

The 3 M's of Breast-feeding the Preterm Infant

Nancy M. Hurst, DSN, RN, IBCLC

Mother's own milk is considered best for preterm infants. Given the often protracted period between birth and breast-feeding for most preterm newborns, a number of challenges exist for mothers and neonatal intensive care unit nurses in establishing lactation, providing mother's own milk, and achieving breast-feeding. This article conceptualizes breast-feeding the preterm infant in the context of the neonatal intensive care unit as a 3-phase process, the 3 M's of breast-feeding: medication, mother's milk feedings, and the mechanics of breast-feeding. **Key words:** *breast-feeding, milk collection, preterm infant, pumping*

Mother's own milk has been accepted as the ideal nutrition for preterm infants.¹ The challenge for the preterm infant's mother and surrogate caregivers (ie, neonatal nurses and physicians) is to obtain the necessary resources to ensure sufficient lactation until such time that direct breast-feeding can occur. This transitional period can be conceptualized in 3 distinct phases, namely, the 3 M's: medication, milk feedings, and mechanics. Recognizing the unique and dynamic cellular components present in mother's milk, it is possible to liken the early trophic milk infusions to administering a *medication*. Once volume requirements increase and attention to infant growth is of primary concern, mother's *milk feedings* must be assessed and decisions made regarding fortification and lactoengineering strategies to ensure adequate energy requirements are maintained. As the infant matures and oral feeding is initiated, the *mechanics* of breast-feeding must be understood in order to evaluate the infant's ability and effective strategies designed to improve performance and outcomes. This article reviews each of

these 3 stages and describes evidence-based guidelines to use for clinical practice and policy development.

PHASE 1: BREAST MILK AS MEDICINE

Breast milk is a dynamic fluid, composed of macro- and micronutrients specially suited to meet the needs of the newborn infant. The presence of other cellular components, referred to as bioactive factors,² such as enzymes, immune factors, and cytokines, set breast milk apart from commercial infant formulas in their unique function and effect on the developing neonatal gut and infant immune responses. Because of these human milk components, the early, trophic feedings (small volume feedings that provide minimal calories) administered to the preterm infant could be considered as medicinal in nature. Colostrum, the initial secretion of the breast, is more concentrated in specific immune factors, and as such, provides a protective coating to the vulnerable gastrointestinal tract of the preterm newborn.³ Procurement of small amounts of colostrum can be labor intensive and requires the coordinated efforts of the mother and nursing staff in the postpartum and neonatal areas in the early days following delivery.

Initiating lactation in pump-dependent mothers of preterm infants

Admission of an infant to the neonatal intensive care unit (NICU) immediately following delivery places profound challenges on the mother planning to breast-feed. Separated from her newborn she must rely

From the Lactation Program and Mother's Own Milk Bank, Texas Children's Hospital, and Baylor College of Medicine, Houston, Tex.

The author has no conflict of interest.

Corresponding author: Nancy M. Hurst, DSN, RN, IBCLC, Lactation Program and Mother's Own Milk Bank, Texas Children's Hospital, Houston, TX 77030 (e-mail: nmburst@texaschildrenshospital.org).

Submitted for publication: May 16, 2007

Accepted for publication: May 28, 2007

on a mechanical breast pump to initiate lactation. However, a pump is not an infant. The sensations experienced by the mother during pumping are very different from those experienced when breast-feeding one's infant. These maternal responses in part set the staging area for milk production. An efficient, comfortable mechanical pump used often enough in the early days postbirth can provide effective nipple stimulation to promote high levels of circulating lactogenic hormones responsible for milk synthesis and ejection. Some mothers may be more successful in expressing small drops of colostrum by hand in the early hours and days following delivery. Once consistent mechanical milk expression begins, manual milk expression, as a prelude to the hospital-grade breast pump, may continue to be helpful in providing qualitative nipple stimulation to trigger the milk ejection reflex. Providing easy access to hospital-grade breast pumps and adequate instruction related to mechanical milk expression to mothers separated from their infants would increase the likelihood of successful lactation outcomes.

