Breastfeeding Update 1: Immunology, Nutrition, and Advocacy

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IMPORTANT POINTS

1. **Human milk protects and promotes infant health by its species-specific immune system, which complements the infant's very immature immune system. Formula cannot provide this immune protection.**
2. **The pediatrician can and should be an advocate for the breastfeeding family.**
3. **There are important differences in the nutrient composition of human milk and artificial milk.**
4. **Current recommendations for feeding infants include breastfeeding for at least the first year of life.**
5. **Human milk has a dynamic nature; changes in composition can vary from one feeding to another and over time as the infant matures.**

Introduction

Most pediatricians are knowledgeable about the advantages of breastfeeding, especially exclusive breastfeeding for the first 6 months of an infant's life. These benefits in developed countries include a reduction in the incidence of infectious disease (in particular, diarrhea, otitis media, upper respiratory tract infections, pneumonia, and urinary tract infections), provision of complete nutrition that sustains adequate growth and hydration of the infant in the first 6 months of life, prevention of disease and allergy, improved child spacing, and psychosocial benefits.

Despite our understanding of the numerous benefits of breastfeeding, a number of studies have found that health-care providers represent one of the major barriers to successful breastfeeding. In 1993, United States statistics revealed breastfeeding initiation rates of 55.9%. At 6 months postpartum, continuation rates for breastfeeding were only 19%. One might ask, "How can *so few* women breastfeed when the American Academy of Pediatrics (AAP) recommends that all infants be breastfed exclusively for the first 4 to 6 months of life and continue to be breastfed for a year or more?" (The World Health Organization [WHO] and United Nations Children's Fund [UNICEF] recommend continuation for 2 years or more.) However, one might also ask, "How can *so many* women in the United States successfully breastfeed with little support from health-care professionals?"

A pediatrician's ability to advocate for and promote breastfeeding is based on many factors, including: 1) the strong belief that human milk is the optimal food for the infant, 2) an affiliation with obstetricians who support breastfeeding, 3) clinical skills to support and manage breastfeeding families, 4) the ability to refer to more knowledgeable health-care providers and support groups when indicated, 5) an affiliation with maternity hospitals that have policies and procedures that support breastfeeding, 6) the establishment of a "breastfeeding culture" in the office and hospital, 7) belief in the importance of continuing breastfeeding even if the mother works out of the home, and 8) a conscious effort to avoid the promotion of infant formula products. (See Appendix for concrete suggestions on breastfeeding promotion.) Many resources beyond formula manufacturers are available to supply information and educational materials (Table 1).

The support of family members is crucial to breastfeeding success (Figure). Health professionals and lay groups have emphasized paternal involvement in encouraging and supporting his partner in breastfeeding. Clinicians should state explicitly the expectations that the father of the baby be involved in prenatal preparations, including parent education about breastfeeding. Frequently it is necessary to describe the many ways that fathers can bond with their newborn infants other than by feeding: holding, playing, singing, changing, bathing, burping, carrying, rocking, or bringing the baby to the mother for feedings. Fathers also can assist with feeding by performing household chores, shopping for food, preparing meals, or performing other tasks that allow mother and baby to get breastfeeding well established in the early weeks.

The Baby Friendly Hospital Initiative, launched by WHO and UNICEF in 1991, is a campaign to improve breastfeeding rates worldwide. The "Ten Steps to Successful Breastfeeding" (Table 2) provide the basis of care in maternity hospitals that fully support breastfeeding. More than 6,000 hospitals have been designated as Baby Friendly in 159 foreign countries. Efforts

ABBREVIATIONS

IgA:	Immunoglobulin A
LC-PUFA:	Long-chain polyunsaturated fatty acids
SIgA:	Secretory immunoglobulin A
UNICEF:	United Nations Children's Fund
WIC:	Supplemental Food Assistance Program for Women, Infants, and Children
WHO:	World Health Organization

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FIGURE. Fathers can provide important encouragement and support to breastfeeding mothers.

in the United States have lagged behind other countries, but as of January 1996, 309 hospitals (including 18 birthing centers) in 43 states have received "Certificates of Intent" to become Baby Friendly under the auspices of the United States Committee for UNICEF, and one hospital has received the designation.

Breastfeeding promotion is in the best interests of patients, physicians, and institutions. In this era of cost containment, increasing the initiation and duration of breastfeeding is one way to reduce health-care costs. Dr. Miriam Labbok estimates that if full breastfeeding were practiced for 12 weeks in the United States, 2.16 billion dollars would be saved annually (using illness as a sole indicator of cost).

