

THIAMINE AND NICOTINIC ACID CONTENT OF VARIOUS
SUBDIVISIONS OF THE BRAINS OF CHILDREN DYING
OF CERTAIN INFECTIOUS DISEASES

D. S. Zaprudskaya

From the Rostov Regional Scientific Research Pediatric Institute (Director-I. Ya.
Serebrysky, Chief of Experimental Section- Active Member Acad. Med. Sci.
USSR Prof. N. A. Rozhansky)

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N. A. Rozhansky)

Our preceding studies have shown that, in experimentally induced thiamine deficiency, various divisions of the nervous system of growing puppies had their thiamine content lowered down to 2-13 $\mu\text{g } \%$ (normal-140-180 $\mu\text{g } \%$) [5].

In addition, these studies established the fact that in these thiamine deficient tissues the nicotinic acid level remains either within normal limits or is actually somewhat elevated.

The frequency and severity of the dystrophic alterations developing clinically in children dying eventually of dysentery led us to undertake an investigation into the amount of thiamine and nicotinic acid found in various subdivisions of the central nervous system of young patients succumbing to dysentery. We also did post mortem studies on cases in which the dysentery was accompanied by pneumonia, as well as cases in which the children had had pneumonia only.

In this study we used autopsy material taken from children dying between the ages of 0 to 2 years.

Material was taken from various divisions of the central nervous system as well as some other tissues of these children dying of dysentery (10 cases), dysentery complicated by pneumonia (12 cases), pneumonia (13 cases) and surgical ailments (5 cases).

The tissues of children dying suddenly of surgical complications were used as controls.

In all cases 6 areas of the brain were subjected to analysis: cerebral cortex (frontal lobe), caudate nucleus, optic colliculi, pons Varoli, medulla oblongata and also tissues from the liver, muscles, lungs and colon. These last were of interest as they represented the organs directly stricken by the listed diseases. The total and free thiamine was determined by the thiochrome method, the total nicotinic acid - by the thiocyanobromide method.

The autopsy material was analyzed within 24-26 hours following the death of the child. Preliminary determinations had shown that when tissues were kept in a moist atmosphere at 24° for a whole day their thiamine or nicotinic acid content did not alter; longer storage of the material (48-72 hours) at these conditions decreased the amount of thiamine. The nicotinic acid remained unaffected.

Among the children dying of dysentery, 8 were in a hypotrophic state II. Of the 9 children dying of dysentery complicated by pneumonia concerning whom we had a dietary history, only one was normotrophic, the others - hypotrophic. The children dying after surgery were well nourished; death was caused by peritonitis developing from bowel obstruction or appendicitis.

All the children had received antibiotics: sintomycin and penicillin. The amount of sintomycin received by each child had been small; only three children had been given 8 to 1 g for the total amount in the entire course of treatment, the other children receiving considerably smaller quantities. Also, the amount of penicillin given appeared to be relatively small. The sulfa preparations were utilized very rarely.

EXPERIMENTAL RESULTS

Thiamine content. As is well known from the literature, total thiamine in the brains of adults averages 140-160 $\mu\text{g}\%$; in muscles and internal organs - 60 to 200 $\mu\text{g}\%$ [1, 6].

We were unable to find data on children.

Table 1 demonstrates the quantitative content of thiamine in the tissues of the dead children. The average content of thiamine in the brain divisions of children dying of dysentery was 3.7-6.9 $\mu\text{g}\%$; in the colonic wall, muscle, lung and liver: 1.9, 3.3, 3.8, 6.2 $\mu\text{g}\%$ respectively.