Neonatal nursing staff supportive of the mother's efforts to provide breast milk to her preterm infant must recognize that encouraging words alone are not sufficient. Early, close physical contact with her newborn, such as that experienced during skin-to-skin holding, provides another stimulus to enhance maternal hormonal response conducive to lactation.⁴ In contrast, infrequent, inefficient breast stimulation combined with restrictive policies preventing maternal-infant interaction may result in a delay or even failure to reach and/or maintain adequate milk volume levels to meet infant needs. Allowing mechanical milk expression at the NICU bedside in proximity to her infant not only allows for the fresh provision of expressed breast milk to the infant but may also augment the stimulation of specific lactogenic hormones known to influence milk production.

PHASE 2: MOTHER'S MILK FEEDINGS

As early trophic milk feedings advance and volume requirements increase, the need for an adequate milk supply becomes evident. During breast-feeding, milk volume is driven by infant demand. For the pump-dependent mother of a very preterm infant, demand is driven by her own motivation to express her milk mechanically and maintain a milk production sufficient to meet the needs of her infant. Without an infant nearby to provide the cues one associates with breast-feeding—such as sucking, smacking, cooing, and crying—the mother of a preterm infant faces a

cold, mechanical machine for breast stimulation. This is the challenge for the mother, as well as the clinician, in developing a workable pumping schedule sufficient to initiate and maintain an adequate milk volume. Current recommendations suggest frequent breast stimulation of approximately every 2 to 3 hours for about 15 minutes per session throughout the day and night, mimicking a feeding pattern similar to a newborn infant.⁵ Keeping a written record to track pumping frequency and volumes obtained may be useful in providing a snapshot of the mother's daily milk production. Based on this documentation, a decision can be made regarding the ability of the mother to maintain current pumping frequency and/or extend nighttime nonpumping intervals. Periodic assessments of maternal milk volume patterns allows for modification of pumping schedules and provides welcome relief from the tremendous burden these mothers experience in their pumping efforts.

Quality control issues

Mother's own milk is a precious and sometimes limited commodity in the NICU. Although antibacterial components present in human milk (ie, macrophages, lysozymes) limit bacterial growth, procedures used during collection, storage, and feeding preparation can affect the preservation of these factors. Mother's own milk is not a sterile fluid, often containing nonpathogenic skin flora such as *Staphylococcus epidermidis*.^{6,7} Adherence to aseptic procedures during milk collection and handling of expressed breast milk is essential in minimizing the introduction and/or growth of additional organisms. Guidelines outlined in Table 1 are recommended for mothers expressing breast milk for their hospitalized infants.^{8,9} However, milk expression is only the first step in a long trajectory of opportunities for bacterial contamination until the expressed breast milk is fed to the infant. Milk-handling procedures, such as milk storage conditions, thawing, and preparation techniques, the addition of nutritional products, and warming techniques prior to feeding, performed improperly can result in a substandard product.

Several features should be considered when determining the optimal container used for milk storage, including size, need to recycle, ease of cleaning/sterilizing, protection of nutrients, bacteriologic considerations, and ability to connect directly to the pump flange. Studies measuring these factors conclude that glass and hard plastic (polypropylene) are the recommended choices for milk collection/storage.^{6,10,11} Plastic bags are a poor choice for milk storage for the

Table 1. Milk collection guidelines

- Assemble clean pumping equipment, including storage bottles and labels
- Wash hands thoroughly prior to each pumping session
- Collect milk in sterile bottles and label with baby's name, medical record number, date and time of pumping, and any maternal medications (if applicable)
- Clean all equipment following each milk expression (using dishwashing liquid/hot water/bottle brush)
- Rinse thoroughly with warm water and dry on clean paper/cloth towel
- Sterilize equipment once a day (dishwasher, boiling water, or microwave steam bag)

