Requirement and Criteria of Adequate Vitamin Supply in Healthy Newborns

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Studies of the relationship between urinary excretion of vitamins and their daily intake in healthy newborns showed that babies aged 3-10 days should receive 30 mg vitamin C, 0.24 mg vitamin B_2, and 0.13 mg vitamin B_1. The criteria of adequate vitamin C, B_1, and B_2 supply evaluated by their urinary excretion are 220.0, 0.7, and 1.4 mg/g excreted creatinine, respectively.

Key Words: *riboflavin; ascorbic acid; thiamin; urine; newborns*

The level of vitamin consumption recommended in Russian and foreign publications is not specified for children of each month of life and is determined for babies aged 0-3 months [2] or 0-6 months [5,8,9]. At the same time, criteria of adequate supply for water-soluble vitamins based on their hourly or daily excretion with the urine were developed for children aged >5 years [4], but not for healthy newborns.

Recommendations on daily vitamin consumption (amount of vitamins completely satisfying physiological requirements) for newborns are based on vitamin concentrations in breast milk [5], but the levels of vitamins in breast milk greatly vary depending on their consumption by breast-feeding woman [5]. The study of the relationship between vitamin content in food and their urinary excretion is an effective approach to determination of reference intakes of vitamins [6]. This approach also helps to determine the criteria of adequate supply with water-soluble vitamins by their excretion with the urine. This method attracts special attention because it is not invasive (requires no blood collection).

Using this approach we determined vitamin requirements of healthy babies during the first days of life and criteria of adequate supply with vitamins C, B_1, and B_2.

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MATERIALS AND METHODS

The study is based on the results of examination of 58 newborns at maternity hospitals Nos. 6 and 32 of Moscow and maternity hospital of Lyubertsy. Selection of the newborns and collection of biological material were carried out by Drs. M. V. Gmoshinskaya, N. N. Pustograev, and L. N. Titova from Institute of Nutrition.

All children were born full-term (after 38-40-week gestation), their mothers had no gestoses and labor complications. All newborns were in a satisfactory state (Apgar score 7), with body weight 2800-4100 g. Sixty-nine percent of women regularly received polyvitamin complexes during gestation, 26% received vitamins during pregnancy and after delivery.

Thirty-five babies were breast-fed, 12 babies received mixed feeding (breast milk and 270 ml of Hipp 1 adapted milk mixture for children from the first days of life), and 11 babies received formula feeding (Malyutka). The volume of nutrition for babies was estimated from their energy requirements.

On days 3-10 of life vitamin concentrations were measured in the morning urine portion: riboflavin by fluorometric titration of riboflavin-binding apoprotein, ascorbic acid (AA) by visual titration, and thiamin by fluorometric thiochrome method with estimation per gram excreted creatinine [4]. The amount of vitamins received by the baby was evaluated by measuring vita-

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mins in breast milk and formula mixtures [3]. Vitamin C concentrations measured by Dr. O. G. Pereverzeva (Institute of Nutrition) were used in the study.

RESULTS

Curves reflecting the relationship between urinary excretion of vitamins and their content in the food were constructed in order to evaluate vitamin requirement of infants during the first days of life. We know that the relationship between consumption of water-soluble vitamins and their urinary excretion is described by a biphasic curve: urinary excretion increases slowly with increasing vitamin consumption, if vitamin consumption does not ensure saturation of the organism. After attaining vitamin saturation of the body (the so-called “breakpoint”) is attained, further increase of vitamin consumption leads to a drastic increase of urinary excretion of its excess [6,7]. The content of vitamin in the ration corresponding to organism’s requirements in this or that vitamin was tentatively determined by the level at which vitamin excretion sharply increases. In parallel, these metabolic curves show the criteria of saturation (the level of urinary excretion corresponding to adequate saturation with the vitamin).

Excretion of riboflavin changed little, when its daily consumption was 0.02-0.29 mg vitamin B_2, (Fig. 1). Increasing vitamin B_2 consumption to a level surpassing 0.3 mg/day led to an appreciable increase of its excretion. The breakpoint corresponds to 0.24 mg of vitamin B_2 in daily ration. Hence, 0.3 mg (the value adopted with some allowance) can be regarded as the reference daily intake for babies during the first days of life. This value does not contradict the value recommended in the Russian Federation for infants up to the age of 3 months (0.4 mg/day) [2] and completely coincides with reference daily intake for this vitamin recommended in the USA for infants up to the age of 6 months [8].

Riboflavin excretion of 1.4 mg/g creatinine should be considered as the criterion of sufficient intake of vitamin B_2 during the early neonatal period (Fig. 1). This value is close to previously determined 2.0 mg/g creatinine for preterm infants aged 0-1 month [1].

Thiamin excretion changed little, when daily intake of vitamin B_1 was 0.02-0.15 mg (Fig. 2). Further increase in vitamin B_1 intake was associated with an increase of its excretion. The breakpoint corresponded to 0.13 mg/day vitamin B_1. The resultant value is close to daily intake of this vitamin recommended in the USA for infants aged up to 6 months (0.2 mg) [8].

Thiamin excretion of 0.7 mg/g creatinine should be taken as the criterion of adequate intake of vitamin B_1 for healthy infants during the first days of life.

