Biochemical detection of thiamin deficiency in infants and children in Thailand

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ABSTRACT  Erythrocyte transketolase activity and the effect of thiamin pyrophosphate stimulation have been determined for 134 infants and children in Thailand. This study included 87 apparently healthy infants and children, 36 sick infants and children admitted to pediatric wards, 8 patients with malnutrition, and 3 patients with clinical beriberi. All three patients with clinical beriberi had definitely abnormal values for thiamin pyrophosphate stimulation. In addition, 10–17% of the subjects in each of the other groups had biochemical evidence of thiamin deficiency, although there was no clinical evidence of beriberi. Measurement of thiamine pyrophosphate stimulation appears to be more specific than measurement of erythrocyte transketolase activity in confirming the diagnosis of beriberi. Possible reasons for the high prevalence of thiamin deficiency in Thai infants and children are discussed.  Am. J. Clin. Nutr. 27: 1399–1402, 1974.

In rice-consuming populations such as Thailand, beriberi has been found sporadically (1). Most cases have been diagnosed clinically without biochemical confirmation. Subclinical beriberi was also suspected in a recent survey (2), but recognition of such cases is difficult, since symptoms and signs are nonspecific. Detection of thiamin deficiency has been accomplished by measuring transketolase activity in experimental thiamin-deficiency studies (3) and in adults with clinical beriberi (4). There are no published reports of the application of this method to the study of beriberi in infants and children. The present report summarizes investigations designed to: 1) Measure the erythrocyte transketolase level (ETK) and the effect of thiamin pyrophosphate stimulation (TPP effect) in apparently normal Thai infants and children. 2) Apply these biochemical methods in the detection of subclinical and clinical beriberi in infants and children.

Material and methods

All apparently healthy subjects were infants and children at the well-baby clinic of Ramathibodi Hospital. These served as a control group. Most of the infants in this group had taken artificial feeding with supplemental vitamins. Sick patients were divided into three groups: those with malnutrition, those with beriberi, and those with other diseases. The latter included patients who were admitted with heart disease, many in congestive heart failure with renal disease, such as acute poststreptococcal glomerulonephritis; with nephrotic syndrome; with neurological disorders; and with a number of febrile illnesses.

Blood was drawn by venipuncture or by the heel-prick method. Measurements of erythrocyte transketolase activity and TPP effect were performed using a modification of the Dreyfus method (5). Transketolase activity in the blood is expressed in international units, equivalent to the number of micromoles of sedoheptulose-7-phosphate formed per minute per liter under specified conditions. The TPP effect is expressed as the percentage increase of sedoheptulose-7-phosphate formation after the addition of thiamin pyrophosphate.

All cases of suspected beriberi admitted to the pediatric ward had a detailed clinical examination and other routine laboratory examinations, including chest X-ray and standard electrocardiogram, before and after treatment. Detailed hemodynamic studies were

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done in certain cases. Results of these hemodynamic studies will be reported separately.

Results

Measurements of transketolase activity and TPP effect in the red cell hemolysate of 87 apparently healthy subjects in different age groups are shown in Table 1. There is no statistically significant difference in either ETK or TPP effect by age groups (P values > 0.5).

Measurements of ETK and TPP effect for all four groups of subjects are shown in Figs. 1 and 2. There are wide ranges of ETK values in all groups. Mean values of ETK and TPP effect in the malnutrition group and in the group with other diseases are similar to values obtained for the controls, with no significant differences. In contrast, there is a significant difference for mean values of both ETK and TPP effect between the beriberi group and the controls (P value = 0.01).

A TPP effect of over 15% is generally considered abnormal (6). Using this criterion, 9 of 87 (10%) of the apparently healthy controls, one of 8 (13%) of the malnutrition group, and 6 of 36 (17%) of those with other diseases have abnormally high values. In the three patients with clinical beriberi, all had very high values for TPP effect (44, 176, and 74%) and very low ETK levels (56, 26, and 27%).