hospitalized infant owing to their nonsterile condition, greater loss of fat (adherence to sides of bag), and difficulty in handling. Figure 1 provides guidelines for the duration of milk storage of expressed breast milk for hospitalized infants and is based on studies measuring a variety of factors including the preservation of nutritional and nonnutritional factors and minimal bacterial contamination as summarized in the Human Milk Banking Association of North America and the American Dietetic Association guidelines.^{8,9} To further reduce bacterial growth, nursing staff should be instructed to avoid repeated handling of the milk and use the minimum length of time necessary to thaw/warm the milk. Routine culturing of milk is not recommended for several reasons including cost-prohibitive, possible delay in feeding, and undue waste of possible scant milk supply, and may contribute to the mother stopping pumping on the basis of culture results. In addition, recent studies have shown bacterial screening with subsequent pasteurization did not improve gastrointestinal tract morbidity¹² and were not predictive of infection when evaluated prior to the occurrence of infection.¹³

Disproportionate milk supply and infant demand

The fluid requirements for a very low-birth-weight (VLBW) infant at full feeding levels range from 150 to

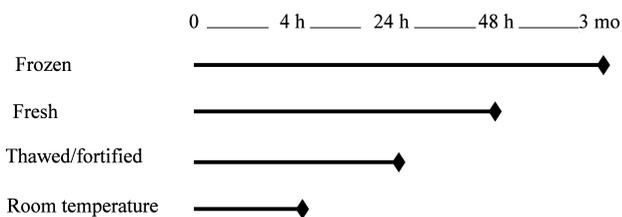


Figure 1. Guidelines for Duration of Breast Milk Storage for Hospitalized Infants.

180 mL/kg per day.¹⁴ For an infant weighing 1 kg, this could represent a third of the mother's daily milk supply. This disproportionate supply and demand presents a situation in which consideration should be made as to the mother's long-term milk expression patterns and the need for implementing specific lactoengineering strategies.

An optimal goal of 750 to 800 mL of expressed breast milk produced each day—or about an ounce an hour—is achievable for most women practicing frequent (6-7 times/d) pumping with a hospital-grade breast pump.⁵ Once this volume is achieved, usually by 2 weeks postdelivery, some mothers are able to maintain their milk production on fewer pumpings per day. This phenomenon is explained by the variation among women in breast storage capacity.¹⁵ While some women are able to store larger quantities of milk (ie, large storage capacity) in the breast at a given time, others have smaller storage capacities. These differences have been shown to have little effect on overall daily milk yield; however, mothers with smaller storage capacities may be required to empty their breasts more frequently to maintain the same milk volume of a woman pumping less frequently with a large storage capacity. Mothers can be counseled to keep a daily pumping record to document the frequency and milk volumes obtained in order to observe their ability to eliminate 1 or 2 milk expressions during a 24-hour period without experiencing a decrease in their daily milk volume. Considering the maternal burden of long-term milk volume maintenance for pump-dependent mothers, decreasing the work load, however small, can serve to minimize an already stressful period.

Lactoengineering strategies

Milk fat rises as the breast is emptied.¹⁶ For the healthy breast-fed infant who takes in a volume that represents most of what his or her mother produces, this fact is not relevant. However, for the mother of a VLBW infant, whose infant consumes only a small fraction of her daily output, special lactoengineering strategies may be warranted. Hind milk, the higher fat milk obtained several minutes following milk ejection, has been shown to enhance growth rates when fed to the VLBW infant.¹⁷ When it is known that the mother's daily milk volume is more than double the infant's daily volume needs, special instructions can be given for the collection and feeding of hind milk (Table 2). A creatocrit, the length of the cream column separated from milk by centrifugation and expressed as a percentage of the length of the total milk column, can be performed when an accurate measure of the lipid content is required.

Table 2. Hind milk feeding: Assessment and collection procedure

- Formulate instructions based on mother's average milk volume and duration of pumping session
- Interrupt pumping session several minutes after the onset of milk ejection (steady milk flow)
- Attach separate milk container(s) and resume pumping to collect hind milk
- Determine number of interruptions based on maternal milk volume*
- Label milk containers appropriately (fore and hind milk)

*For mothers with very high milk volumes, 2 interruptions, and therefore separations of pumped milk, may be preferred.

