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Personalized Modification of Breast Milk to Help Enhancing Nutrition Profile of Neonates: A short Communication

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ABSTRACT

Personalized Nutrition means in practice, adapting food to individual needs, depending on the host's genome, this calls for an emerging field of nutrigenomic approach in order to build the tools for individualized diet, health maintenance and disease prevention. Based on this principle, breast milk is now being analyzed, modified and administered in smaller infants to provide them personalized diet, ensuring the premature infants are receiving correct amounts of nutrients they need to thrive. In the past, all milk was fortified to the same and it was 'one-size-fits-all'. Now, nutrigenomics is moving towards having the ability to personalize each mother's milk to give her baby precise nutrition he needs by stressing upon nutrition and interaction of three health relevant genomes in perspective, namely the food, the gut microbial and the human host genome in context of individualized nutrition and optimum health.

Key words: Breast milk, Personalized nutrition, Nutrigenomics, Optimum health, Genome, Genetic expression.

INTRODUCTION

Human breast milk is the gold standard for neonates and infant nutrition. Secretory immunoglobulin, lysozyme, interferon and growth factors are also known as 'immunological assets' of breast milk.Human milk is also enriched with nutrients and bioactive derives of proteins and peptides, lipids and oligosaccharide to ideally support neonatal healthy growth and development in favor the maturation and maintenance of a balanced immune system.Breastfeeding and human milk are the normative standards for infant feeding and nutrition. Given the documented short- and long-term medical and neurodevelopmental advantages of breastfeeding, infant nutrition should be considered a public health issue and not only a lifestyle choice.[1]Nutrient content of human milk is not affected by maternal nutritional status, but milk of a preemie baby is reported to be different from the milk of a mother who delivered a full term baby.Preterm milk is in excess of theoretic intrauterine requirements for all substrates except calcium and phosphorus. [2]Preterm human milk is theoretically more suitable for the premature infant than either mature or term human milk, but may be deficient in specific nutrients for the very low birth weight baby. [3]Very low birth weight neonates who need more nutrients to survive thus need to get adequate nutrition from breast milk.[4] In this context it is needed to analyze the mother's milk to calculate the composition and additional amount should be determined to fill the gap for optimum growth and development of the child. This communication focuses on how personalized diet is important to balance the interaction of food genome, human host genome and gut microbial genome even in case of a neonate for proper homeostasis and optimum nutrition.[5]

A new study proposes an interesting new approach for non-invasively examining host gene expression within the infant intestinal wall and looking for correlations between this expression and the structure of the gut microbial community. [6] It is observed that the human body sheds epithelial cells from the intestines, which can then be recovered from the stool, providing the means to explore the transcriptional activity in the intestinal wall. This approaches to explore the effect of diet on the host-microbiome interaction. The study examined stool samples from 12 children, 6 of whom were exclusively breastfed, the remaining being fed a commercial infant formula. From each stool sample, they extracted bacterial DNA, which was subjected to high-throughput sequencing on the Roche/454 platform, and eukaryotic mRNA (from shed epithelial cells), which was analyzed on a microarray platform. [6]

The taxonomic assignment of bacterial reads confirmed the previously reported impact of diet on the gut microbiome: the microbiota of breastfed and formula-fed infants differed significantly in both composition and diversity.[6] The breastfed samples were more heterogeneous than the formula-fed samples and contained a higher taxonomic diversity (as measured by the Shannon-Wiener index). This observation may confirm the popularly believed benefit of breastfeeding - in ecological systems greater population diversity is thought to imply greater system stability.[7] Similarly, this insight could guide the development of pro- and pre-biotic supplements to infant formula that are aimed at increasing the bacterial diversity within the gut.

Functional analysis of the gut microbiome revealed a significant enrichment of genes related to microbial virulence in the microbiome of breastfed babies, a result complemented by enrichment in immunity and defense gene expression in the host transcriptome. This result is perhaps counter-intuitive as it seems to imply a potentially unhealthy gut community. However, the infant gut microbiome has an important role in the development of the host immune system, and potential pathogenic organisms are often the early colonizers of the gut. It is thus likely that these initial attacks on the host are a necessary factor in the development of host immunity and, therefore, the increased virulence in the breastfed infants is beneficial to development.

