

Preventive aspects of breast milk feeding in premature infants

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This article is dedicated to the issue of infant feeding. It is universally recognized that the best product for neonatal and infant feeding is breast milk. On the basis of the worldwide literature data, the authors give a detailed account of breast milk advantages from various (biological, clinical and psychological) perspectives. They convincingly demonstrate that knowledge of preventive and medical aspects of breast feeding benefits allows conducting effective educational programs regarding motivation, struggle for breast feeding and long-term maintenance among medical personnel, mothers and their families. It is especially important to provide premature infants and sick children, who are often born unable to suck adequately, with breast feeding. The authors provide results of a study conducted at the SCCH demonstrating that special medical devices (nipples, feeding bottles) developed on the basis of studies of maternal breast sucking physiology facilitate a gradual transition from tube feeding to breast feeding.

Keywords: breast feeding, breast milk, neonate, premature infant, infant, feeding bottles, nipples.

The benefits of breast feeding are widely known. Since the last decades breast milk has been considered the indispensable product or the gold standard in neonatal breast feeding. Breast feeding of healthy infants is recommended up to 4-6 months; after introducing supplemental feeding breast feeding can still be relative even at an older age (after the first year of infants' lives) [1, 2]. More and more facts are proving benefits of breast milk for breast feeding sick and premature infants both at resuscitation and intensive care units for neonates and in further nursing [3–5].

BIOLOGICAL ASPECTS

Breast milk is the optimal product for enteric feeding of premature infants. It can be viewed as biological dynamic system specific for *Homo sapiens*. Breast milk which contains a large complex of protective factors, hormones, enzymes, cytokines, growth promoting substances, antioxidant complex, essential nutrient materials, and is not only a nutritious substrate but also has preventive and medical properties.

Special attention is paid to certain biological active and immunomodulatory factors of breast milk which can not only provide infants' adequate protection from infection, but also actively simulate the immune response and modify intestinal microbiota [6, 7]. A very important role among the abovementioned factors belongs to oligosaccharides. Initially they were described as prebiotic bifidus factor which serves as a metabolic substrate for indigenous bacteria and forms the composition of the intestinal microbiota; currently it is known that oligosaccharides are more than just food for microbes. Recent studies have shown that oligosaccharides can directly prevent pathogen adhesion to intestinal tract's mucosa; they are also able to minimize the risks of infection and simulate epithelial and immune response of the cells [8]. The recent study also informs on higher concentration of oligosaccharides in breast milk after premature labor

compared to the milk of women who have given birth to children on term. This fact emphasizes the important role of breast feeding for premature infants, who have higher risks of infectious diseases due to immaturity of their immune system.

Breast milk after premature labor has a specific composition which meets the raised demands of premature infants in nutrient materials to the maximum extent and at the same time corresponds with their physiological maturity. Premature breast milk is also characterized by high energy value. The concentration of proteins and fats in this milk is higher, especially in colostrum and transitional milk; the concentration of lactose is lowered while the content of common carbohydrates is equal to the milk of women who have given birth to children on term. Low lactose concentration can cause positive effect on breast feeding of premature infants and facilitate lowering of osmolality of breast milk, as well as in connection with lactase deficiency which is widespread among premature infants [9].

Secretory immunoglobulin (Ig) A plays an equally important role in immune protection. The concentration of IgA in breast milk both after premature and term birth has its maximum in the beginning of lactation and starts to decrease rapidly within the first week. This changeability reflects an important function of breast milk in donation of immune factors which allow preventing penetration of high molecular weight proteins through the gastrointestinal tract during the first days of life [10].

Glycosaminoglycans (lactoferrin) of breast milk are being actively studied in recent years. It has been established that these components can serve as antioxidants and anti-inflammatory agents, just like soluble receptors which can interact with pathogens and compete for adhesion thereof to intestinal wall. High concentration of glycosaminoglycans observed in breast milk after premature labor can be beneficial for premature infants along with oligosaccharides in providing protective processes against a range of causative agents and free radicals [11, 12].

NUTRITIONAL ASPECTS

Breast milk is universally admitted to be the optimal nutrition choice for any infant [1]. Nevertheless, in order to satisfy peculiar requirements of premature feeding and to preserve the unique properties of breast feeding, breast milk should be fortified in order to provide normal growth and preventive measures against premature osteopenia [13]. In two Cochrane reviews, C.A. Kuschel and F.M. McCormick confirmed that the enrichment of breast milk with more than one nutritious component is connected with the short-term effect in weight gain, linear growth, and head circumference. Further research should include a comparative evaluation of the immediate and long-term effects of using different fortification in order to make adjustments in their composition. This will ensure adequate physical development, especially of premature infants born with very low birth weight (VLBW) and extremely low birth weight (ELBW) [14, 15].