Despite lactoengineering strategies, current recommendations suggest adding additional protein, minerals, and calories to mother's own milk for a VLBW infant.¹⁸ Special formulations of powdered human milk fortifiers are preferable to liquid additives to avoid the displacement of mother's own milk. Proper storage and measuring techniques should be followed to assure accuracy of nutrient delivery.

PHASE 3: MECHANICS OF BREAST-FEEDING

Early oral stimulation sessions that include suckling at the emptied maternal breast provide a safe and positive oral experience for the preterm infant. Suckling at the emptied breast integrates research-based interventions of nonnutritive suckling and kangaroo care research affording a nonthreatening opportunity for early maternal-infant feeding interaction. Instructing the mother on infant signs of feeding readiness during these sessions would allow for the development of critical assessment skills as oral feeding progresses. An added benefit of these sessions is the possible enhancement of the mother's milk production. For small (<1000 g) infants, these sessions can be initiated as soon as they are extubated and transitioned to neonatal continuous positive airway pressure. For larger infants, timing sessions to coincide with the administration of gavage feedings provides an opportunity for the infant to experience a full stomach while at the breast. No effort is made for the infant to latch on to the breast, but to merely lick and/or suckle on the tip of the nipple is sufficient to allow the infant to taste the milk. As the infant matures, and the mother's observational skills improve, an individualized plan of care related to the progression of oral feeding can be developed with the mother's invaluable input. A case study is offered to

illustrate this process from data collected by the author for completion of her dissertation (Appendix).

Advancing oral feedings

As feedings advance, discussions related to evidence-based oral motor mechanics and the objective measurement and facilitation of milk transfer are incorporated into the plan of care. Early studies by Meier^{19,20} and others²¹⁻²³ reveal more optimal physiologic variables (ie, oxygen saturation, respiration, heart rate, and body temperature) during breast-feeding than during bottle-feeding. In several observational studies by Nyqvist et al,^{24,25} preterm infants as early as 28 weeks demonstrated rooting, areolar grasp, latching on, nutritive sucking from 30.6 weeks, and repeated swallowing at 31 weeks. The compilation of these studies demonstrates the physiologic stability of the preterm infant during breast-feeding, and thus shatters the myth of the necessity to delay breast-feeding until the infant has demonstrated the ability to bottle-feed successfully.

Careful attention to positioning during feeding sessions provides a compensative strategy for the preterm infant's weak musculature of the neck and head, and limited intraoral suction pressures. Using the football or cross-cradle holds provides support for the head while maintaining alignment with the infant's trunk. The mother needs to position her thumb above and fingers below the nipple, using gentle compression to reduce the surface area behind the nipple to facilitate attachment. She may need to sustain this position throughout the feeding to avoid infant detachment. An assessment of the mother's nipple size and protractility is necessary to evaluate the need for additional strategies (ie, nipple shield, pumping prior to feeding) to assist with sustained latch-on to the breast. As bottle-feeding studies in preterm infants have demonstrated,²⁶ the 2 components of infant sucking—expression and suction—are present during mature sucking. For the preterm infant, expression (the squeezing of the nipple) is favored over suction (the generation of intraoral pressure) for less mature infants. For this reason, some infants may have difficulty sustaining attachment to the maternal nipple and the use of a thin, silicone nipple shield has been shown to provide a useful milk transfer device until the infant's sucking ability matures.²⁷

As breast-feeding progresses in the NICU, discharge planning should include the mother's long-term goals as they relate to feeding. If the mother wishes to exclusively breast-feed and is available for frequent daily feeding attempts, delaying/avoiding the introduction of bottle feeding should be incorporated into the plan. When an accurate measure of milk transfer during breast-feeding is needed to assess feeding efficiency, test

weighing procedures should be used. Test weighing, whereby the clothed infant is weighed before and after feeding (the difference in weight equals the volume consumed; 1-g weight increase equals 1-mL milk intake) is an accurate clinical measure of milk intake.^{28,29} Studies have demonstrated that mothers want access to test weighing measures to determine feeding progress and need for additional milk feedings prior to discharge in order to plan appropriate strategies.³⁰

CONCLUSIONS

The value of breast milk and breast-feeding for preterm infants is well established. The challenge for NICU staff is to provide mothers with the necessary tools and support to provide this precious product and facilitate the establishment of this special relationship. As careful attention is given to other aspects of the NICU environment and standards of care, consideration of the lactation needs of the mother as an extension of her infant's care are required. Critical review of current NICU policies and procedures should be performed to ensure the avoidance of hospital-induced obstacles to the successful provision of expressed breast milk and breast-feeding for preterm infants.

