WHAT KIND OF MILK CAN PREVENT INFANT’S SIDEROPENIC ANEMIA – COMPARATIVE STUDY

KOJOM VRSTOM MLEKA JE MOGUĆE PREVENIRATI NASTANAK SIDEROPENIJSKE ANEMIJE KOD ODOJČADI – KOMPARATIVNA STUDIJA

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Introduction

The most common cause of sideropenic anemia in infants, during the period of their fast growth and development, is inadequate nutrition or insufficient intake of food rich in iron. The aim of this paper is to provide the insight into the problem of anemia and to emphasize nutrition as an important etiologic factor in the onset and prevention of anemia in infants. Material and Methods. Two retrospective studies were conducted at the Institute for Child and Youth Healthcare of Vojvodina, Department for Infant and Small Children’s Pathology. The first study covered the period of eight years (1988-1995), and it included a total of 507 children, aged 1-24 months. The second study covered the period of two years (2010-2011) and a total of 290 children aged 1-12 months were included. The diagnosis of anemia was made according to clinical examination or after taking routine laboratory tests. According to the criteria of the World Health Organization, all children were divided into those with severe, moderate or mild anemia. Results. Out of 507 children examined in the first study, 333 (65.68%) were breastfed, while 174 (34.32%) had never been breastfed. In the second study, 206 (71.03%) out of 290 children were breastfed, while 56 (19.31%) had never been breastfed. In both studies the highest percentage of children breastfed for the longest period was among children with mild form of anemia, while the children who were breastfed for the shortest period had severe anemia. In addition, the highest percentage of anemic children was supplementary fed with cow’s milk in both studies. Conclusion. Short natural diet, early introduction of supplementation and choice of milk could be determining factors in the development and manifestation of anemia.

Key words: Milk; Infant; Anemia, Iron-Deficiency; Breast Feeding; Infant Nutritional Physiological Phenomena; Risk Factors; Hemoglobins; Iron

Introduction

The problem of iron deficiency anemia, although being a multi-interesting topic, is still not enough talked about. According to the reports of the World Health Organization (WHO), anemia is "... one of the most common diseases of undernourishment in the world...". Thirty percent of the...
world’s population, that is 1.3 billion people have iron deficiency; the percentage being 43%, 51% and 37% in the children of pre-school population, women and children of school-age, respectively [1].

Iron deficiency anemia is the most common hematological disorder among infants encountered in everyday practice. Although many studies have tackled this problem, it has not lost any of its relevance over time, since the factors causing iron deficiency anemia are still present in our environment [2]. Three quarters of cases of anemia in the first two years of life are caused by iron deficiency. During this period of life there is an increased need for iron, combined with iron loss and undernourishment, which is why this age is known as “hematologically vulnerable age”. According to some authors, anemia affects children from poor social, hygienic and cultural backgrounds. Studies indicate that iron deficiency anemia has a growing trend, especially in economically deprived conditions, in the countries where iron is almost completely absent in the diet of population, or in countries where the diet is reduced because of poverty, war, inadequate agricultural policy or wrong social doctrine [2-4]. However, this type of anemia is also present in rich, industrialized countries, where it is caused by the consumption of refined and technologically processed food, which is rich in energy but less valuable in quality. A certain amount of iron and other elements involved in the synthesis of hemoglobin is lost in the process of food production. Therefore, many countries started iron supplementation of different types of food in order to compensate for inadequate food intake of iron. Flour, salt, cereals, rice and various spices are enriched with iron to prevent the development of anemia [5]. The most often cause of sideropenic anemia in infants during the period of their fast growth and development is incorrect nutrition or insufficient intake of food rich in iron. This is the reason why this anemia falls into the group of nutritional anemias. The prevalence of anemia in this vulnerable period is more than 30% [2, 6]. It is well known that both human and cow’s milk contain insufficient amount of iron (1.5 mg/L and 0.5 mg/L, respectively). Keeping in mind the average absorption of iron of about 10%, it is to be expected that infant’s nutrition will be deficient in iron, because milk is the main and basic food for an infant. Due to the increased need for iron intakes at this age, and because of the relatively low value of iron in foods, even in its most perfect form, with a proper diet, the quantity of iron consumed is not enough for most children to prevent the development of nutritional anemia. Therefore, iron deficiency in infants is often caused by the use of milk diet without added iron or with inadequate addition of iron [2, 7, 8]. During the first year of life, infants born at term require 160 mg, and pre-mature infants about 240 mg of iron to meet the needs of erythropoiesis. Approximately 50 mg of iron is provided from the disintegrated erythrocytes that are physiologically present in the first week of life. The rest of iron must be provided through food. Human and cow’s milk contain small amounts of iron (about 1 mg Fe/L). However, iron in human milk is absorbed better (49% vs. 10% in cow’s milk). This is the reason why infants who are breastfed for the first six months of life have higher levels of serum ferritin and saturation of transferrin greater than children fed with cow’s milk. In addition, in children who were fed with unmodified cow’s milk, iron deficiency can occur not only because of scarce iron content of milk and reduced absorption of iron from milk, but because of possible bleeding from gastrointestinal organs [2, 8].