A variety of protocols of breast feeding of premature infants are currently used at neonatal units. It has been noted that in case of standard (stated in the label) fortification of expressed breast milk protein intake does not meet the requirements for their donation to premature patients, especially to infants with VLBW and ELBW. Studies show that the actual protein intake is significantly lower than anticipated with fortification [16].

It has also been revealed that the main factor limiting the growth of small premature infants is a low protein intake. Positive results have recently been obtained at individualized fortification of expressed breast milk; this allows compensating high changeability of its composition.

Two models of individual fortification of breast milk have been proposed:

- an adjustable one based on metabolic response of infants;
- a purposeful one carried out on the basis of analysis of breast milk and introducing the amount of fortification required to achieve the recommended protein intake (in accordance with birth weight) [17].

Adjustable fortification has an advantage, namely, the protection against excessive protein intake [17].

There is now evidence for a positive impact of breast milk on plastic processes in premature infants [18]. It has been proved that premature infants who have been receiving breast milk have a more optimal body composition (smaller percentage of fat tissue) compared to the infants fed with the specialized infant formula; this supports the hypothesis of prophylactic effect of breast feeding for preventing late metabolic disorders (hypertension, heart cardiovascular disease, obesity, type 2 diabetes).

The abovementioned data suggest that breast feeding of premature infants, especially of the infants born with very low and extremely low body weight, is the most urgent healthcare issue [18].

CLINICAL ASPECTS: SHORT-TERM AND LONG-TERM RESULTS OF PREMATURE BREAST FEEDING

Necrotizing enterocolitis

Necrotizing enterocolitis (NEC) remains one of the most important diseases of premature infants with mortality rate from 15 to 30% even in the developed countries [19]. Although some randomized controlled studies of the connection of nature of feeding with NEC have never been conducted, two meta-analyses confirmed the reduction in the NEC incidence rate in premature patients receiving breast milk [20, 21]. In the other two meta-analyses [22, 23], premature infant formula and donor breast milk were compared: as human milk contains more immunoprotective factors, it provides a better protective effect. Premature patients who were receiving donor breast milk as the first enteric substrate had 4 times fewer cases of necrotizing enterocolitis compared to the children fed with a specialized infant formula.

Psychomotor development

The best performance of psychomotor development has been observed in the premature infants fed with breast milk.

Studies of the children born prematurely in catamnesis at the age of 8 and until adolescence have shown that the results of psychometric tests, as well as an assessment of total brain volume and the volume of cerebral alba are higher in the group of children who received breast milk at resuscitation and intensive care units. Premature infants with ELBW, whose diet predominantly consisted of breast milk, had better results of cognitive, motor and behavioral development tests at the age of 18 and 30 months [24]. Studies of D.L. O'Connor should also be noted: he has discovered the optimal neuropsychological and motor development of the infants with VLBW in the corrected age of 1 year with fortified breast milk feeding in this period; however, physical development parameters of these children were reduced [25]. The author considers the qualitative characteristics of growth previously studied by A. Lucas [26]: no differences between the neuropsychological development of the children who received fortified breast milk and the infants fed with a specialized infant formula have been discovered despite faster pace of growth of the children who were fed with infant formula.

Thus, studies have shown that breast milk can have an independent beneficial effect on the development of the nervous system of premature infants.

Infectious diseases

A systematic review of A. de Silva is focused on three randomized studies and six observations of the relationship between the character of feeding including the role of breast milk and the development of infections in premature infants. Even taking into account methodological issues

of research the authors make conclusion on the protective role of breast milk in relation to infectious diseases compared with infant formula. [27] A large prospective study of premature infants with ELBW has shown that the risk of late neonatal sepsis is significantly reduced with early enteric breast feeding [28].

Food tolerance

Separate experimental studies of food tolerance especially with regard to mother's milk have been made. According to the results of a meta-analysis of randomized controlled studies, C.A. Boyd pointed out that feeding with infant formula compared to donor breast milk enhances the frequency of food intolerance and NEC in premature infants [20]. On the other hand, the meta-analysis by G. Henderson has not revealed any convincing evidence of the benefits of a particular type of feeding of premature infants in relation to their growth, development and other clinical parameters [29]. Certain non-experimental studies confirming the better food tolerance and faster transition to full enteric feeding of premature infants fed with breast milk have been presented. A recently published study [30] has investigated the practice of prescribing enteric feeding to premature infants in four different regions of the world. A variety of approaches to prescribing breast milk at resuscitation and intensive care units has been discovered; according to the authors, that explains the different availability of donor milk. Most centers, which have the opportunity to use donor milk for enteric nutrition from the first day of life, have reached full enteric feeding faster.