To bolster your confidence regarding the benefits of breastfeeding/human milk and to strengthen your resolve to become an active advocate, we discuss some highlights of recent research regarding the immunologic and nutritional aspects of human milk.

The Immune System of Human Milk

Studies of the immune system of human milk provide indisputable evidence that it is the optimal food for the infant and that there really is no such thing as a substitute. As Dr. Armond Goldman so nicely describes (see Suggested Reading), the immune system of human milk provides for a continuum of the maternal immune protection that extends from transplacental transfer of immunoglobulin G (IgG) in utero until the second year of life. Human milk furnishes the necessary immunologic protection while the infant's immune system is maturing. Production of secretory IgA in the infant begins at about 4 months and is not fully established until 12 months of age, production of the full antibody repertoire is not fully mature until about 24 months of age, lysozyme production is not fully mature until 1 to 2 years of age, and production of memory T cells in the infant is not mature until about 2 years (Table 3). Although numerous other immunologic components have been identified, their maturation patterns are not well established. It is no wonder that breastfed infants are at lower risk for infections, with the human milk immune system compensating for their own immature immune systems.

Human milk contains three major categories of immunologic factors: antimicrobial agents, anti-inflammatory agents, and immunomodulating agents. The list of factors in each category grows longer each year as more and more properties of human milk are identified. For example, in one study, after exposure to respiratory syncytial virus, breastfed infants had significantly higher levels of serum alpha interferon than did formula-fed infants. The fact that alpha interferon is not measurable in human milk suggests that direct transfer is not occurring. Rather, human milk appears to contain an "immunomodulator" that "turns on" the infant's own production of interferon. Lactoferrin has been shown to operate in a similar manner in each sector of the immune system of human milk. In light of these discoveries, formula appears less than adequate in terms of replacing human milk.

ANTIMICROBIAL FACTORS

The antimicrobial agents in human milk illustrate the unique interaction between infant and mother in responding to environmental challenges. For example, within a few days of maternal exposure to pathogens such as *Shigella*, antibodies to this bacterium are noted in the mother's milk, which confers protection to the breastfeeding infant. This is due to the enteromammory circulation pathway, which is triggered by antigen exposure to B cells (IgM+) from the Peyer patches of the lower small intestinal tract and the consequent migration of those isotype-switched B cells (IgA+) to the lamina propria of the mammary gland with the help of cytokines. At the mammary gland, the transported B cells differentiate into IgA-producing/secreting plasma cells, and through a number of steps within the mammary gland, secretory IgA is formed and secreted. A similar pathway for B cell migration from the lymphoid centers in the bronchial tree to the lamina propria of the mammary gland is called the bronchomammary pathway. Thus, it is not surprising to find specific secretory IgA antibodies for a wide spectrum of bacterial, viral, and protozoal antigens (Table 4). Secretory IgA (SIgA) is the major antibody in human milk; a fully breastfed infant receives 0.5 to 1 g of SIgA orally per day.

As Goldman has summarized, SIgA and the other antimicrobial agents present in human milk (Table 5) are resistant to digestive enzymes, confer protection without triggering inflammatory reactions, compensate for the infant's inability to process antimicrobial agents, kill certain bacterial pathogens synergistically, and are common to mucosal sites. Note the differences in the presence of antimicrobial agents between human and bovine milk (Table 6), illustrating the species specificity of human milk for the human infant.

ANTI-INFLAMMATORY AGENTS

The anti-inflammatory agents present in human milk represent a complex group of immune factors whose roles have not been elucidated completely (Table 7). Acetylhydrolase, an enzyme that degrades platelet activating factor, is present in human milk and may play a role in the decreased risk of necrotizing

TABLE 1. Resources for Breastfeeding

Academy of Breastfeeding Medicine
University of Rochester Medical Center
601 Elmwood Ave, Box 777
Rochester, NY 14642
(professional association for physicians)

Best Start
3000 E. Fletcher Avenue
Suite 308
Tampa, FL 33613
(videos and materials for low-income women)

Breastfeeding and Human Lactation Study Center
University of Rochester School of Medicine and Dentistry
Box 777
Rochester, NY 14642
(professional resource center)

Clearinghouse on Infant Feeding and Maternal Nutrition
American Public Health Association
1015 Fifteenth Street NW
Washington, DC 20005
(literature)

Food and Nutrition Information Center
National Agricultural Library Building, Room 304
Beltsville, MD 20705
(literature)