For five patients, three clinical beriberi and two in the other disease group, the ETK and TPP effect were repeated after administration of thiamin. The TPP effect returned toward normal in all cases. The earliest change in TPP effect was seen in a beriberi patient at 30 min after 100 mg of thiamin was given intravenously.

Discussion

Since the ETK values showed a great variation even in normal controls and since 16 of 87 (almost 20%) of controls had ETK values below the highest ETK value for beriberi patients, the ETK value seems to be somewhat nonspecific. The use of this test alone would not appear to be satisfactory for the specific diagnosis of thiamin deficiency. In our hands, the TPP effect seems to be more specific which is consistent with previous results in adults (4). If one uses Brin's criterion (6) which places the upper limit of normal for TPP effect at 15%, then 9 (10%) of the apparently healthy infants and children in our study have biochemical abnormalities suggestive of thiamin deficiency. Of these, 6 cases (7% of all controls) may be classified as severe deficiency (TPP effect over 25%). Although only 10% of our well-baby group were being breast fed, most of them had received supplemental vitamins and many were already on solid food by the time these tests were performed. Of the 9 controls with a TPP effect over 15% only one was still being breast fed. Three were on sweetened condensed milk. The age ranges in these cases were from 2 months to 3 years.

In comparing our results for apparently healthy controls with those from studies of well babies in Ubol Province in Northeast Thailand and with those from studies in Bang-pa-in District in central Thailand (7), we found a lower mean value for TPP effect in the well babies in Bangkok. This is probably due to the fact that in Ubol and Bang-pa-in most infants are breast fed without supplemental vitamins. It has been shown that in certain areas of Thailand, breast milk may be deficient in thiamin (8).

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tr>
<td>Erythrocyte transketolase and percent of TPP effect</td>
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<td>in apparently normal infants and children of various age groups</td>
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<table>
<thead>
<tr>
<th>Age group</th>
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<th>6-12 Months</th>
<th>1-2 Years</th>
<th>2-4 Years</th>
<th>4-6 Years</th>
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<tbody>
<tr>
<td>No. of Subjects</td>
<td>48</td>
<td>14</td>
<td>9</td>
<td>9</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>a/ ETK, IU</td>
<td>81.1 ± 25.5</td>
<td>66.6 ± 5.9</td>
<td>76.4 ± 18.8</td>
<td>76.2 ± 26.6</td>
<td>57.7 ± 15.4</td>
<td>42.0 ± 13.0</td>
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<tr>
<td>b/ % TPP effect</td>
<td>5.9 ± 8.0</td>
<td>5.9 ± 10.8</td>
<td>9.0 ± 10.6</td>
<td>10.4 ± 11.0</td>
<td>5.4 ± 4.9</td>
<td>7.8 ± 6.9</td>
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</table>

Values are means ± SD. No statistically significant difference in either ETK or TPP effect by age groups (P values > 0.5).
THIAMIN DEFICIENCY IN INFANTS AND CHILDREN

FIG. 1. Erythrocyte transketolase activity in four groups of infants and children.

FIG. 2. Percent TPP effect in four groups of infants and children.

The rarity of classical infantile beriberi in most hospitals in the Bangkok area at the present time is presumably related to the replacement of breast feeding by the use of commercial milk with usually adequate vitamin supplements. Most Bangkok mothers are delivered in hospitals with adequate pre- and postnatal care. In contrast, mothers in suburban and rural areas are usually delivered at home and take only a small variety of food which is deficient in thiamin during pregnancy and after delivery. It is our impression from this study that, although the thiamin status of infants and children has improved considerably in the
Bangkok area, many infants and children still have a marginal thiamin intake, and they may become deficient if the child becomes sick or dietary intake becomes inadequate for other reasons. Our studies have demonstrated biochemical evidence of thiamin deficiency in some apparently normal children and in some children with other illness, all of whom may have had subclinical beriberi. This subclinical form may be difficult to diagnose, unless a careful dietary history is taken.

References

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