TABLE 1

Thiamine Content of Brain Subdivisions and Various Organs

Name tissue	Thiamin content in $\mu\text{g}\%$ of tissues in children dying of			
	Dysentery	Dysentery compl. by pneumonia	Pneumonia	Surgical diseases
Spinal cord	4.5. (2-8)	5.4 (1-10)	8.3 (4-20)	12 (6-20)
Medulla oblongata	6.5 (4-10)	5.5 (1-10)	10.0 (4-25)	12.7 (10-16)
Pons varoli	6.9 (3-12)	6.0 (1-15)	12.2 (5-40)	19.2 (8-25)
Ocular colliculi	5.8 (4-8)	4.5 (1-8)	9.5 (5-20)	15.2 (5-25)
Head caudate nucleus	4.8 (2-8)	5.7 (2-15)	9.0 (4-12)	31 (30-35)
Cerebral cortex	3.7 (2-5)	3.7 (0-8)	5.5 Traces -10)	33 (10-45)
Averages for nerve tissues	5.44	5.13	9.1	23.9
Liver	6.2 (2-10)	5.5 (4-8)	14.0 (3-60)	42.2 (25-60)
Lung	3.8 (1-7)	2.2 (0-4)	7.0 (0-15)	10.6 (4-15)
Colon	1.9 (0-5)	4.5 (0-25)	6.2 (0-12)	10.8 (0-30)
Muscle*	3.3 (0-6)	3.9 (2-8)	7.2 (2-20)	17.4 (8-35)

* The table presents the average values of total thiamine. In parentheses are given the limits of fluctuation of the thiamine concentrations.

When studying the peripheral tissues it was observed that the severest diminution of thiamine took place in the wall of the colon: in three out of ten cases thiamine had disappeared completely.

The thiamine content in the various subdivisions of the brain in children dying of dysentery complicated by pneumonia equaled 3.7-6 $\mu\text{g}\%$. In the lungs of these children was found the smallest quantity of thiamine - 2.2 $\mu\text{g}\%$; the fluctuation in the thiamine concentration in the colonic wall in 12 cases was 0-25 $\mu\text{g}\%$ (average 4.5 $\mu\text{g}\%$), in muscle - 3.9 $\mu\text{g}\%$, in liver - 5.5 $\mu\text{g}\%$.

Similar quantities were found in the brain tissues of children dying of pneumonia (Table 1).

In all brain and other tissues of children dying of surgical causes, the thiamine content was much higher than in children dying of dysentery or pneumonia.

Nicotinic Acid content. In the brain tissues of children succumbing to dysentery the nicotinic acid content was 0.17-4.23 mg % (Table 2). The average content of this vitamin in the various brain subdivisions remained within normal limits (nicotinic acid in the brains of normal adults— 1.8-2 mg %). Nicotinic acid in the wall of the colon averaged 1.47 mg % in children dying of dysentery, the limits of fluctuation being 0.4-3.4 mg %. The accepted normal content of nicotinic acid in the colon is considered to be 1.3-2.4 mg%. In the muscles of the children of this group, nicotinic acid content averaged 1.69 mg % with fluctuations within the limits of 0.1-6.3 mg % (normal— 4.8-5 mg %). In this instance, there should be noted a diminution of nicotinic acid in the muscle tissues.

TABLE 2

Nicotinic Acid Content of Brain Subdivisions and Various Organs

Name of tissues	Nicotinic acid content in mg % in the tissues of children dying of			
	Dysentery	Dysentery complicated by pneum.	Pneumonia	Surgical diseases
Spinal cord	2.05 ¹ (0.33-3.33)	2.64 (1.73-5.53)	5.0 (1.15-8.91)	4.02 (1.5-7.5)
Medulla oblongata	1.86 (0.17-3.96)	2.61 (1.2-4.0)	4.93 (1.0-13.6)	4.5 (3.14-7.1)
Pons varoli	1.72 (1.0-2.33)	2.71 (1.3-4.22)	4.6 (1.5-9.3)	4.5 (1.7-8.24)
Ocular colliculi	1.98 (1.1-4.23)	2.44 (0.6-4.94)	5.8 (1.5-17.5)	6.15 (3.5-9.2)
Head caudate nucleus	1.87 (0.57-2.86)	2.64 (1.5-3.94)	4.5 (1.43-11.6)	5.21 (3.0-8.1)
Cerebral cortex	1.54 (0.5-2.03)	2.53 (1.63-4.77)	4.4 (1.95-9.0)	5.3 (4.1-7.0)
Average for nerve tissues	1.84	2.6	5.0	5.16
Liver	3.54 (1.2-6.13)	3.69 (2.13-6.2)	6.8 (1.5-18.6)	5.6 (2.04-10.0)
Lungs	2.06 (0.76-5.06)	2.8 (0.6-6.7)	4.1 (0.6-6.6)	3.2 (1.34-4.8)
Colon	1.47 (0.4-3.4)	2.6 (0.5-4.84)	4.9 (1.5-13.0)	2.76 (0.44-4.0)
Muscle	1.69 (0.1-6.3)	2.3 (1.13-5.2)	4.6 (1.58-12.74)	3.93 (2.8-5.4)