Georgetown University Hospital
National Capital Lactation Center
3800 Reservoir Road NW
Washington, DC 20007
(professional educational material, continuing education programs, hospital protocols, and nursing care plans)

Human Milk Banking Association of North America, Inc
PO Box 370464
West Hartford, CT 06137-0464
(professional education, access to banked donor milk, publications)

International Lactation Consultant Association (ILCA)
20 N. Michigan Ave, Suite 300
Chicago, IL 60601-3821
(professional association for lactation consultants; publishes *Journal of Human Lactation*; sells resource materials)

International Nutrition Communication Service
Education Development Center
55 Chapel Street
Newton, MA 02160
(literature)

La Leche League International
9616 Minneapolis Avenue
Franklin Park, IL 60131
(mother-to-mother support groups, professional and lay materials, professional workshops on lactation in various US locations annually)

Lactation Training Program
UCLA Extension
Department of Health Sciences
10995 Le Conte Avenue
Room 614
Los Angeles, CA 90024
(professional training courses for certification in lactation)

National Health Information Clearinghouse
PO Box 1133
Washington, DC 20013
(literature)

UNICEF
United Nations
New York, NY 10017
(promotes breastfeeding worldwide)

Wellstart International
4062 First Avenue
San Diego, CA 92103
(professional educational program for multidisciplinary lactation teams)

World Health Organization (WHO)
Publication Center
49 Sheridan Avenue
Albany, NY 12210
(publications by WHO)

enterocolitis in the preterm infant fed human milk. Another anti-inflammatory agent present in human milk, epithelial growth factor, may explain why infants who continue to breastfeed through diarrheal infections recuperate sooner and experience less morbidity than formula-fed infants.

Feeding of human milk not only reduces rates of infections, but it also decreases the risk for immunologically associated disorders, such as atopy, in infants from families at high risk. Dr. Anne Wright and coworkers from Arizona found that 11% of recurrent wheezing among nonatopic children studied was attributed to *not* breastfeeding. It is hypothesized that protection against atopic disease is due not only to decreased exposure to potential allergens such as soy proteins and cow milk proteins that are present in formulas, but to the protection associated with the anti-inflammatory agents present in human milk. The current breastfeeding recommendation that infants exclusively breastfeed for the initial 4 to 6 months of life is especially important for infants who have a strong family history of atopic disease. For families that have a strong history of atopy, some allergists recommend avoidance of all cow milk-based products in the maternal diet for the last trimester of pregnancy and during lactation.

IMMUNOMODULATING FACTORS

The complex role of human milk in maintaining the health of the infant is well represented by the immunomodulating factors, including cytokines, alphatocopherol, beta-casomorphins, and prolactin. These agents may play a role in disease prevention after infancy and be factors in the decreased risk for breastfed infants to develop Crohn disease, insulin-dependent diabetes, and lymphoma. The immunomodulating

**TABLE 2. Ten Steps to Successful Breastfeeding
A Joint WHO/UNICEF Statement (1989)**

Every facility providing maternity services and care for newborns should:
1. Have a written breastfeeding policy that is communicated routinely to all health-care staff.
2. Train all health-care staff in the skills necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breastfeeding.
4. Help mothers initiate breastfeeding within 30 minutes of birth.
5. Show mothers how to breastfeed and how to maintain lactation even if they are separated from their infants.
6. Give newborns no food or drink other than human milk unless medically indicated.
7. Practice rooming-in: Allow mothers and infants to stay together 24 hours a day.
8. Encourage breastfeeding on demand.
9. Give no artificial teats or pacifiers (also called dummies and soothers) to breastfeeding infants.
10. Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from hospital or clinic.

TABLE 3. Representative Immune Factors in Human Milk Production That Are Delayed in the Recipient Infant

AGENTS	TIME OF MATURATION
Secretory IgA	4–12 months
Full antibody repertoire	24 months
Lysozyme	1–2 years
Lactoferrin	?
Interleukin 6	?
PAF-actylhydrolase	?
Memory T cells	2 years

From Goldman, AS. The immune system of human milk: antimicrobial, antiinflammatory and immunomodulating properties.* Pediatr Infect Dis J. *1993;12:664–671.

role of cytokines (Table 8) has been documented to include the possible functions of activating T cells, enhancing IgA and secretory component production, and participating in the entero- and bronchomammary circulation. All of these processes potentiate the infant's infection fighting response.

