

CHANGE IN THE SEROTONIN CONTENT OF THE BLOOD  
AND ORGANS IN PARTS DURING EXPERIMENTAL  
PNEUMOCOCCAL INFECTION

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On the basis of their experiments with dysenteric endotoxin, Shimamoto and co-workers [6, 7] believe serotonin (5-hydroxytryptamine) to be an important factor in dysenteric intoxication. Other authors [3, 4, 5] have shown the importance of serotonin in the pathogenesis of endotoxin shock. In a previous work [1], we established that there are considerable quantitative changes in the serotonin content of the blood, lungs, brain, small intestine and skin of rabbits following the intravenous injection of typhoid endotoxin.

At the acme of typhoid intoxication, when the general condition of the animal has deteriorated, there is a marked increase in the serotonin content of the blood and organs.

The purpose of this work was to determine whether these quantitative changes in the serotonin of the blood and organs are specific to typhoid intoxication, or whether they occur with any bacterial intoxication and infection – specifically, experimental pneumococcal infection.

#### EXPERIMENTAL METHODS

The work was performed on 108 male rats weighing 170-200 g each. The animals were infected with type I pneumococcus, administered intracutaneously into the middle of the animal's right side in a dose of 0.2 ml of an 18 hour culture, diluted 100 times, which dose caused death after 72-80 hrs. One half hour and 1, 3, 5, 12, 24, 48 and 72 hrs after the infection, the rats were decapitated, and their blood, brains, lungs, small intestine and a 3 · 3 cm piece of skin from the middle of the right side were taken for examination. The blood and organs from non-infected rats served as the control. The methods described in the preceding article [1] were employed to extract and determine the serotonin in the blood and organs. The number of thrombocytes was determined by Fonio's method [2]. The results obtained are shown graphically in the form of average data.

#### EXPERIMENTAL RESULTS

As Fig. 1 shows, the serotonin content of the rats' blood was reduced by about half (from 0.19 to 0.11  $\mu\text{g/ml}$ ) 30 min after the pneumococcus infection. One hour after the pneumococcus injection, the serotonin content returned to the original level. Then the serotonin content increased gradually until it was twice as high as in the blood of the control rats 3 hrs after infection. The serotonin content remained at this level until 12 hrs had passed since the time of the pneumococcus injection. At the later stages of the pneumococcal infection, 24-72 hrs after the administration of the microbes, when the rats' condition had deteriorated (1-2° rise of temperature, loss of appetite, apathy, adynamia pneumonia, inflammatory focus present around the site of the pneumococcus injection), the serotonin in the blood again increased sharply, this time until its content became 25-28 times as high as the control.

Simultaneous determination of the number of thrombocytes, which are the main depot of serotonin in the blood, showed that the changes in the serotonin content and the number of thrombocytes were parallel only during the first hour after the pneumococcus infection. At the latter stages in the development of the infection, no direct relationship between these indices could be observed (Fig. 2).

The serotonin content in the lungs (see Fig. 1) decreased about 1/3 (from 0.38 to 0.26  $\mu\text{g/g}$ ) one hour after the pneumococcus infection. Subsequently, the curve of the serotonin content in the lungs almost repeated the curve showing its content in the blood. The serotonin content of the lungs was 11-19 times higher than the control 24-72 hrs after the administration of the microbes.

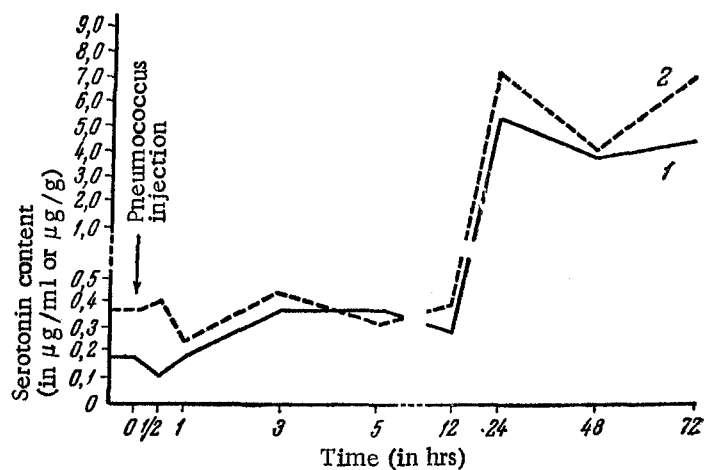


Fig. 1. Change in the serotonin content of the blood (1) and lungs (2) of rats during pneumococcal infection.

