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# Minimum Vitamin A Requirements in Infants as Determined by Vitamin A Concentration in Blood.

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In previous communications<sup>1</sup> we reported that the vitamin A concentration in the blood is a good indicator of the size of the vitamin A stores in the rat. Thus, low levels of the vitamin in the blood were usually associated with little or no storage in the liver, the chief depot of vitamin A, whereas high concentrations in the blood were accompanied by large stores. Intermediate blood values were of less significance as they were associated with either small or large amounts of vitamin A in the liver.

Studies carried out in infants<sup>2</sup> coincided, in general, with the results of our experiments in rats and indicated the practical importance of the vitamin A blood level in the diagnosis of vitamin A deficiency. In a series of 93 normal infants, ranging in age from 3 weeks to 6 months, the lowest concentration of vitamin A in the blood was found to be 45 international units per 100 cc plasma. Further observations have indicated that 40 international units may be regarded as the lower limit of the normal range of the vitamin A concentration of the blood for infants under 6 months of age. Values below this level were obtained in infants who, either were suffering from disorders interfering with the absorption of the vitamin as, for example, cystic fibrosis of the pancreas, coeliac disease and congenital obliteration of the bile ducts, or were receiving diets devoid of vitamin A.

The present study was undertaken to determine the daily minimum intake of vitamin A

required to bring about normal blood levels in young infants having low concentrations of the vitamin in the blood as a result of a diet devoid of vitamin A. It was thought that an investigation of this kind might be of value in ascertaining the minimum vitamin A requirements in infants. In a previous communication<sup>3</sup> we found that, as judged by dark adaptation, the minimum vitamin A requirement for infants was 25 international units per kilogram of body weight. As a more recent study<sup>4</sup> revealed that the vitamin A blood level is a more sensitive indicator of vitamin A deficiency than is dark adaptation, the possibility arose that the requirements might be higher if the former were used as a criterion of vitamin A adequacy.

Daily supplements of 150, 600 and 1200 units of vitamin A in the form of U.S.P. reference cod liver oil were given to 12 infants who had subnormal blood levels following the administration of a diet devoid of vitamin A. Also included in this study is an infant (A.I.) who had been receiving a vitamin A-free diet for several weeks and who had a blood vitamin A level within the normal zone, *i.e.* 48 units. Six hundred units were given daily to this baby to determine whether the blood level could be maintained in the normal range at this level of vitamin A intake. After the supplements were given for a period of 4 weeks, the concentration of vitamin A in the blood was determined by a method which was fully described elsewhere.<sup>2</sup>

The effect of these supplements on the vitamin A blood levels and, in several instances, on dark adaptation, may be observed in the accompanying table. It will be noted that a daily intake of 150 and 600

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<sup>1</sup> (a) Lewis, J. M., Bodansky, O., Falk, K. G., and McGuire, G., *PROC. SOC. EXP. BIOL. AND MED.*, 1941, **46**, 248; (b) Lewis, J. M., Bodansky, O., Falk, K. G., and McGuire, G., *J. Nutrition*, 1942, **28**, 351.

<sup>2</sup> Lewis, J. M., Bodansky, O., and Haig, C., *Am. J. Dis. Child.*, 1941, **62**, 1129.

<sup>3</sup> Lewis, J. M., and Haig, C., *J. Pediatrics*, 1939, **15**, 812.

<sup>4</sup> Bodansky, O., Lewis, J. M., and Haig, C., *Science*, 1941, **94**, 370.

TABLE I.  
Effect of Varying Supplements of Vitamin A on Concentration of the Vitamin in Blood and on Dark Adaptation in Infants Previously Receiving a Diet Devoid of Vitamin A.

| Subject | Age, mo. | Weight, kg | Units of Vit. A daily for 4 weeks | Vit. A in blood plasma units per 100 cc |                  | Final rod threshold log micromicro-Lamberts* |                  |
|---------|----------|------------|-----------------------------------|-----------------------------------------|------------------|----------------------------------------------|------------------|
|         |          |            |                                   | Prior to supplement                     | After supplement | Prior to supplement                          | After supplement |
| J.K.    | 3½       | 6.2        | 150                               | 13                                      | 16               | 4.4                                          | 3.3              |
| N.R.    | 5½       | 6          | 150                               | 11                                      | 16               | 5.0                                          | 3.0              |
| J.R.    | 6        | 8.3        | 150                               | 23                                      | 35               | 4.7                                          | 3.3              |
| L.R.    | 3¾       | 5.8        | 600                               | 30                                      | 26               | 3.8                                          | 3.0              |
| J.K.    | 4½       | 6.7        | 600                               | 16                                      | 17               |                                              |                  |
| N.R.    | 6½       | 6.4        | 600                               | 16                                      | 32               |                                              |                  |
| J.R.    | 7        | 9          | 600                               | 35                                      | 28               |                                              |                  |
| A.I.    | 4⅓       | 6          | 600                               | 48                                      | 32               |                                              |                  |
| S.K.    | 3¾       | 5          | 1200                              | 30                                      | 41               |                                              |                  |
| J.R.    | 3½       | 5          | 1200                              | 16                                      | 41               |                                              |                  |
| L.G.    | 4        | 5.7        | 1200                              | 27                                      | 41               |                                              |                  |
| G.A.    | 3        | 5.5        | 1200                              | 37                                      | 53               |                                              |                  |
| M.S.    | 5        | 6.2        | 1200                              | 33                                      | 54               |                                              |                  |

\* Final rod thresholds higher than 3.3 are abnormal.<sup>3</sup>

units for 4 weeks had no appreciable effect on the vitamin A concentration in the blood whereas 1200 units brought the blood concentration into the normal range in the 5 infants receiving this dosage. In the infant whose blood concentration was normal (48 units) prior to the administration of 600 units the blood level dropped to 32 units at the end of 4 weeks. Thus, an intake of 600 units not only failed to raise the blood levels to the normal range in 4 infants but also was unable to maintain the normal blood level in one infant. Although the administration of 150 units of vitamin A did not increase the blood concentration, this unitage, as previously reported,<sup>4</sup> was adequate to restore dark adaptation to normal.

The results of this study indicate that, when

the blood concentration is employed as the criterion of vitamin A adequacy, the daily minimum requirement for infants under 7 months of age lies somewhere between 600 units, or 100 units per kg body weight, and 1200 units, or 200 units per kg body weight. It is probable, however, that the requirement is much closer to the latter value since this amount raised the plasma concentration to values, 41-54 units per 100 cc, which were just within the normal range, 40-114 units per 100 cc.<sup>2</sup> Thus, more than 4 times and probably close to 8 times as many units are required when the blood level of vitamin A rather than dark adaptation is used as the basis for estimating the vitamin A status of the infant.