Human Milk: The First 6 Months of Life and Beyond

It is clear that human milk plays a vital role in the immunologic development of the infant at birth and well into the second year. Its nutritional role also is clearly superior to that of other alternatives. Case reports and media hype accentuate concerns about what might be lacking in human milk, but all of the necessary nutrients and water are provided by human milk for the first 6 months of an infant's life with the exception of:

1. Vitamin K. Vitamin K (0.5 to 1 mg given intramuscularly at birth) helps prevent hemorrhagic disease of the newborn (breastfed infants have been found to be at a higher risk if not supplemented with vitamin K). The AAP Vitamin K Ad Hoc Task Force states that when an appropriate oral preparation becomes available in the United States, vitamin K may be given orally 0.2 mg at birth, 0.2 mg at 1 to 2 weeks, and 2 mg at 4 weeks.
2. Vitamin D (200 to 300 IU/day) in climates or cultures where the infant is not exposed to sunlight for at least 30 minutes per week wearing only a diaper (or at least 2 hours a week fully clothed with no hat). Supplementation also may be warranted if the mother has inadequate sources of vitamin D.
3. Fluoride (0.25 mg/day) after 6 months of age in areas where the water supply is not fluoridated adequately (<0.3 ppm fluoride). The AAP states that in areas where water is treated adequately with fluoride, the breastfed infant may *not* necessarily be supplemented with fluoride.
4. Vitamin B_{12} (0.3 to 0.5 mcg/day) for infants whose mothers eat a strict vegetarian diet (no animal products) and take no vitamin B_{12} supplements.

COMPLEMENTARY FOODS AND SLEEP NORMS

Infants thrive on exclusive human milk for the first 6 months of life, although excuses frequently are made to start foods earlier.

One common misperception is that the addition of solid foods to the diet will lengthen night sleep episodes; no evidence supports this belief. In addition, the myth of infants sleeping through the night is partially dispelled by one study in Australia that showed that more than 50% of the infants studied did not sleep through the night at 1 year of age.

Human milk contains significantly less protein than does cow milk (Table 9). The protein composition in human milk also is very different from that of formula. Human milk has a high whey:casein ratio of 90:10 at 4 to 10 days postpartum, 60:40 in mature milk at 11 to 240 days, and 50:50 in late lacta-

tion at 241+ days, reflecting the developmental stages of the infant's ability to digest the casein proteins. Formulas contain the opposite set ratio, ranging from 20:80 to 50:50 whey to casein, depending on the brand. The difference in protein composition between human milk and formula results in digestion times of 1.5 hours for breastfed infants compared with 4 hours for formula-fed infants. This underscores the need for infants fed human milk to be fed on demand and as often as demanded, especially in the early weeks when the whey:casein ratios are the highest. The shorter digestion time of human milk also contributes to less gastroesophageal reflux among breastfed infants compared with those fed formula.

Breastfed infants need to be fed at night to maintain growth and to receive consistent responses to hunger cues. In addition, night feedings often are necessary to maintain adequate milk production. Pediatricians need to be aware of this when advising mothers about infants' sleeping habits. Care should be taken not to frown upon mothers who continue to feed their infants at night or who sleep with their babies because these are normal physiologic processes for the breastfeeding mother-infant couple. Strategies on how a mother can minimize awakening when feeding at night is a supportive step for breastfeeding families.

Mothers should be made aware that introduction of formula or cereal prior to 6 months of age as a strategy to increase sleeping at night has not been proven to be effective. Further, with the formula replacing human milk, human milk production eventually will diminish significantly. Introducing formula or cereals also decreases the nutritional value of human milk by interfering with the absorption of minerals.

A transition to additional foods is appropriate at about 6 months of age. Human milk accounts for 100% of energy needs at 6 months; at 12 months it still may account for 20% to 35% of the infant's total energy intake. During this transitional period, the energy density and micronutrient content of complementary food must be considered. A detailed discussion of the weaning process is beyond the scope of this article. For additional information, refer to Satter's book listed in Suggested Reading.

Breastfed infants never need to be bottle-fed; they can graduate directly to a cup for drinking human milk when separated from their mother. For families who are more comfortable giving human milk in a bottle, 4 to 6 weeks of age (when breastfeeding usually is well established) is a reasonable time to introduce a bottle.