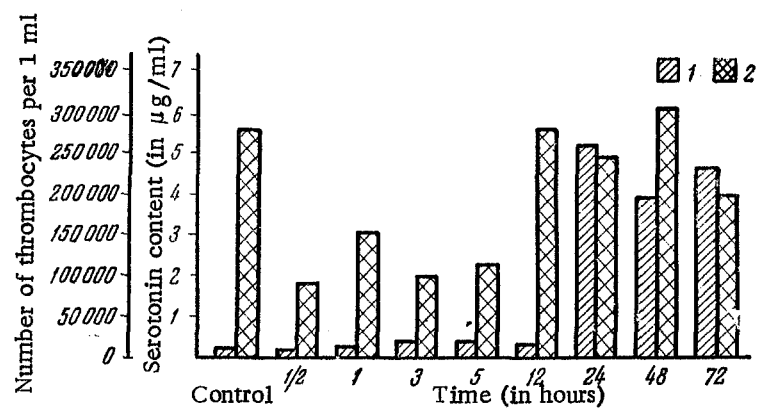


Fig. 2. Change in the serotonin content and number of thrombocytes in the blood of rats during pneumococcal infection.

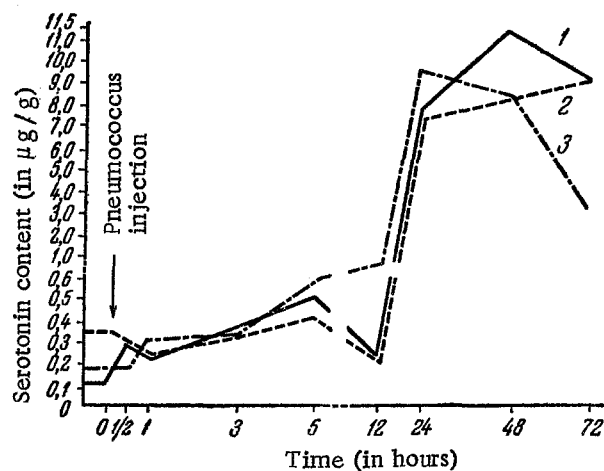


Fig. 3. Change in the serotonin content of the brain (1), small intestine (2) and skin (3) of rats during pneumococcal infection.

In the brain of the rats (Fig. 3), the serotonin content increased soon after the pneumococcus injection. Thirty minutes after the pneumococcus injection, this index had increased 2.5 times ( $0.28 \mu\text{g/g}$ ); after 3 hrs, it was 3.4 times higher ( $0.37 \mu\text{g/g}$ ), and after 5 hrs, it was 4.7 times higher ( $0.52 \mu\text{g/g}$ ) than in the healthy animals ( $0.11 \mu\text{g/g}$ ). At the later stages of the infection, the serotonin content of the brain increased considerably, becoming 73-105 times higher than the control.

In the small intestine of the rats, there was no material change in the serotonin content for 12 hrs after the pneumococcus injection. A sharp increase in this index occurred 24-72 hrs after the injection, raising it to a level 21-27 times higher than the control.

The serotonin content of the rats' skin began to increase gradually one hour after the pneumococcus injection and reached a level 2.5-3.5 times higher than the control during the first 12 hrs of the infection.

The serotonin content of the rats' skin increased sharply to 18-51 times higher than the control 24-72 hrs after the pneumococcus injection.

In a few animals, we noted a considerable increase in the serotonin content of the blood and organs as early as 3-5 hrs after the pneumococcus injection.

The results obtained permit one to conclude that there is a biphasic change in the serotonin content of the blood and organs of rats infected with pneumococcus. The first phase consists in a slight and gradual rise of the serotonin content (first 12 hrs), while the latter increases sharply during the second phase (24 hrs, after the pneumococcus infection).

Therefore, the serotonin content in the blood and organs of rats infected with pneumococcus increases as the infectious disease develops, i.e., as the intoxication increases. These investigations of typhoid intoxication [1] and pneumococcal infection permit the hypothesis that the nature of the quantitative change in the serotonin content of the blood and organs depends primarily on the concentration of bacterial toxic products circulating in the organism, the rate of their administration or formation, the duration of their action and, to a lesser extent, on the microbial nature of the toxic products. The mechanism causing the change in the serotonin content of the blood and organs is difficult to explain at this time. It may be associated with disturbance of the metabolism of tryptophan, the source of serotonin, or, equally, with change in the activity of the monoamine oxidase enzyme which breaks down serotonin and change in the adsorptive properties of the blood thrombocytes. Explanation of this mechanism is the aim of our next investigation.

#### SUMMARY

The content of serotonin in the blood, lungs, brain, small intestine and skin has demonstrated phasic changes in the development process of experimental pneumococcus infection in rats. During the first 12 hours after the pneumococcus infection a gradual insignificant rise of serotonin content occurred in the blood and organs with a subsequent sharp rise of biogenic amine (in 24-72 hours).

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