STUDY OF THE HEAT EXCHANGE LEVEL IN RABBITS VACCINATED AGAINST TUBERCULOSIS (BY DIRECT AND INDIRECT CALORIMETRY)

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Anti-tuberculous immunization produces changes in the experimental animal which reflect many different aspects of vital function—from the cellular level to behavioral reactions [1, 5, 7, 9]. In this connection it appears necessary to study the degree of the anti-tuberculous vaccination effect on heat exchange.

In the present work parallel determinations of heat production were carried out by direct and by indirect calorimetry during the period in which the postvaccination anti-tuberculous immunity was forming.

METHODS

Heat production was measured in a calorimeter system LITMO [2], which permits simultaneous calculation both of the value of the true heat production and of the total changes in gas exchange during the entire experimental period, lasting usually five to six hours. In addition, the oxygen requirement in a closed system was measured by the method of Rene and Reiss as modified by P. N. Veselkin at 20-30 min intervals.

The results obtained were subjected to statistical treatment by the method of Student.

During four to eight days we determined the initial level of basal metabolism in 16 animals. Subsequently six rabbits were retained as controls, ten were immunized with five mg of BCG vaccine intracutaneously. The oxygen requirement was measured every two to three days during the first one and one-half months after the start of the experiment, then once every two weeks up to the 105th day post-vaccination. In all, 467 investigations of oxygen requirement were carried out (Fig. 1).

Calorimetric experiments with vaccinated animals (six rabbits) were done on the third, ninth, 16th, 24th, 60th and 105th day of observation. The control rabbits were investigated one to two times a month. A total of 56 calorimetric studies was done.

It was established that vaccination does not appear to have a statistically valid effect on the basal metabolic level ($P > 0.05$). In both groups of animals a regular decrease in the basal metabolic level was noted in comparison to the initial value, which we are disposed to explain by the progressive increase in weight of the animals during the observation period. Vaccination did not appear to have a noticeable effect on the true value of heat production ($P > 0.1$). As in the studies of basal metabolism, the degree of heat production in both groups of animals fell significantly as compared with the original level. In comparing the heat production values measured in the calorimeter and calculated according to gas exchange data in the control experiments before vaccination, small discrepancies were observed which ranged within the limits of error for the method (from zero to 5.2%, mean of 1%). In distinction to this, on the ninth post-vaccination day in experimental animals the actual heat production was an average of 15.3% lower than the gas exchange calculation showed (Fig. 2), with a statistically valid difference ($P < 0.01$). The predominance of heat production calculated by gas exchange over the actual heat formation (average of 9%) was

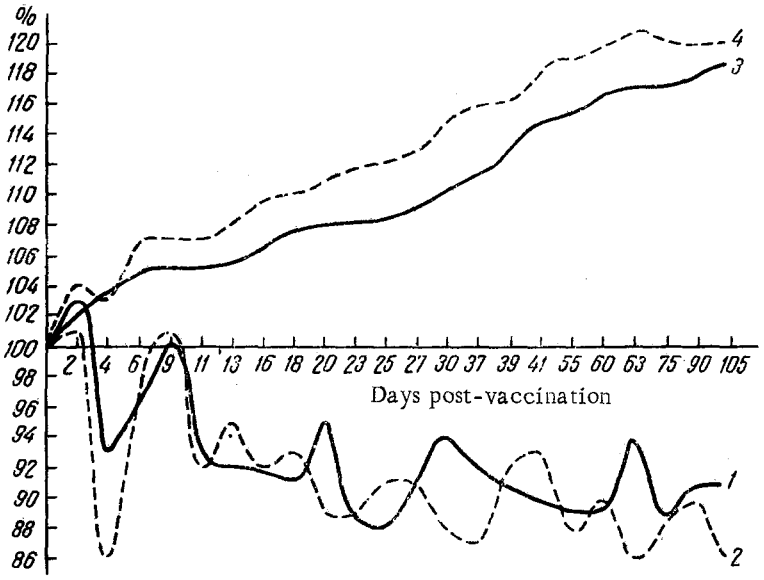

Fig. 1. Mean values of oxygen requirement and body weight in vaccinated and control rabbits at different periods after vaccination. I) Gas exchange in vaccinated rabbits; 2) gas exchange in control rabbits; 3) body weight in vaccinated rabbits; 4) body weight in control rabbits.

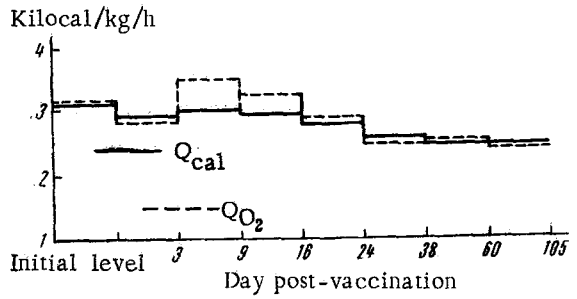

Fig. 2. Change in actual heat production (Q_{cal}) and heat production calculated from gas exchange (Q_{O_2}) in vaccinated rabbits (mean value in kilocalories/kg per hour).

also observed on the 16th post-vaccination day, but to a lesser degree of statistical validity ($P > 0.05$). The discrepancy between data of direct and indirect calorimetry at later periods after vaccination was irregular and had a mean value near that of the control.

Thus, it appears that antituberculous immunization is accompanied by increase in heat production calculated by gas exchange in comparison to the actual heat production. This appears to the greatest degree in the second to third week post-vaccination, i.e., in the period, when the most intensive reaction conditioned by BCG vaccination is taking place. Phenomena similar to that we observed in our experiments, have been described previously in pregnancy and in fever produced by weakly toxic pyrogens [4, 8]. Judging from the data of biochemical studies [3, 6] the predominance of heat production calculated according to gas exchange over the actual reflects the increase in energy processes at the cellular level with only slight changes in the total level of gas exchange. Consequently, it may be hypothesized that in the initial period of anti-tuberculous immunity formation a more intensive synthesis of macroenergetic compounds and their accumulation are observed in the vaccinated organism without substantial change in the total heat exchange level.

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