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Got Milk? Human Milk Components and the Benefits of Breast Feeding

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Nutrition is an essential component of infant growth and development. Breast milk provides infants with all the necessary nutrients needed during this crucial period. Breast milk is made up of a number of components ranging from proteins and oligosaccharides to fatty acids and antibodies. It is recommended that all infants be exclusively breast fed for the first six months of life (World Health Organization, 2014). The American Academy of Pediatrics recommends that infants should be breast fed until one year of age to maximize the full benefits (Kim & Froh, 2012, p. 122). The actual statistics in the U.S. show that many infants are not meeting this goal. The percentage of infants that are breast fed exclusively for three months is 37.7%. The percentage is even lower for those that are exclusively breast fed for six months at 16.4%. Only 27% of the 76.5% of infants that are ever breast fed make it to the 12 month recommendation (*Breast Feeding Report Card,* 2013). There are many reasons that women choose not to breast feed their infants, some of them are personal, yet some are related to lack of information and support shortly after their child is born. Healthy People 2020 have identified ways that could increase the rates of breast feeding among the U.S. population. Only 7.79% of infants are born at "baby-friendly" hospitals that encourage and educate mothers to breast feed and in some states this number is 0. These "baby-friendly" hospitals are recognized because they provide optimal lactation care to mothers based on the WHO/UNICEF top 10 Steps to Successful Breastfeeding for Hospitals (*Breastfeeding Report Card*, 2014, p. 6). Almost 20% of infants are being fed formula by two days after birth, but baby-friendly hospitals are providing more support to these mothers to help reduce the occurrence of this practice. Another initiative to help support mothers who are choosing to breast feed is the placement of Lactation Consultants in these baby-friendly hospitals. These members of the health care team help to assist the mother and infant

through educate and creation of a plan for each individual. Lactation Consultants also help to educate other health care providers so they can be more prepared and comfortable assisting new mothers (*Breastfeeding Report Card*, 2014).

Breast feeding has numerous benefits for the infant over the first year of life. Breast milk plays a role in the development of the immune system and protecting the infant against some types of chronic disease. Breast feeding can decrease the incidence of Type II diabetes, becoming overweight or obese as an adult and may increase performance on IQ tests (Horta & Victoria, 2013). Breast milk has also been found to decrease the occurrence of necrotizing entercolitis and Campylobacter in infants (Bode, 2009). It has also been shown to play a protective role in the prevention of Type I diabetes mellitus ((Patelarou et al., 2012, p. 518). Breastfeeding is not only a way for mothers to bond with their infants; it can also provide essential nutrients and protective properties that can benefit the baby past the infant stage of life.

The theoretical frameworks chosen for this project are related to using the information to help educate new mothers and to assist them if they choose to breast feed their infants. Roy's Adaptation Model can be useful in helping to assist a mother as she transitions into this new role and as she begins to breast feed her infant. This model contains four adaptive modes that the individual or group encounters to overcome stimuli or stressors (Phillips, 2010). Intervention and evaluation are based on how the patient moves toward adapting to the new environment. Mercer's Theory of Becoming a Mother can also be applied to the new transition that a mother makes as she begins her pregnancy and postpartum. There are four stages that a mother moves through as she journeys from pregnancy, to postpartum and into the first year of the infant's life (Meighan, 2010). By educating health care provider and supporting mothers using these

theoretical frameworks, there is a potential to increase the number of infants being breast fed over time.

The information gathered from this literature review and research assistantship was used to educate other professionals on human breast milk at a conference in October 2014. There were three objectives for this educational session. The first was to develop a better understanding of the bioactive molecules of breast milk by addressing the current statistical data on breast milk in the U.S., reviewing the composition of human milk and the roles of these components of human milk. Another objective was to describe how human milk effects immunity, growth and disease prevention. The last objective was to discuss and consider human milk banking. The focus of this literature review was to obtain information that could be beneficial to the education of providers on the topic of human breast milk and its benefits.

Methodology

In searching for research information on breast milk, the McKee Library online at Southern Adventist University was accessed from April to June 2014 to search numerous health related databases. The search terms used were specific to ensure that the correct data was received in the search. These terms were “Breast milk”, “Human milk”, “nutrition”, and “components” and were used interchangeably in an advanced search limiting articles to those that were peer reviewed, designated as research articles and from the years 2009-2014. The main databases accessed during this research were CINHAL, PubMed, Medline and Ovid Nursing.

While searching for these articles, each one was reviewed for relevance to the topics of breast milk composition, breast milk nutrition and the relationship of breast milk to disease processes in the infant. The articles were also from a specified time frame from of 2009-2014.