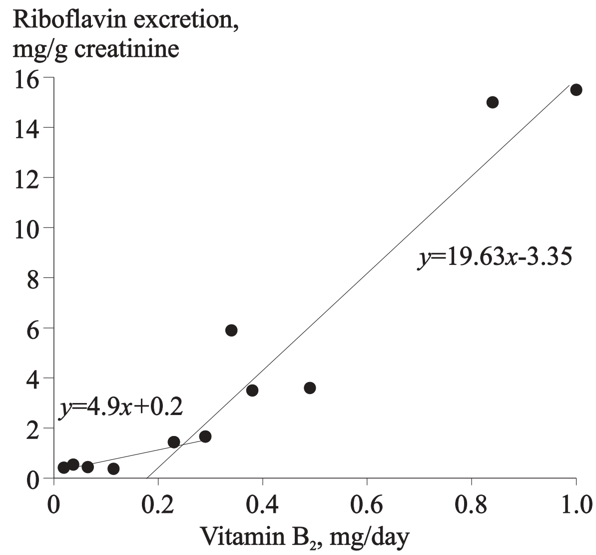

Fig. 1. Relationship between urinary excretion of riboflavin and vitamin B_2 content in the ration.

The excretion of AA virtually does not change, when daily intake was 12-32 mg vitamin C (Fig. 3). Increase in this vitamin intake to 40 mg/day lead to a sharp increase of its urinary excretion. Hence, reference intake of vitamin C for healthy infants of the first days of life is 31 mg/day, which corresponds to the level recommended in Russia for infants aged 0-3 months [2] and does not contradict the value (40 mg/day) recommended in the USA for infants aged 6 months [9].

The level of 220 mg/g creatinine should be considered as the lower level of AA excretion reflecting normal intake of vitamin C. This value is close to previously determined 250 mg/kg creatinine for preterm babies of the first month of life [1].

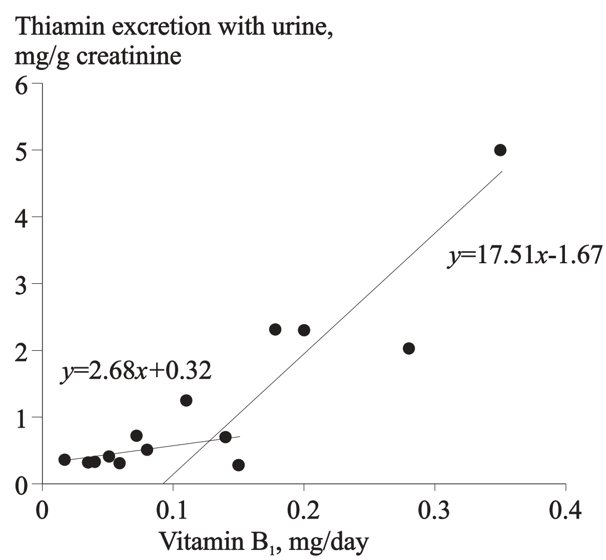

Fig. 2. Relationship between urinary excretion of thiamin and vitamin B_1 content in the ration.

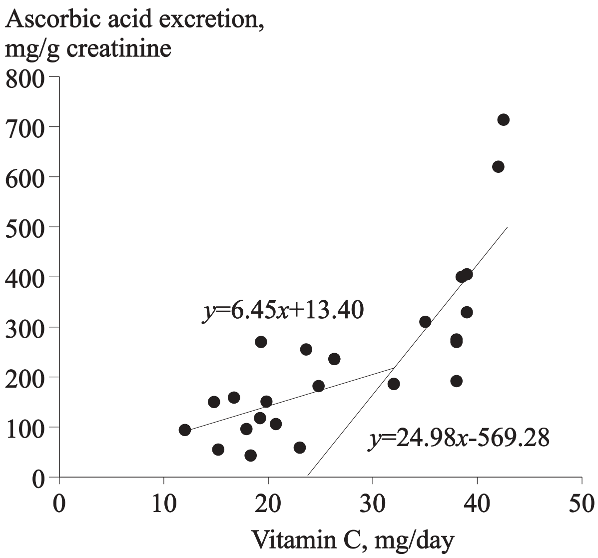

Fig. 3. Relationship between urinary excretion of ascorbic acid and vitamin C content in the ration.

The data on the maximum possible daily intake of vitamins with breast milk under condition of adequate intake of vitamins by breast-feeding women (30.00 mg vitamin C, 0.16 mg vitamin B_2, and 0.11 mg vitamin B_1) indirectly confirm the correctness of the vitamin needs of healthy infants of neonatal age determined in our study.

The equations describing the relationships between excretion of vitamins C and B_2 and their intake by healthy infants virtually coincide with curves for preterm babies of the first month of life [1]. This means that the requirements and criteria of saturation for full-term and preterm infants aged below 1 month are the same.

The determined criteria of adequate vitamin supply help to diagnose C, B_1, and B_2 hypovitaminosis in infants of the first month of life by noninvasive methods.

REFERENCES

1. V. M. Kodentsova, O. A. Vrzhesinskaya, and O. L. Lukoyanova, *Vopr. Med. Farm Khim.*, No. 2, 38-42 (2002).
2. *Standards for Physiological Need in Nutritives and Energy for Different Populations of the USSR* [in Russian]. Ministry of Health of the USSR, Moscow (1991), pp. 125-126.
3. *Manual of Methods for Analysis of Foodstuffs Quality and Safety*, Ed. M. Skurikhin *et al.* [in Russian], Moscow (1998).
5. V. B. Spirichev, V. M. Kodentsova, O. A. Vrzhesinskaya, *et al.*, *Methods for Evaluation of Vitamin Saturation of the Population* [in Russian], Moscow (2001).
5. N. P. Shabalov, *Neonatology*, St. Petersburg (1997), Vol. 1, pp. 196-205.
6. C. Bates, *Int. J. Vitam. Nutr. Res.*, **63**, No. 4, 274-277 (1993).
7. H. Berger and M. Gracey, *Clinical Nutrition of the Young Child*, New York (1994), Vol. 2, pp. 517-534.
8. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline*, Washington (2000).
9. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*, Washington (2000).