Prevention of cardiovascular diseases

The results of longitudinal studies of the development of infants born prematurely show that breast feeding reduces the risk of development of resistance to insulin and the development of metabolic diseases in the future. In adolescence, these children reveal lower blood pressure and concentration of low-density lipoprotein [24].

PSYCHOLOGICAL ASPECTS

Premature labor may be related to situations that have a negative impact on psychological state of all family members and the entire system of social relations. Generally, mothers tend to experience the worst emotional load. They experience acute stress, state of shock because of what had happened, and feel a sense of guilt in relation to the child. [31] The situation is aggravated by the fact that a mother has the impression that she is not able to help a small immature child. Most often the state of emotional stress of mothers of premature infants remain for a rather long time; it may last for several weeks and sometimes months depending on the personality. The process of formation of maternal affection is distorted. That is why the possibility of "skin to skin" contact of a mother and a child in accordance with the "kangaroo" method, as well as the provision of an infant with expressed breast milk, has an important psychological aspect: mother's affection to a child is enhanced, their close relationship is formed, as well as mother's belief that she is involved in child's care.

One of the important conditions of prolonged breast feeding is rooming-in.

It should be remembered that parental education on nutrition and treatment, upbringing, and development of mental abilities of ill infants should start from the first days of their joint stay in a hospital ward.

DONOR BREAST MILK

In its policy statement on breast feeding, the American Academy of Pediatrics recommends pasteurized donor milk reinforced accordingly for feeding premature infants if their own mother's milk is not available or its use is contraindicated for certain reasons [24].

In Europe, the USA and Canada numerous human milk banks in obstetric institutions and infant hospitals were established in the 1980-90s, most of them are state-funded and free for users. The experience of breast milk banks in Italy is widely known; an association involving 23 such banks and generalizing the results of research in this area has been established there. The initiative of the World Health Organization has been embodied in the creation of the European and North American Association of Breast-Milk Banks, which combined the work of more than 180 banks in Europe and 23 banks in North and South America.

By 2011, 165 active breast milk banks have been created in 25 European countries, 26 of them in Italy – more than in any other European country.

Currently, a considerable amount of scientific, research, and applicable medical data has been accumulated; it allows extensively justifying the operation algorithm of breast milk banks (the rules of donors' admission to participate in donor breast milk collection, the collection and sorting of breast milk, bacteriological testing and quality control of donor breast milk); protocols of pasteurization, freezing, and defrosting of breast milk have been developed [32].

Pasteurization of donor breast milk is needed to inactivate most viral and bacterial pathogens; however, it partially affects the nutritional and immunologic properties of breast milk; it is known that some beneficial (including protective) effects of milk are retained [32].

Donor milk banks are not only aimed at collecting, processing and storing breast milk. They also represent a tool for breast feeding promotion and support.

A study carried out in Italy showed that exclusive breast feeding at discharge from a resuscitation and intensive care unit is achieved by almost 30% of infants if a breast milk bank is available during hospitalization, and only by 16% of neonates in case donor milk is not available [33].

M.A. Quigley [21] reports that it is necessary to conduct more randomized controlled studies to compare results of feeding premature infants with infant formulas and enriched donor breast milk. Research of various cultural, religious and social aspects of donor breast milk banks creation are also required. [34]

MODERN WAYS OF SUPPORTING AND RETAINING PREMATURE LONG-TERM BREAST FEEDING

Retaining of long-term breast feeding of term and premature infants born with health deviations caused by chronic (intrauterine) and/or acute (intranatal) hypoxia constitutes a serious problem. These children are in need of maternal breast milk, but they often cannot get it for several reasons related to critical condition after birth.

According to the data obtained at the premature neonatal unit of the Scientific Center of Children's Health, which works in accordance to the principle of "Mother and Child" (full-time joint stay of a mother and a child), the proportion of exclusive neonatal breast feeding (n = 198) was 32.3%, mixed - 56.6%, artificial - 11.1%.

Main causes of temporary weaning were:

- severity of infant's condition and inability to suck without assistance (tube feeding);
- supplementation with an infant formula in case of mothers' insufficient lactation;
- lactostasis and pathology of nipples.