The aim of this paper is to provide at least a partial insight into the problem of anemia and to emphasize nutrition as an important etiologic factor for the development of anemia in infants.

Material and Methods

We compared two retrospective studies conducted at the Institute of Child and Youth Healthcare of Vojvodina, Department for Infant and Small Children’s Pathology in different periods of time. The first one was conducted from 1988 to 1995 and included 507 hospitalized children aged from 1 to 24 months. The second study was conducted from 2010 to 2011 and included 290 hospitalized children aged from 1 to 12 months. The children were referred to the Institute with different diagnoses, and diagnosis of anemia was based on the typical history, physical examination and the results of routine laboratory tests. All laboratory data were obtained in the laboratory of the Institute for Child and Youth Healthcare of Vojvodina in Novi Sad and the following instruments were used: automatic biochemical system Hitachi 704, hematological counter MS9 (Medlet Schlossing), ISE analyzer AVL 983 Sartorius 6000, centrifuge Hermle 9 and mixer Hanna 4. Hematological parameters were obtained by using the hematological instrument MS9. This instrument determines the number of erythrocytes with the help of volumetric impedance (Baker’s principle). The principle of counting and determining the size of cells is based on the difference in the conductivity of pure cells and diluents in which the cells are suspended. The level of hemoglobin (HGB) was determined by the standard cyanmethemoglobin method.

According to the criteria of the WHO, the entire population of children was divided into three groups by the values of hemoglobin, biochemical and hematological status. These groups were as follows: 1) children with severe anemia (hemoglobin level below 70 g/L), 2) children with moderate anemia (hemoglobin level between 70 and 90 g/L), and 3) children with a mild form of anemia (hemoglobin 90 to 110 g/L). All children were analyzed according to
the type of milk feeding and the intensity of anemia. The collected data were processed by the appropriate modern statistical methods.

**Results**

The first retrospective study included 507 children aged 1 to 24 months with sideropenic anemia who were hospitalized at the Institute of Child and Youth Healthcare of Vojvodina, Department for Infant and Small Children’s Pathology during the period of eight years. Among the examined children, 9.07% suffered from severe anemia, 43.98% had a moderate form, while 46.94% had a mild form of anemia. The second retrospective study included 290 children aged from 1 to 12 months with sideropenic anemia who were hospitalized at the Institute for Child and Youth Healthcare of Vojvodina, Department of Infant and Small Children’s Pathology during the period of two years. Among the examined children, 4.82% suffered from severe anemia, 24.13% had a moderate form, while 71.03% had a mild form of anemia (Graph 1). Out of 507 children examined in the first study, 61.74% were undernourished. The analysis of the collected data shows that the highest percentage of underweight children had severe anemia (15.22%). Children who had been well-fed developed a mild form of anemia (48.74%). Out of 290 children examined in the second study, 23.44% were undernourished. Body weight in children with a mild form of anemia was significantly higher compared to children with moderate and severe forms of anemia. In the first study, 333 children (65.68%) were breastfed, while 174 (34.32%) had never been breastfed. Further analysis of the data shows that 102 children (19.92%) were breastfed only. The percentage of breastfed infants in different grades of anemia was as follows: 50% (severe), 64.13% (moderate), and 70.17% (mild). In the second study, 206 children (71.03%) were breastfed, while 56 (19.31%) had never been breastfed (Table 1). Further analysis of the data shows that 83 children (28.62%) were breastfed only. The percentage of breastfed infants in different grades of anemia was as follows: 57.1% (severe), 62.9% (moderate), and 74.8% (mild). In the first study, 223 children (43.98%) were fed only complementary food, while 141 children (27.81%) were both breastfed and given complementary food. In the second study, 156 children (53.79%) were fed only complementary food, while 32 children (11.03%) were both breastfed and given complementary food (Table 2). Among all the children examined in the first study, 2/3 diluted cow’s milk was given as complementary food to 34.52% children, undiluted cow’s milk and goat’s milk was given to 5.33% and 4.14% children, respectively; whereas 28.4% of children were fed different industrial milk formulas. In the second study, the highest percentage of children were fed industrial milk formulas (50%), 25.64% were fed 2/3 diluted cow’s milk, while ⅓ cow’s milk, undiluted cow’s milk and goat’s milk were rarely used.

Our studies showed that there were significant differences among children with anemia of varying intensity with respect to breastfeeding. The highest percentage of children who were breastfed for the longest period were found to be the children with the mild form of anemia, while the children who were breastfed for the shortest period had severe anemia. In addition, there was a significant difference in terms of complementary feeding among the three groups of children in both studies. The results revealed that cow’s milk was given as supplementary food to 56.52% of the seriously anemic

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Anemia in children under two years of age is a common health problem due to the fact that their growth requires a high intake of iron which is usually not provided by their diet [9]. By comparing these two studies it was observed that the percentages of the children with severe and moderate forms of anemia were twice lower in the second study, while the percentage of the children with a mild form of anemia almost doubled compared to the first study. Anemia is usually caused by several associated factors, rather than individual ones. The important factors are the impact of environment, socio-economic factors, habits in the family, especially the ones related to the mother, certain individual characteristics (gender, time and way of delivery, birth weight and associated diseases) as well as the child’s diet. The level of nutrition is certainly correlated with different quality of alimentary deficit. In infancy, the overall mental and physical development depends primarily on the diet, and the diet relies almost entirely on the attitude, perception, cultural and health education of the mother [2].

