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What Nurses Need To Know Regarding Nutritional and Immunobiological Properties of Human Milk

Jae H. Kim and Elizabeth B. Froh

ABSTRACT

In this article, we discuss the nutritional and immunobiological components of human milk that nurses need to know to offer optimal care and education to their patients and families. We describe the major macronutrients and micronutrients in human milk that are essential to the growth and development of the newborn infant, and we discuss the immunobiological components of human milk that supplement and boost the newborn's immune system.

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Newborn nutrition is of critical importance from a worldwide perspective. The choice between human milk (HM) and artificial nutrition is one that every parent has to make, and a choice that will continue to be a challenging one for future parents to make. Understanding the science behind the benefits of HM and disseminating that knowledge to parents of newborn infants is of utmost importance to the medical and nursing community. Human milk is an evolutionary wonder whereby the lactating mother produces a species-specific nutritional and biologically active (bioactive) product that confers the best health to the human offspring. Human milk, like blood, is a liquid tissue with cellular components, nutritional components, and bioactive factors. Interestingly, the number of bioactive factors (>200) far outnumbers the nutritional components in HM.

These facts provide the basis for the recommendations that newborns have an exclusive diet of HM from birth to age 6 months made by the following organizations: the American Academy of Pediatrics (AAP) Section on Breastfeeding (Gartner et al., 2005), the American College of Obstetricians and Gynecologists (ACOG, 2005), the American Academy of Family Physicians (AAFP, 2007), the Academy of Breastfeeding Medicine (ABM, 2008), the Canadian Paediatric Society (CPS) (Boland, 2005), the European Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) (Agostoni et al., 2009), the World Health Organization (WHO) (2001), and the United Nations Children's Fund (UNICEF, 2003).

In this article, we focus on what nurses need to know about the nutritional and immunobiological activity of HM to best prepare them for handling, delivering, discussing, and promoting the use of HM for sick and healthy newborns.

Nutritional Perspective

Human milk is the ideal and preferred nutritional source for all preterm and term infants throughout the first year of life. Although the optimal duration of breastfeeding is unknown, most health organizations currently recommend exclusive breastfeeding from birth to age 6 months. The AAP further recommends a total duration of breastfeeding for $\geq$ 1 year to maximize the full benefits of breastfeeding (Gartner et al., 2005). The major nutritional components of HM are macronutrients, micronutrients, vitamins, and trace elements (see Table 1).

Macronutrients

Fats. Fat is the largest single source of energy in HM. The principal fat found in HM is in the form of triglycerides (>98%) that are structurally three fatty acids linked to a 3-carbon glycerol molecule. The mammary gland packages these triglycerides uniquely compared to the triglycerides found in commercial infant formulas. The mammary epithelium processes triglycerides into membrane-bound globules that contain a surface of glycoproteins, glycolipids, phospholipid, cholesterol, and enzymes with a dense triglyceride core (See Fig. 1). Fat globule size varies over the first week of life postpartum and then gradually increases over the next several months. This process appears to depend on the abundance of cell membrane from which the globules are made (Michalski, Briard, Michel, Tasson, & Poulain, 2005).

Unlike infant formula, the fatty acid profile in HM highly reflects the dietary fatty acids of the mother's diet. For instance, a mother who eats a generous amount of omega-3 oil not typical of the North American diet will pass on these long chain fatty acids into her milk and change the fractional portion of omega-3 fats in her milk (Lauritzen & Carlson, 2011). A study in mother/infant dyads where mother and infant were supplemented with omega-3 supplements during pregnancy and afterwards demonstrated an increased omega-3 content in mother's milk and favorable outcomes in a subset of girls (Olsen et al., 2008). Fish oil taken by pregnant mothers may affect later health outcomes in their children, as one longitudinal study found a reduced incidence of asthma in infants of supplemented mothers (Smithers, Gibson, McPhee, & Makrides, 2008). Trans fatty acid content is a prime negative example of dietary influences on HM. Trans fatty acids was prevalent in the North American diet, but after tighter regulation in the food industry resulted in decreased levels of trans fatty acids in daily food, a corresponding reduction in trans fatty acids in HM was seen (Friesen & Innis, 2006).

Fat digestion starts immediately with the activity of lipases secreted from the salivary glands and stomach. To digest these large globules of fat, however, the membranes have to be broken down to allow access to the triglyceride core. Proper digestion of HM fat does require the presence of bile acids, and therefore cholestatic infants may not digest HM effectively. Once made accessible, lipases found in the small bowel and secreted by the pancreas attack the free triglycerides.

With a sound knowledge base, the nurse can provide the parents with the information needed to make an informed decision regarding infant feeding.

Human milk contains its own lipases, which is a convenient design for improving fat digestion and is most active in fresh milk. The fat globules appear unaffected by refrigeration but may disrupt with freezing. The relevance of this disruption is with some mothers, generally later in lactation, who produce milk with high lipase activity. Their stored milk can develop a significant "soapy" or rancid odor and taste, and infants may refuse to drink. Heat, such as that applied during pasteurization, can readily inactivate lipases. Unfortunately, no proven practical method for reducing lipase activity without losing other bioactive properties is available.

Fat digestion is superior in HM compared to that in formula milk. Triglycerides in HM are broken down into free fatty acids and glycerol by the activity of bile salt–dependent and pancreatic lipase-related lipases found within HM (Lindquist & Hernell, 2010). The digestion of formula milk requires the primary activity of pancreatic lipases that are more restrictive and digest triglycerides to fatty acids and 2-mono-glycerol chains (one fatty acid in middle carbon position of a glycerol chain). As a result, some plant sources of triglycerides found in formula milk have saturated fats in the outer positions of the glycerol chain that make their digestive products more prone to calcium binding, soap formation, and subsequent energy loss (Koo, Hockman, & Dow, 2006).

Fat content in HM varies the most of any nutrient component. This variation is largely due to the graded increase in fat content of milk during a lactation cycle where foremilk is relatively fat poor and hind milk is relatively enriched in fat and can contain 3 times the fat content (Bishara, Dunn, Merko, & Darling, 2008; Saarela, Kokkonen, & Koivisto, 2005). For the breastfed infant, this variability is virtually unnoticeable due to the ingestion of all the milk. However, for the preterm or sick term infant where HM is pumped and stored, large variability in fat content may be present. Using nonsequential delivery of milk may disadvantage an infant to receive predominantly lower fat and thereby lower calorie milk. Nonsequential milk delivery is the delivery of stored milk without consideration of matching the pumping sequence to the milk delivery (Spatz, 2012).

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