Lack of awareness of patients' parents (mothers and fathers) regarding necessity and possibility of retaining breast feeding of infants born with perinatal pathology (including premature infants) leads to unnecessary transitions to artificial feeding and rejection of direct emotional and tactile contact with the infant in the first months of his/her life.

Personnel at the department of special psychology and remedial teaching have studied the attitude of mothers of premature infants to the process of breast feeding in order to create the necessary conditions for them to form a lactation dominant (n = 85).

The data received at the premature neonatal unit have shown that the main cause of weaning from infant's side was the critical condition with forced feeding through a nasogastric tube, and from mother's side – the inability to provide sufficient feeding (hypogalactia) with an infant formula supplementation. Feeding with pasteurized breast milk served as another specific cause of temporary weaning. Pasteurization of expressed breast milk became necessary in case of Rh or ABO conflict between a mother and a child, as well as in case of pre-stimulated storage of preliminarily expressed breast milk in a refrigerating chamber for more than one day. In this case, feeding bottles with rubber nipples were used; this often leads to further infant's breast refusal.

Modern technological capabilities and thorough studies of the mechanisms of lactation and sucking allowed developing and creating a special rubber nipple Pigeon Peristaltic PLUS™ (Pigeon Corporation, Japan), which simulates the shape of the nipple; the nipple has such a surface texture that facilitates capturing and reproducing the peristaltic component of natural sucking. Use of the feeding bottle with the nipple manufactured by the Japanese corporation suggests the possibility of returning to breast feeding for infants forcedly weaned from breast, and thus contributes to long-term breast feeding.

An observational non-comparative prospective study of effectiveness of the bottle with a rubber nipple was conducted for beginning and return to breast feeding (including premature infants and children temporarily weaned from the breast in the first months of life) on the basis of the premature neonatal unit and the medical rehabilitation unit for infants with a perinatal pathology. The study included neonates and infants aged 1-10 postnatal weeks (n = 33) with no contraindications to inclusion in the study and whose parents gave written informed consent to participation. The study has also included children with a perinatal injury of the central nervous system of mild and moderate severity, as well as children with low birth weight and/or premature infants capable of sucking without assistance.

One premature infant had the birth weight < 1,500 g, 4 infants had their birth weight between 1,501 and 2,000 g, 7 had their birth weight between 2,001 and 2,500 g; one premature infant (35-36 weeks of gestation) weighed 2,880 g.

The number of children with perinatal injury of the central nervous system of mild and moderate severity was 9 (27.3%), prolonged conjugated jaundice was observed in 6 infants (18.1%), 5 children suffered from intrauterine pneumonia (15.1%). Respiratory distress syndrome was diagnosed in 5 children (15.1%), bronchopulmonary dysplasia - in 1 (3%), lactase deficiency - in 6 (18.1%).

Causes of temporary weaning were:

- 1) supplementation with expressed breast milk in the event of sufficient lactation due to the difficulties of breast feeding (flat, taut nipples, cracked nipples) - 5 patients (15.2%);
- 2) supplementation with an infant formula (up to 30% of total feeding) in the event of insufficient lactation - 7 patients (21.2%);
- 3) prolonged conjugated jaundice and feeding with pasteurized expressed breast milk - 4 patients (12.1%);
- 4) supplementation with expressed breast milk in case correction of severe lactase deficiency with lactase medication is required (the enzyme is put into a pre-expressed breast milk) - 4 patients (12.1%).

The study included 13 (39.4%) children after health improvement and development of the ability to suck without assistance (in the transition from tube feeding to bottle feeding): first – expressed breast milk, later – breast feeding.

The duration of bottle feeding using a Pigeon Peristaltic PLUS™ nipple was between 10 and 14 days. Separate indicators characterizing the quality of the physiology of suckling (aerophagia,

colics) and readiness to suck breast were evaluated. The evaluation was made in the beginning, in the middle and in the end of the study.

The following results have been shown: in the beginning of the study aerophagia was entirely absent in 2 infants (6.06%), was extremely rare (2-3 times a day) in 14 (42.42%), rare - in 11 (33.33%), frequent (1 per hour) – in 6 (18.18%), very frequent - in 0 (0.00%).

After 14 days, aerophagia was completely absent in 7 (21.21%) infants, extremely rare (2-3 times a day) in 24 (72.73%), rare - in 1 (3.03%), frequent (1 per hour) - in 1 (3.03%).

Consequently, aerophagia was observed in 31 children before the start of the study, and continued to persist in 26 infants in the end of the study. However, aerophagia only rarely occurred in 24 children (72.7%) (pic. 1).