TABLE 4. Secretory IgA Antibodies in Human Milk Against Common Microbial Pathogens

BACTERIA AND TOXINS	VIRUSES	OTHERS
Escherichia coli	Rotavirus	*Giardia*
Shigella	Respiratory syncytial virus	*Candida albicans*
Salmonella		
Campylobacter	Poliovirus	
Vibrio cholerae	Other enterovirus	
Haemophilus influenzae	Influenza virus	
Streptococcus pneumoniae	Cytomegalovirus	
Clostridium difficile	Human immunodeficiency virus	
Clostridium botulinum		
Klebsiella pneumoniae		

From Goldman, AS. The immune system of human milk: antimicrobial, antiinflammatory and immunomodulating properties. **Pediatr Infect Dis J.** ***1993;12:664–671.***

TABLE 5. Function of Antimicrobial Agents in Human Milk

AGENTS	PRIMARY FUNCTIONS
Proteins	
Lactoferrin	Iron chelation
Lysozyme	Peptidoglycan degradation
Fibronectin	Opsonins
Secretory IgA	Antigen binding
C3	Fragments are opsonins
Mucins	Antirotavirus; receptor analogues
Oligosaccharides	Receptor analogues
Lipids	Disrupts enveloped viruses

From Goldman, AS. The immune system of human milk: antimicrobial, antiinflammatory and immunomodulating properties. **Pediatr Infect Dis J.** ***1993;12:664–671.***

TABLE 6. Comparison of the Relative Amounts of Representative Direct-acting Antimicrobial Agents in Human and Bovine Milk

	HUMAN	BOVINE
Lactoferrin	++++	+
Lysozyme	++++	+
Secretory IgA	++++	+
IgG	+	++++
C factors	+	++++
Lactoperoxidase	+	++++

From Goldman, AS. The immune system of human milk: antimicrobial, antiinflammatory and immunomodulating properties. **Pediatr Infect Dis J.** ***1993;12:664–671.***

TABLE 7. Anti-inflammatory Factors in Human Milk

- Cytoprotectives
- Epithelial growth factors
- Maturational factors
- Enzymes that degrade mediators
- Binders of enzymes
- Modulators of leukocytes
- Antioxidants

From Goldman, AS. The immune system of human milk: antimicrobial, antiinflammatory and immunomodulating properties. **Pediatr Infect Dis J.** ***1993;12:664–671.***

TABLE 8. Concentrations (Mean Values) and Potential Functions of Cytokines in Human Milk

CYTOKINES	POSSIBLE FUNCTIONS	CONCENTRATION (pg/mL, approximate)
Interleukin-1-beta	Activates T cells	1,130
Interleukin 6	Enhances IgA production	151
TNF-alpha*	Enhances secretory component secretion	620
TGF-beta**	Enhances isotype switching to IgA+ B cells	?

**** TNF = tumor necrosis factor***
***** TGF = transforming growth factor***
From Goldman, AS. The immune system of human milk: antimicrobial, antiinflammatory and immunomodulating properties. **Pediatr Infect Dis J.** ***1993;12:664–671.***

TABLE 9. Composition of Human Milk

CONSTITUENT (per 100 mL)	COLOSTRUM 1–5 DAYS	MATURE MILK >30 DAYS	COW MILK
Energy (Kcal)	58	70	66
Lactose (g)	5.3	7.3	4.8
Total protein (g)	2.3	0.9	3.4

Human Milk Composition: Issues and Answers

Most concerns about the composition of human milk are cloaked in cultural tradition and personal anecdotes. The following list reviews some common myths about human milk composition, followed by information addressing these issues.

1. MYTH: There is not enough iron in human milk to meet the needs of the exclusively breastfed infant in the first 6 months of life.
REALITY: Infants who are breastfed exclusively for the first 6 months of life have been found *not* to be at risk for iron deficiency anemia or depletion of iron stores. The bioavailability of iron in human milk is 50%, which is substantially higher than that in infant formulas (7%) and infant cereals (4%). When other foods or liquids are introduced, the bioavailability of iron in human milk is reduced.

Other minerals in human milk are also much more bioavailable when compared with formula: calcium (75% versus 50%) and zinc (41% versus 31% in cow milk-based formula and 14% in soy-based formula). Formulas compensate for the low bioavailability of the minerals by providing higher mineral concentrations.

2. MYTH: Failure to thrive in the breastfed infant could be due to the poor nutrient quality of human milk.
REALITY: In most instances, poor growth in the breastfed infant is related to low volumes of milk intake. However, because fat in human milk accounts for 50% of the calories, it is of major importance when assessing human milk caloric content. Fat content varies widely from woman to woman and between feedings for an individual woman. Thus, it becomes difficult to ascertain what is a "normal" fat content. In certain individual mother-infant pairs, a foremilk/hindmilk imbalance may develop, resulting in low-fat, relatively high-volume intake. Allowing the infant to nurse until finished on one breast usually will ensure that the infant gets sufficient hindmilk.