The articles that were chosen were from reputable national journals, were peer-reviewed and specified as research articles. Of the articles used eight were level I, one was a level II, five were level IV, one was level V and one was level VI. The Rating System for the Hierarchy of Evidence was used for this evaluation (Ebling Library, 2014).

Literature Review

Breast milk formation and composition are both very complex processes. Thomas et al (2010) explains mammary gland development, the stromal matrix and milk removal. Colostrum precedes mature milk synthesis and is rich in protein and carbohydrates. It has been shown to "promote cell proliferation development of the GI tract and other factors that stimulate hematopoiesis and cytokine production to develop acquired immunity (Thomas, Williams, & Hartman, 2010, p. 87).

The nutrient content in breast milk can depend on many different aspects. Qian et al (2010) measured and compared the micro- and macro-nutrients of breast milk in Chinese woman. There were some significant variations of the nutrient levels of the breast milk based on geographical region. These differences were related to decreased economical means, education level and access to nutrition (Qian, Chen, Lu, Wu, & Zhu, 2010). The contents of breast milk can also differ based on the health status of the mother. Olivares et al (2014) investigated the breast milk of mothers with celiac disease to see if the components differed from healthy mother's milk. The milk of the mothers with celiac had decreased amounts of cytokines and microbiota when compared to healthy mothers. These differences could have an effect on the infant's immunity (Olivares et al., 2014)

Oligosaccharides are one of the many components of breast milk. Over 200 different complexes exist in human milk. Bode (2009) found that human milk oligosaccharides have

numerous beneficial properties for infants. Oligosaccharides can interfere with bacteria-host interactions and positively impact the composition of intestinal flora. They can block the adhesion of pathogens, which protects infants against infection and diarrhea such as Campylobacter. Oligosaccharides have been shown to significantly decrease the rate of Necrotizing entercolitis (Bode, 2009).

Bioactive proteins are a main component in human milk. Lonnerdale (2013) helped to identify and define their roles. These proteins are responsible for nutrition absorption, growth stimulation, modulation of immune system and pathogen defense. They also have enzymatic properties (Lonnerdal, 2013). Mehta and Petrova (2011), studied the milk of mothers who gave birth to premature infants was studied to determine if preterm birth had an effect on the bioactive proteins present in milk. The milk from preterm mothers was found to have increased antibacterial and anti-inflammatory activities like secretory IgA, lysozyme and adinopectin ($P<0.05$ to 0.0001). The preterm milk did have lower levels of leptin in comparison to term milk samples ((Mehta & Petrova, 2011). Ricci-Cabello, Herrera and Artacho (2012) found that milk-derived bioactive peptides can help to decrease an individual's overall incidence of metabolic syndrome by promoting satiety, which can decrease over body mass index. Over time this will help to decrease blood pressure, cholesterol and enhance anti-thrombotic effects (Ricci-Cabello, et al, 2012).

Fatty acids are present in breast milk and have many distinct properties. Antonakou et al., (2012) assessed the fatty acid content of breast milk in Greek mothers during the first six months of exclusive breast feeding. Total milk fat levels did not differ during the first six months of exclusive breast feeding. The amount of weight gained during pregnancy was related to the increased saturated fatty acid levels in breast milk ($p<0.01$), mean pre-pregnancy BMI was 22.2

+/- 4., mean weight gain was 15.9kg +/- 6kg. DHA was positively related to ($p=0.03$) increased fat intake, and overall the distinct diet of Greek women effect the composition of their breast milk (Antonakou et al., 2012). In a study to determine if the fatty acid content of breast milk differed between overweight and normal weight women, Makela, Linderborg, Niinikoski, Yang, & Langstrom (2013) found that the breast milk of overweight women was higher in saturated fatty acids ($p=0.012$) and lower in unsaturated ($p=<0.05$) and n-3 fatty acids ($p=0.010$) than the breast milk of normal weight women. There was no significant difference in the growth or cholesterol levels of the infant (Makela, et al., 2013). Willemsen et al (2008) investigated the effects of polyunsaturated fatty acids on epithelial integrity in vitro. Polyunsaturated fatty acids were found to "support natural resistance by enhancing intestinal epithelial barrier integrity" (Willemsen et al., 2008, p. 190). The breast milk of Iranian women was studied to determine the correlation of the amount of fat in breast milk, maternal anthromorphic status, energy/macronutrient intake and infant weight (Nikniaz et al., 2009). Most of the mothers were found to be overweight with energy intake and macronutrients well below the RDA recommendations ($p<0.05$) (Nikniaz, Mahdavi, Arefhoesseini, & Sowti Khaibani, 2009). Infants with a higher weight for age Z-score had mothers with higher lipid content in breast milk ($P<0.031$) (Nikniaz et al., 2009, p. 41).