The possibility of returning to full breast feeding among the following patients has been studied:

- infants with the refusal from breast in the beginning of the study - 10 (30.30%);
- infants with short sucking and anxiety - 3 (9.09%);
- infants who suck about 20-30% of necessary amount of milk, and then refuse to suck - 6 (18.8%);
- infants who suck about 50-60% of necessary amount of milk, and then refuse to suck - 3 (9.09%);
- infants who easily suck the necessary amount of breast milk - 11 (33.33%).

In 14 days, no infants refusing to suck were observed; short sucking and anxiety were observed in 4 patients (12.12%); the number of patients who sucked about 20-30% and 50-60 of the necessary amount of milk and then refused to suck reduced down to 3 (9.09%) and 10 (30.30%), respectively; the number of those who easily sucked the necessary amount of breast milk was 16 (48.48%, pic. 2).

Consequently, in the beginning of the study the number of children who refused to suck was 10 (30.30%), by the 14th day of the study the number of these infants reduced down to 0 (0%); the number of those who sucked up to 60% of the necessary amount of breast milk and those who easily sucked all the necessary breast milk was 14 in the beginning of the study (42.42%), and 26 by the end of the study (78.78%); in other words the proportion of children receiving predominantly breast feeding almost doubled.

In the event of forced medical weaning, special medical products (bottles, nipples) can be recommended for neonatal breast feeding developed on the basis of infant sucking physiology studies reproducing a peristaltic component of natural breast sucking. The studies have shown that the use of such products greatly reduces aerophagia and provides a real opportunity for premature infants to shift to the 100% breast feeding.

CONCLUSION

The studies have proved that the use of bottles and Pigeon Peristaltic PLUS™ nipples allows securing breast milk in nutrition of premature infants and ensuring a successful transition to breast feeding. Adequate breast feeding of premature infants predetermines their successful nursing and long-term prevention of metabolic disorders.

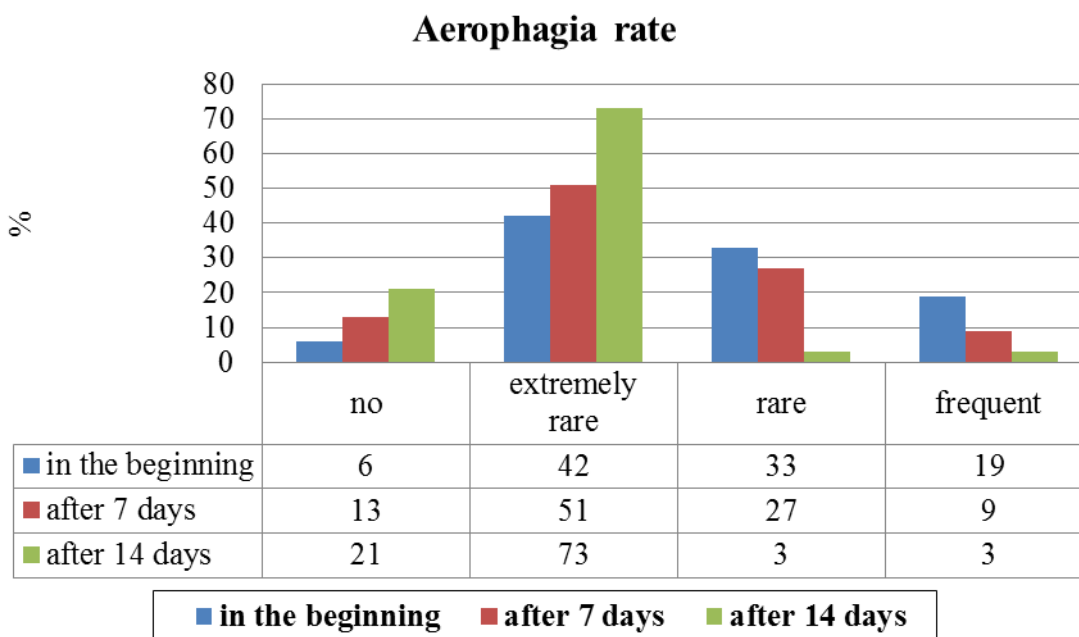
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Pic. 1 Aerophagia rate in the beginning, after 7 and 14 days of the trial



Note. Journal “Pediatric Pharmacology”, 2014, Vol. 11, No. 1

Article “Modern methods of breast feeding maintenance in children with intestinal colics” contains a mistake in p. 57, pic. 1. We apologize for any inconveniences. Please consider this pic. 1 correct.

Pic.2.Children’s capacity for breast feeding in the beginning, after 7 and 14 days of the trial