For the preterm infant who has slow growth, it is possible to fractionate maternal milk if the mother's production exceeds her infant's needs. The hindmilk contains approximately 24 kcal/oz, on average, yet maintains normal amounts of other nutrients. Another technique for maximizing fat and caloric delivery to the preterm infant is to use milk infusion systems with the syringe tip oriented upright, so that the fat rises to the top of the syringe, is delivered first, and is not wasted by clinging to tubing at the end of the feeding (see article by Schanler in Suggested Reading).

3. MYTH: The fussy breastfeeding infant must be agitated because of the mother's diet, so she should give up milk products.
REALITY: Before eliminating milk products from a new mother's diet, consider some of the more common reasons for a breastfed infant to be fussy. After determining that the infant or mother does not have an underlying illness or infection, consider the following possibilities:

a. An unsatisfied baby who is receiving low intake because of poor attachment at the breast, infrequent

feeding frequency at the breast, ineffective feeding, or low maternal milk supply may be crying from hunger! For more details on the management of an infant who is gaining weight slowly, refer to texts in Suggested Reading.

b. In some mother-infant pairs, a foremilk/hindmilk imbalance may develop when the infant nurses briefly and frequently. The constant concentration of lactose of about 7% throughout the feeding can result in a relative lactose overload. Symptoms in the infant include gassiness; crying; regurgitation; nonprojectile vomiting; and profuse, watery, foamy, or green stools. Maternal signs and symptoms may include breast engorgement, copious leaking of milk, or rapid milk ejection. The diagnosis is based on history and physical examination of the infant as well as on observation of a breastfeeding episode. One very useful intervention is to have the mother breastfeed on one breast only for each feeding, then offer the other breast at the next feeding. Women who have large volumes of milk may need 10 days or more for their milk production to equilibrate after the intervention has started.

c. No foods universally cause problems in breastfed infants. Excessive maternal caffeine intake (32-ounce soft drink cups, refillable!) may cause fussiness in some breastfeeding infants (especially in the neonatal period), even though only about 1% of caffeine is absorbed into human milk. On the other hand, gas produced in a mother's intestine following ingestion of "gassy" foods is not absorbed into her circulation and, therefore, will not affect human milk. In individual infants, parents may observe an association between a particular food and infant fussiness or distress. If so, remove the food from the mother's diet for 1 week, then reintroduce it to see if the reaction recurs. The objective is to avoid unnecessary restrictions so that breastfeeding can be enjoyed.

After considering the previously noted factors, if you believe that milk is the culprit for the infant's fussiness, exclude milk products (including prepared foods that contain milk, cheese, casein, etc) for 1 week. Nutrition consultation is indicated to assist in planning meals without milk. If the mother continues to exclude diary products, she will need to include other foods (or a supplement) to provide adequate sources of calcium. Milk can be reintroduced periodically into the maternal diet to determine whether it continues to be a problem.

4. MYTH: It is too much to ask a mother of a preterm infant to pump her breasts and give her baby human milk.
REALITY: Giving human milk to the preterm infant has innumerable advantages for both the mother and the infant. A mother who is separated from her infant can participate in the baby's regular care by providing nourishment. The human milk produced following a preterm birth is uniquely suited to the preterm infant in many respects: it has higher protein for growth, taurine for vitamin D absorption, and lactoferrin and SIgA for immune protection; lower lactose levels; higher concentrations of antioxidants such as beta carotene and inositol (recently inositol was found to increase survival of preterm infants and decrease their incidence of bronchopulmonary dysplasia and retinopathy of prematurity); and a perfect combination of lipids (along with lipases) for maximal rates of fat absorption.

In addition to its inherent nutrient composition, human milk has exceptional long-term benefits for the preterm infant. Recent work suggests that infants fed human milk have higher scores on intelligence tests when measured at school age. This is believed to be due to the critical role that long-chain polyunsaturated fatty acids (LC-PUFA) present in human milk play in the development of the neurologic system. Linoleic and linolenic fatty acids, the precursors of the LC-PUFA, are available in formula, but the endogenous conversion of these fatty acids into LC-PUFA is limited in early life. In addition, preterm infants miss the period during late gestation when rapid neurologic growth coincides with the transplacental delivery of LC-PUFA. LC-PUFA, therefore, are considered to be conditionally essential nutrients for low-birthweight infants. LC-PUFA are not present in standard preterm formulas. Retinopathy of prematurity also is thought to be reduced in preterm infants fed human milk because of the abundance of LC-PUFA in human milk.