Appendix

Case Study*

Debbie, a 29-year-old primiparus Hispanic woman, delivered David at 31 weeks by cesarean section for compli-

cations of HELLP syndrome. She initiated pumping approximately 8 hours following delivery and began collecting an average of 10 to 15 mL of colostrum on the 2nd day postpartum. Averaging a pumping frequency of 7 times per day, she achieved a daily milk volume of 340 mL on the 3rd day postpartum and 820 mL on day 10 postpartum. Debbie pumped both breasts simultaneously with a hospital-grade breast pump maintaining a pumping frequency of 6 to 7 times per day and a daily milk output averaging 930 mL (range = 305–1220 ml) for David's 8-week hospitalization.

Skin-to-skin holding was initiated when David was 2 weeks old and suckling at the emptied breast a week later when he was extubated and placed on nasal continuous positive airway pressure. At 4 weeks of age, David was put on a nasal O₂ cannula and breast-feeding progressed from 1 to 2 attempts per day. Over the course of the next few weeks, David progressed to 4 breast-feedings per day with the other feedings given as mother's expressed breast milk via bottle feeding. Test weighing was performed periodically to assess milk transfer and modify need for additional supplemental feedings. More often than not David transferred more than the prescribed volume during breast-feeding. Prior to discharge, Debbie was instructed to wean slowly from the breast pump as she advanced to exclusive breast-feeding. Given her pumped daily milk output of twice the volume required to meet David's needs, these instructions were key in order to prevent a sudden change in breast emptying pattern and resultant drop in milk volume.

Follow-up phone calls to monitor Debbie and David's progress revealed progression to exclusive breast-feeding by 3 weeks posthospital discharge. Debbie had returned to work part-time during David's hospitalization and continued a similar schedule following his discharge from the hospital. At the last follow-up call when David was 9 months old, Debbie reported that she was still breast-feeding.

REFERENCES

- Schanler RJ. The use of human milk for premature infants. *Pediatr Clin North Am.* 2001;48(1):207-219.
- Hamosh M. Bioactive factors in human milk. *Pediatr Clin North Am.* 2001;48(1):69-86.
- Ballabio C, Bertino E, Coscia A, et al. Immunoglobulin-A profile in breast milk from mothers delivering full term and preterm infants. *Int J Immunopathol Pharmacol.* 2007;20(1):119-128.
- Hurst NM, Valentine CJ, Renfro L, Burns P, Ferlic L. Skin-to-skin holding in the neonatal intensive care unit influences maternal milk volume. *J Perinatol.* 1997;17(3):213-217.
- Hurst NM, Meier PP. Breastfeeding the preterm infant. In: Riordan J, ed. *Breastfeeding and Human Lactation.* Boston: Jones & Bartlett; 2005:367-408.
- Pardou A, Serruys E, Mascart-Lemone F, Dramaix M, Vis HL. Human milk banking: influence of storage processes and of bacterial contamination on some milk constituents. *Biol Neonate.* 1994;65(5):302-309.
- el-Mohandes AE, Picard MB, Simmens SJ, Keiser JF. Use of human milk in the intensive care nursery decreases the incidence of nosocomial sepsis. *J Perinatol.* 1997;17(2):130-134.
- Robbins ST, Beker LT, eds. *Infant Feedings: Guidelines for Preparation of Formula and Breastmilk in Health Care Facilities.* Chicago: American Dietetic Association; 2004.
- Jones F, Tully MR. *Best Practices for Expressing, Storing and Handling Human Milk.* Raleigh, NC: Human Milk Banking Association of North America; 2006.
- Manohar AA, Williamson M, Koppikar GV. Effect of storage of colostrum in various containers. *Indian Pediatr.* 1997;34(4):293-295.
- Williamson MT, Murti PK. Effects of storage, time, temperature, and composition of containers on biologic

*Pseudonyms are used.