Fields and Demerath (2012), studied the relationship between insulin, glucose, leptin, IL-6 and TNF-α in breast milk on infant growth and size at one month. Breast milk glucose was positively associated with infant fat mass and weight. The glucose has been associated with greater weight gain and fat-free mass. Milk leptin had a negative association with infant weight related to lower lean body mass, as did IL-6, insulin and TNF-α. Higher insulin levels were also

associated with lower relative weight and reduced total lean mass due to its nutrient influence on growth such as the development of lean body mass stores (Fields & Demerath, 2012).

Immunologic factors are also present in the breast milk of humans. Kim and Froh (2012), discussed some of these factors and their role in infant immunity was defined. These factors consist of macronutrients (fat, carbohydrates, proteins), micronutrients (Calcium, Phosphorus, Magnesium, Iron, vitamins) and Trace elements (Zinc, copper, etc.) (Kim & Froh, 2012). Protein and carbohydrates are essential cell growth/development and mineral absorption. Iron has more bioavailibity in human milk. Oligosaccharides help to foster normal gut flora. Human breast milk's overall advantages to the infant consist of increased barrier protection, inflammation prevention, bacterial cell wall lysis, and decreased risk of nosocomial infections (Kim & Froh, 2012). Rahamon & Arinola, (2012), focused more on the immunologic factors in breast milk and plasma that were present in the milk of 50 Nigerian women with and without HIV (Rahamon & Arinola, 2012). Levels of IgE were lower in HIV- infected mothers' milk; as levels of IgA ($p=0.000$), IgM ($p=0.008$), CLP ($p=0.004$), C3c ($p=0.000$) and TRF ($p=0.000$) were significantly elevated in the milk of HIV-infected mothers (Rahamon & Arinola, 2012). The increased levels are thought to help protect the mother and infant from the HIV-infection or to neutralize some strains (Rahamon & Arinola, 2012).

Breast milk has also been shown to affect the occurrence of some medical problems. Patelarou et al (2012), studied the association between breastfeeding and the incidence of Type I diabetes mellitus. Breastfeeding for a short period of time or not at all can be a risk factor of developing Type I DM, while exclusive or total breastfeeding has been shown to play a protective role. Breastfeeding can help to protect the immature immune system of the infant from B cell autoimmunity that can lead to Type I DM (Patelarou et al., 2012). Gribble (2011)

discussed the role of breast milk in preventing and protecting against diarrhoeal illness in infants. Antibodies in human breast milk can help bind pathogens that enter the infant gut and prevent adhesion to the intestine. Glycans in breast milk bind to pathogens like *V. cholera, Campylobacter jejuni, E. coli, Shigella* and *G. lambilia* and remove them from the gut. Oligosaccharides in the milk encourage the growth of healthy intestinal flora, which also prevents illness (Gribble, 2011). Breast milk has the possibility of being used to help with tissue regeneration. Twigger et al (2013) discusses the potential for using the stem cells that are present in breast milk for cell replacement therapies. The stem cells that are present in breast milk can differentiate into many other types of cells, more importantly neural-like cells. This finding has created research into using the stem cells for CNS cell replacement therapies (Twigger, Hodgetts, Figueira, Hartmann, & Hassiotou, 2013). In premature infants breast milk was found to reduce morbidity and mortality. Cristofalo et al, discusses premature infants that were given either bovine milk-based formula or donor human milk and assesses their nutrition, growth and morbidity. The group of infants fed human donor milk had a decreased need for parenteral nutrition, but had a decreased growth rate compared to the formula fed group. The human milk group did have a decreased incidence of necrotizing entercolitis and the need for surgical intervention if NEC did occur (Cristofalo et al., 2013).

Results and Discussion

The research assistant's role was to gather research articles related to human milk, its components and the relationship to disease prevention. The researcher spent about eight weeks compiling research articles from numerous databases on the above listed topics. All of the 19 articles were read and the contents were summarized. Next each article was placed into a matrix based on information content. Within the matrix the article information was broken down based

on purpose, level of evidence, definition of variables, sampling and findings. The matrix process took about four weeks to complete. Once the matrix was finished, the articles were reviewed and summarized for the literature review portion of the paper.

Evaluation

The overall experience of being a research assistant was very informing and enlightening. There is an incredible amount of work that goes into researching a topic and gathering relevant data based on the topic of choice. A new respect has been gained for those who do research on a daily basis. Little was known about breast milk besides that it is best for infants in general. From reviewing this information, new knowledge was gained about what the actual components of human milk are and how they benefit the infant overtime. It was eye-opening to learn that breastfeeding an infant for even a short period of time can possibly decrease some disease processes from occurring. The information acquired from this experience will be beneficial in practice to educate new mothers and their families about the incredible benefits of breastfeeding newborns and infants.

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