feeding with expressed milk, and/or formula as well as the infant's growth status and anticipated need for postdischarge milk fortification. It is optimal for health insurers to provide coverage for lactation support to mothers who continue to provide breast milk after the VLBW infant is discharged from the hospital. More than one-half of VLBW infants have extrauterine growth failure (weight for gestational age: less than 10th percentile) at discharge.[68] Postdischarge fortification may be considered among these infants. However, current evidence supporting the use of postdischarge fortification among VLBW infants fed mother's own milk is limited. In one small RCT ($n = 39$), researchers examined fortification of half of mother's own milk feedings for 12 weeks versus no fortification and found improved growth outcomes and bone mineral content in the fortification group,[125] and another larger Danish RCT found no growth benefit among very preterm infants who received less fortification (1 fortified mother's own milk feeding per day) versus no fortification.[126] Neither study showed differences in neurodevelopment. The duration and dose of postdischarge fortification to optimize postdischarge growth and neurodevelopment among former VLBW infants fed human milk requires further study. When developing postdischarge feeding plans, the NICU team should optimally balance the need for fortification (on the basis of existing evidence and the individual infant's nutritional and growth status) with the mother's breastfeeding goals. The logistic challenges of expressing and fortifying milk in the home environment should also be considered. It is helpful to communicate postdischarge lactation and nutrition plans to the infant's outpatient pediatric providers.

Summary

Mother's own milk is the normative standard for VLBW infant nutrition and is associated with multiple health benefits. Neonatal staff and health care providers caring for VLBW infants and their mothers play a critical role in advocating and supporting mothers in NICU lactation.

Key Points

1. Human milk is the optimal nutrition for VLBW infants and decreases the risk of significant complications of prematurity, most notably, NEC. Pasteurized donor milk feeding is recommended when mother's own milk is not available, is insufficient, or is contraindicated.
2. Culturally appropriate information on lactation and the health benefits of human milk should be provided to families of VLBW infants.
3. NICU care for VLBW infants includes determination and support of maternal lactation goals. Lactation consultation with expertise in the needs of preterm infants is an integral part of VLBW NICU care.
4. Racial and ethnic disparities in the provision of mother's own milk and pasteurized donor milk for VLBW infants exist and may be best addressed with center-specific efforts to identify and mitigate local disparities.
5. Effective and efficient double electric breast pumps for mothers of VLBW infants will maximally support mothers in milk expression at the hospital and at home.
6. Because of the need for early and frequent milk expression to maintain milk supply, technical assistance in early milk expression should be available to mothers within 6 to 8 hours of birth of any VLBW infant.
7. Mothers should be encouraged to express their milk as often as needed to maintain a milk supply for their infant(s), ideally every 3 to 4 hours.
8. Written protocols and maternal education addressing milk collection, storage, and transport will optimize infant feeding safety.
9. Centers may encourage and support families in SSC, nonnutritive suckling, and direct breastfeeding, when appropriate to the infant's medical condition.
10. Human milk frequently requires fortification to meet the nutritional needs of VLBW infants. Centers may provide mothers with information on the rationale for and the content of HMFs.
11. CMV infection can be acquired through mother's own milk feeding. Current evidence is insufficient to support withholding mother's own milk solely on the basis of this risk.
12. NICU discharge planning optimally includes defined feeding plans that consider and address the mother's breastfeeding goals in conjunction with the infant's need for milk fortification.

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ABBREVIATIONS

Abbreviations
CMV: cytomegalovirus
HMF: human milk fortifier
NEC: necrotizing enterocolitis
pCMV: postnatally acquired cytomegalovirus
RCT: randomized control trial
SSC: skin-to-skin contact
VLBW: very low birth weight

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