Nutrition, genomes and health

Personalized nutrition means in practice adapting food to individualized needs.[7] This need is decided by the interplay between three genomes – the food, the host and the gut microbial genome. The food genomes interact with the human genome directly, mediated by the interfacing gut microbial metagenome.[8] Polyunsaturated fatty acids for examples directly bind to particular transcription factors that in turn switch on gene expression machinery – a gene direct interaction between a food component and the host genome.[9]On the other hand, human milk derived oligosaccharides favor the colonization of the infant gut by health-beneficial bacteria that impacts in host's metabolism.[10] This interaction may be hampered if desired amount of nutrient is not available. Epigenetic modulation, protein expression and genetic imprinting may also g*et al*tered as the whole mechanism is dependent upon nutrient-gene interaction. [11]From a point of view of basic physiology as well as genetic makeup, adequate amount of nutrients have to be availed by the neonates from mother's milk without any compromise to maintain general growth, development, homeostasis and genetic environment.

Personalized nutrition for diverse needs

Human infants and neonates differ from nutritional needs and responses to diet.[12]All children differ in view of genetic diversity, environmental inputs, prior imprinting and resistant

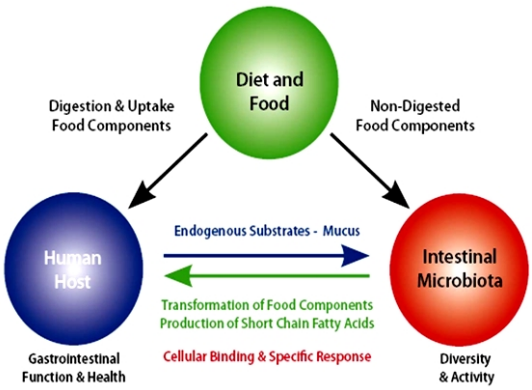

Fig. 1: Impact from Intestinal Interactions

microflora.[13] Currently, the only way to determine if premature new borns are malnourished is to monitor the growth rate. If infant's growth rates are lagging behind the norm, it is likely they are not receiving nourishment they need[14] So, analyzing mother's milk and then adding food supplements accordingly is extremely important for the smallest infants as pre-matured babies are most challenged with weight gain and often leads to the delayed development of neuro logical functions.[15] In the past all milk was added with nutrients to bring a diet that was fitted to every neonate irrespective of their individualized need, genetic makeup and 'food-host-genome' interaction[16] Now, Nutrigenomics has stepped towards personalizing each mother's milk according to the need of her child.

DISCUSSION

Challenges in establishing secured personalized breast milk feeding

Traditionally, nutrigenomics and nutrigenetics are seen as the key sciences to understand human variability in preference and requirements for diet as well as responses to nutrition. A recommended diet formula was set to every individual. 'Extended nutrigenomics' puts the three nutrition and health relevant genomes into perspective in order to build the future tools for personalized nutrition, health maintenance and disease prevention. This article discusses the newest trend of feeding an infant by modifying his mother's milk according to his personalized need by device mediated spectroscopic analysis of the milk to get exact amount of nutrients present in it. The analysis enables us to determine which babies may need nutritional supplement and to what extent for optimum growth. Now it is to be seen that how far this lab-based technique can be implemented in the field of public health nutrition to ensure personalized breast milk for every neonates. This new research surely added some very important message to the existing knowledge of nutrigenomics but it is difficult for the low income countries to avail this method in primary health care level to provide optimum nutrition to their upcoming generation though the maternal malnutrition and low birth weight babies are serious public health concerns in these countries. But, in gradual process of upliftment of economic condition if this method is adopted by the Govt. of developing countries as a pilot project then results may be seen in general growth and development of their children.

CONCLUSION

Research has shown that human respond differently to diets and moreover they display varying predispositions to many diet dependent metabolic and degenerative diseases. The focus of nutritional science is thus shifting from dietary guidelines for population to gene-dependent individualized foods and diet. It is the aim of nutrigenomics to assign this human diversity in nutritional response to diet as well as the subsequent consequences to human health to specific genetic elements. At the same time, evidences suggest that diet itself is a critical determinant of human diversity. Incorporating this concept, the article tries to identify some directions for future research and practical application in the field of neonatal personalized nutrition that leads to attainment of more rapid weight gain and quicker release of premature infants from the hospital.

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