• The table presents the average values of total nicotinic acid. In parentheses are given the limits of fluctuation of the nicotinic acid concentrations.

In the lungs nicotinic acid averaged 2.06 mg % with fluctuations from 0.76 to 5.06 mg % which is practically normal (1.8 mg %).

The content of the vitamin in the liver averaged 3.54 mg % in the fluctuations being from 1.2 to 6.13 mg %, this being below the data in the literature (5.3-6.7 mg %).

In the brain tissues of children dead from dysentery complicated by pneumonia, the nicotinic acid content fluctuated within the limits 0.6-5.53 mg %. The different brain subdivisions had sharply different amounts of this vitamin within them.

It was anticipated that the lung—the organ directly affected—would show alterations of the nicotinic acid content. Actually, the average was 2.8 mg % with fluctuations between 0.6 to 6.7 mg %—values somewhat higher than those obtained from children dying of dysentery only.

The nicotinic acid content of the colonic wall was somewhat greater than in the preceding group, averaging 2.6 mg % with fluctuations within the limits of 0.5–4.84 mg %. These figures can be evaluated as being within the upper limits of the normal seen in adults.

In muscles the nicotinic acid fluctuated between 1.13 and 5.2 mg %, the average being 2.3 mg %.

High nicotinic acid levels were discovered in the brain tissues of children dying of pneumonia or of acute surgical complications. In the first instance of the fluctuations were between 4.4 and 5.8 mg %, in the latter instance—4.02–6.15 mg %.

Within the various subdivisions of the brain in children, dying at ages 0 to 2 years, from dysentery and dysentery complicated by pneumonia, there was discovered a marked lowering of thiamine—3.7–6.7 mg %, while in those dying of pneumonia—5.5–12.2 mg %.

In children of same age range dying of short term surgical conditions the thiamine content proved to be high equaling 12–33 mg %.

The nicotinic acid content of the brain and other organs in children dying from dysentery was lowered only minimally while in other conditions it was within normal limits.

This severe lowering of thiamine content in children dying of dysentery agrees with the experimental data obtained from puppies put into a prelethal state by prolonged thiamine deprivation. This gives substantial basis for the belief that thiamine insufficiency plays an important role in the pathogenesis of dysentery.

SUMMARY

The vitamins thiamine and nicotinic acid were studied in the tissues of children dying from dysentery alone, dysentery complicated by pneumonia and various acute surgical conditions. Specific subdivisions of the brain as well as some internal organs were examined. The age range was 0 to 2 years.

Nicotinic acid was not found to be diminished seriously, if at all. Thiamine underwent marked depletion, particularly in the central nervous system. This is in agreement with experimental data obtained on studies performed with growing puppies.

There is substantial reason for the belief that thiamine depletion plays a role in the pathogenesis of dysentery.

LITERATURE CITED

- [1] K. E. Leytsky, *The Vitamins (B₂ complex)**, 1949.
- [2] A. N. Tikhomirova, *Voprosy Pitaniya*, 1952, Vol. 11, No. 4.
- [3] R. I. Tatarskaya, *Biokhimiya*, 1952, Vol. 17, No. 5.
- [4] G. A. Clerkess, *Biokhimiya*, 1952, Vol. 17, No. 6.
- [5] D. S. Zaprudskaya and N. I. Petrovskaya, *Voprosy Med. Khim.*, 1955, No. 4, p. 269.
- [6] J. Williams, *The Vitamins and Hormones*, Vol. 1, 1945.
- [7] R. Z. Whipple, *Am. Heart J.*, 1951, Vol. 42, No. 3, pp. 414–420.

* In Russian.