According to WHO/UNICEF, fortification of human milk is indicated for infants weighing less than 1,500 g at birth or born at fewer than 32 weeks' gestation. The levels of protein, calcium, phosphorus, and possibly zinc, copper, iron, and some vitamins are not adequate to meet intrauterine requirements for these small babies. In the United States, neonatologists' recommendations vary regarding fortification at different weights and gestational ages. A detailed discussion of these issues is available in the article by Schanler (see Suggested Reading). Needless to say, the immune system of human milk provides innumerable immunologic advantages for the pre-term infant during extrauterine life.

5. MYTH: Working mothers (women who work outside the home) breastfeed for shorter durations than do women who stay at home full-time.
REALITY: Although work has been considered by many to be a barrier for breastfeeding mothers, studies reveal that women who go back to work full-time breastfeed as long as those who stay at home. Women who return to work part-time breastfeed longer than those who return to full-time work.

Infants who are cared for outside of their own home are particularly vulnerable to infectious processes, making the beneficial maternal immunologic contribution through human milk even more compelling in this high-risk group. Infants 3 to 4 months of age are poorly equipped to fight infection because the maternal IgG stores that were transferred passively in utero are nearly depleted at this point. One researcher found 30% less absenteeism from the work site due to less illness among the infants of mothers who continued to breastfeed their infants in the first year of life.

TABLE 10. Strategies for Continued Breastfeeding When Returning to Work or School

• Get breastfeeding well established the first 4 to 6 weeks postpartum
• Consider a longer maternity leave, if possible
• Once breastfeeding is established, start expressing milk to store in the freezer; this will provide a surplus of stored milk and increase the maternal supply somewhat
• Ask the employer for some flexibility in length of maternity leave; have the option to extend it if necessary
• Return to work part-time, temporarily or permanently
• Take your child to work
• Use on-site child care; take breaks and lunch time to feed the baby
• Have someone bring your child to the work site for feedings
• Obtain child care close to the work site and go to the baby for feedings
• Express milk at work and store it for use by the caregiver the following day
• Express milk on workdays and fully breastfeed on days off
• "Reverse schedule feedings": Sleep with the baby and feed more often at night and less frequently during the day (some infants will determine this routine themselves!)
• If it is impossible to express milk at work, pump at home; pump on one side while the baby is nursing on the other or express milk after the baby has nursed
• Some breast milk is better than none; if expressing is not possible, breastfeed as much as possible while with the baby
• Join (or start) a workplace support group for breastfeeding mothers
• USE ANY OTHER IDEA THAT WILL WORK FOR YOU AND YOUR FAMILY

The psychological benefits for the mother and infant can be as rewarding as the immunologic and nutritional benefits (the effects are interrelated and synergistic). Breastfeeding mothers who work out of the home can feel a connection with their infants even when they are separated physically. When they reunite, breastfeeding is an opportunity for close interaction. Because breastfed infants have a lower incidence of illness, there is a definite financial advantage, as well as an immeasurable reduction of worry and lost sleep. A recent case report documented a "relaxed" maternal electroencephalographic pattern associated with breastfeeding episodes that persisted over many weeks. This suggests that breastfeeding can benefit busy mothers by allowing them some relaxation time.

Supporting women in continuing to breastfeed after they return to work (Table 10) is not only a viable strategy for increasing the duration of breastfeeding, but also can be vital for the mother's productivity at work and the health and well-being of her infant. Pediatricians need to advocate changes in maternity leave and the work environment that enhance women's abilities to continue breastfeeding or to give human milk to their infants.

Summary

When one reviews the wealth of information about the advantages of breastfeeding, there can be no doubt that this practice is healthy for both mother and infant. It is time for the "culture of medicine" to move beyond slogans. It is time for enthusiastic encouragement backed by meaningful action and time to move forward from personal perceptions and experiences to demonstrate to the culture at large that breastfeeding is normal, expected, and achievable.