- components of human milk. *J Hum Lact.* 1996;12(1):31-35.
12. Willeitner A. Transmission of cytomegalovirus (CMV) through human milk: are new breastfeeding policies required for preterm infants? *Adv Exp Med Biol.* 2004;554:489-494.
 13. Schanler RJ, Lau C, Hurst NM, Smith EO. Randomized trial of donor human milk versus preterm formula as substitutes for mothers' own milk in the feeding of extremely premature infants. *Pediatr.* 2005;116(2):400-406.
 14. Schanler RJ, Hurst NM, Lau C. The use of human milk and breastfeeding in premature infants. *Clin Perinatol.* 1999;26(2):379-398, vii.
 15. Cregan MD, Hartmann PE. Computerized breast measurement from conception to weaning: clinical implications. *J Hum Lact.* 1999;15(2):89-96.
 16. Saarela T, Kokkonen J, Koivisto M. Macronutrient and energy contents of human milk fractions during the first six months of lactation. *Acta Paediatr.* 2005;94(9):1176-1181.
 17. Valentine CJ, Hurst NM, Schanler RJ. Hindmilk improves weight gain in low-birth-weight infants fed human milk. *J Pediatr Gastroenterol Nutr.* 1994;18(4):474-477.
 18. Schanler RJ. The role of human milk fortification for premature infants. *Clin Perinatol.* 1998;25(3):645-657, ix.
 19. Meier PP. Bottle- and breastfeeding: effects on transcutaneous oxygen pressure and temperature in preterm infants. *Nurs Res.* 1988;37(1):36-41.
 20. Meier PP. Transitional suck patterns in premature infants. *J Perinat Neonatal Nurs.* 1994;8(2):vii-viii.
 21. Dowling DA. Physiological responses of preterm infants to breastfeeding and bottle-feeding with the orthodontic nipple. *Nurs Res.* 1999;48(2):78-85.
 22. Martell M, Martinez G, Gonzalez M, Diaz Rossello JL. Suction patterns in preterm infants. *J Perinat Med.* 1993;21(5):363-369.
 23. Blaymore Bier JA, Ferguson AE, Morales Y, Liebling JA, Oh W, Vohr BR. Breastfeeding infants who were extremely low birth weight. *Pediatrics.* 1997;100(6):E3.
 24. Nyqvist KH, Farnstrand C, Eeg-Olofsson KE, Ewald U. Early oral behaviour in preterm infants during breastfeeding: an electromyographic study. *Acta Paediatr.* 2001;90(6):658-663.
 25. Nyqvist KH, Sjoden PO, Ewald U. The development of preterm infants' breastfeeding behavior. *Early Hum Dev.* 1999;55(3):247-264.
 26. Lau C, Schanler RJ. Oral feeding in premature infants: advantage of a self-paced milk flow. *Acta Paediatr.* 2000;89(4):453-459.
 27. Meier PP, Brown LP, Hurst NM, et al. Nipple shields for preterm infants: effect on milk transfer and duration of breastfeeding. *J Hum Lact.* 2000;16(2):106-114; quiz 129-131.
 28. Scanlon KS, Alexander MP, Serdula MK, Davis MK, Bowman BA. Assessment of infant feeding: the validity of measuring milk intake. *Nutr Rev.* 2002;60(8):235-251.
 29. Meier PP, Lysakowski TY, Engstrom JL, Kavanaugh KL, Mangurten HH. The accuracy of test weighing for preterm infants. *J Pediatr Gastroenterol Nutr.* 1990;10(1):62-65.
 30. Hurst NM, Meier PP, Engstrom JL, Myatt A. Mothers performing in-home measurement of milk intake during breastfeeding of their preterm infants: maternal reactions and feeding outcomes. *J Hum Lact.* 2004;20(2):178-187.