Most of the authors think that children suffering from anemia due to iron deficiency tend to have lower body weight [10, 11]. Other authors, however, believe that better nutritional status does not necessarily mean higher hemoglobin values, that these two factors are not directly related [12–14]. According to the data from both studies, the body weight of children with a mild form of anemia was significantly higher compared to the children with moderate and severe forms of anemia.

It is well known that milk is a prototype of food poor in iron. In the first six months of life, milk is the basic food. It has been shown that the absorption of iron from breast milk is much higher compared to cow’s milk. Fortified milk formula contains the highest amount of iron, and its use is recommended in the diet of children under one year of age. Literature indicates that anemia has the highest prevalence in children fed with cow’s milk, while it is less common in breastfed children. Prevalence of anemia is the lowest in children fed with adapted milk formulas. These are the reasons why the WHO recommends that infants who are not breastfed should not get diluted or unmodified cow’s milk until the age of one. Iron rich baby formulas are therefore highly recommended [2, 15–19]. The comparison of these two studies shows that the children from the second study sample were breastfed in a slightly higher percentage (71.03%) compared to the first study (65.68%). In both studies, the children with a mild form of anemia were breastfed in the highest percentage.

In 1928, Helen McKay concluded that anemia was common in infants on complementary diet, but did not know the exact reason for this phenomenon. Eight decades later, studies suggested that the results of her research about the dependence of infant feeding and the development of anemia could be accepted with only minor adjustments. Therefore, she is considered to be the founder of modern study of anemia caused by iron deficiency. At that time, breastfeeding lasted much longer than today, and the results of her study showed that the hemoglobin concentration was higher in breastfed children. Complementary feeding at that time was actually cow’s milk powder, without the addition of iron and other minerals or vitamins. She identified the real cause of this phenomenon to be better absorption of iron from human milk (50%) than from cow’s milk (10%). Approximately one third of the infants who were fed with cow’s milk showed blood loss through stool, which could be another factor in developing anemia due to iron deficiency. In addition, she suggested a definition of anemia, which is very similar to the one given by the WHO 40 years later [2, 15, 20].

As for the kind of milk introduced during the complementary feeding, 2/3 diluted cow’s milk was mainly used in the first study, whereas in the second study, the use of industrial milk formulas was dominant, which is in accordance with the recommendations of the WHO. Frequent use of industrial milk formulas in nutrition of children, that was observed in the second study, may indicate a higher level of health education of mothers and may suggest the increase in socio-economic standards of the population compared to the previous periods [2, 5].

Inadequate nutrition is a significant problem, especially in this vulnerable population. Since deficient diet has a negative impact on general health of population, anemia is considered to be not only a health problem, but a social problem as well [2]. The analysis of the results of our studies shows that children who used cow’s milk as complementary food had severe form of anemia. Short-termed natural nutrition, early supplementation, and choice of milk could be determining factors in the development and manifestation of anemia [2, 8, 16, 19, 20]. Breastfeeding for more than six months of life without the addition of iron, early feeding with unmodified cow’s milk or solid foods can be the causes of sideropenic anemia. It can also be caused if non-fortified baby formulas are used longer than four months without introducing other mixed foods. Children who are born at term and breastfed for the first six months of life are not at risk in terms of iron deficiency. After this age, if the child is not breastfed, supplementary diet should include industrial milk infant formula enriched with iron. At the same time, it is recommended to introduce mixed foods. If solid foods are introduced to children who are still
being breastfed, it can improve the bioavailability of iron from human milk [21].

**Conclusion**

Anemia due to iron deficiency effects people of all ages and from all economic groups, although it is more common among the younger population groups, particularly infants and young children aged from 1 to 24 months. It is particularly common among people with insufficient nutrition. From what has been said, one can only imagine the extent to which iron deficiency anemia is widespread in our country and worldwide. What is yet undiscovered is the percentage of patients who are not registered and are thus not treated.

The comparison of two retrospective studies shows that the percentage of children with severe and moderate forms of anemia had decreased through the years and it was twice lower in the second study, while the percentage of children with a mild form of anemia had increased, in fact it doubled in the second study. Both studies confirmed the significant role of breastfeeding in prevention of sideropenic anemia. Also, it has been observed that the diet of children changes through the years and that diluted 2/3 cow’s milk, which was previously frequently used in complementary feeding of children, is now often replaced by adapted milk formulas, which is in accordance with the World Health Organization recommendations.

Given the high prevalence of anemia in infants (30% of children treated at the Department), all the necessary social, economic and educational measures must be taken to correct the diet and to ensure optimal nutritional and energy needs, as well as the needs for iron, and thus prevent development of sideropenic anemia in this age group.

**References**