SUGGESTED READING

Armstrong KL, Quinn RA, Dadds MR. The sleep patterns of normal children. *Med J Austr*. 1994;161:202–206

Cervantes M, Ruelas R, Alcala V. EEG signs of "relaxation behavior" during breastfeeding in a nursing woman. *Arch Med Res.* 1992;23:123–127

Chiba Y, Minagawa T, Mito K, et al. Effect of breastfeeding on responses of systemic interferon and virus-specific lymphocyte transformation in infants with respiratory syncytial virus infection. *J Med Virol.* 1987;21:7–14

Cohen R, Mrtek MB. The impact of two corporate lactation programs on the incidence and duration of breastfeeding by employed mothers. *Am J Health Promot.* 1994;8:1–6

Cunningham AS, Jelliffe DB, Jelliffe EFP. Breastfeeding and health in the 1980s: a global epidemiologic review. *J Pediatr.* 1991;118:659–666

Goldman AS. The immune system of human milk: antimicrobial, antiinflammatory and immunomodulating properties. *Pediatr Infect Dis J.* 1993;12:664–671

Labbok MH. Costs of *not* breastfeeding in the U.S. *ABM News and Views (the newsletter of the Academy of Breastfeeding Medicine).* 1995;1:7

Lawrence RA. *Breastfeeding: A Guide for the Medical Profession.* 4th ed. St Louis, Mo: Mosby-Year Book, Inc; 1994

Neville MC, Neifert M, eds. *Lactation: Physiology, Nutrition and Breastfeeding.* New York, NY: Plenum Press; 1983

Riordan J, Auerbach KG. *Breastfeeding and Human Lactation.* Boston, Mass: Jones and Bartlett Publishers, Inc; 1993

Satter E. *Child of Mine.* Palo Alto, Calif: Bull Publishing Company; 1991

Schanler RJ, Hurst NM. Human milk for the hospitalized preterm infant. *Semin Perinatol.* 1994;18:476–484

APPENDIX. Methods for Developing a Breastfeeding Culture in Your Office/Health Facility

- Work as a team with obstetricians who share your patients.
- Have an open attitude toward breastfeeding in waiting areas (or designate a separate breastfeeding room).
- Educate yourself and office staff about specifics of breastfeeding clinical care.
- Display tasteful, noncommercial educational materials and artwork that depict breastfeeding women.
- Create a bulletin board for photos of breastfed babies (they don't have to be breastfeeding in the photo).
- Identify and eradicate unspoken support for bottle feeding in your office/institution.
- Facilitate a mother-to-mother support group for your practice.
- Encourage and support "baby friendly" policies and practices in your hospitals (see Table 2).
- Be familiar with other community resources for breastfeeding help, such as lactation consultants, mother-to-mother support groups, and some WIC sites.
- Provide outreach to major employers in your communities.
- Review your policy (or develop one) regarding acceptance of free samples from infant formula companies.
- Support, encourage, and clinically assist all working mothers who breastfeed (whether they work at home or outside of the home).
- Keep statistics on differences in your patients who breastfeed versus those who do not.
- Use your influence in the community at large to promote breastfeeding.

PIR QUIZ

1. Which one of the following is a difference between human milk and formula in supplementing the immune system of the young infant?
   A. Human milk contains higher amounts of activated T cells.
   B. Human milk contains higher levels of alpha-interferon.
   C. Human milk contains higher amounts of atopic substances.
   D. Human milk contains higher levels of IgA antibodies.
   E. Human milk contains higher levels of IgG antibodies.
2. Of the following routine practices in the offices of many physicians, which actually may be a deterrent to breastfeeding?
   A. Breastfeeding is welcome in the waiting room.
   B. Educational information is printed on material supporting formula feeding.
   C. Office personnel are very knowledgeable about breast-feeding techniques.
   D. Pediatricians and obstetricians coordinate care and promote breastfeeding.
   E. There are active support groups for breastfeeding.
3. Which one of the following statements about human milk composition is *true*?
   A. Colostrum production is insufficient to meet a term infant's needs in the first few days of life.
   B. Human milk contains signifi-cant caffeine levels after maternal ingestion of one cup of coffee.
   C. Human milk contains adequate levels of vitamin K to prevent complications in the infant.
   D. Human milk contains no fluoride.
   E. Iron levels in human milk are adequate because the iron is more bioavailable.
4. Of the following, an important difference in the composition of foremilk and hindmilk is:
   A. Foremilk contains less immune substances.
   B. Foremilk contains no long-chain polyunsaturated fatty acids.
   C. Hindmilk contains more calories per ounce.
   D. Hindmilk contains more fat.
   E. Hindmilk contains more lactose.

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