THE TWENTY-FOUR HOUR RHYTHM IN URINARY EXCRETION OF CERTAIN MICROELEMENTS

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(Presented by Active Member of the Academy of Medical Sciences,
USSR, S. E. Severin
Translated from Byulleten' Eksperimental'noi Biologii i Meditsiny, Vol. 52, No. 8
pp. 64-66, August 1961.
Original article submitted for publication July 11, 1960

The scientific literature contains many reports devoted to the study of 24-hour, periodic, renal excretion of the organic [9,10,13,15-18,22] and the inorganic [14,16,19] microelement components of the urine; almost none of these deal with 24-hour periodic, urinary excretion of the microelements. According to Balzer and Newman, [12] during the course of 24 hours, different amounts of copper are excreted in the urine during the same time interval, and, according to Oshima et al., [20] a 24-hour fluctuation occurs in the urinary excretion of lead.

The purpose of the present work was to study the 24-hour rythm in the urinary excretion of manganese, silicon, aluminum, titanium and copper.

METHOD

We carried out 22 experiments on four female dogs with urinary bladder fistulas (the tests were always carried out on dogs with empty stomachs).

We collected the urine for the study from the urinary bladder fistula for each three hour period in the course of 24 hours. The urine samples obtained were evaporated, dried and then ashed in a platinum dish in a muffle furnace at a temperature no higher than 400°. We employed spectrochemical analysis, in the ISP-22 spectrograph, for the quantitative assay of the content of manganese, silicon, aluminum, titanium and copper in the ash of the test samples.

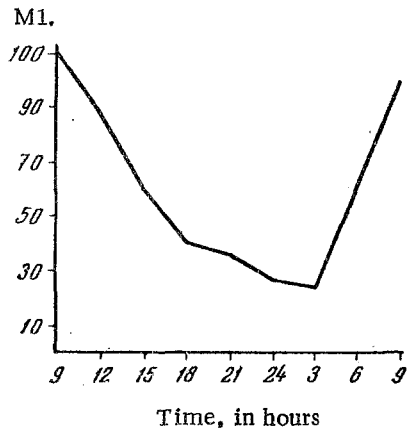

Fig. 1. Excretion of urine in dogs at different times of the day (in milliliters).

RESULTS

A regular fluctuation occurs in the excretion of urine by the dogs during the course of 24 hours (Fig. 1). Maximal excretion is noted from six to nine oclock in the morning (in five cases - from nine to 12 oclock). In the course of the day, the urine excretion decreases, arriving at a minimum from nine oclock in the evening to three oclock in the night.

Results of the study of the urinary excretion of microelements are presented in Fig. 2 in the form of 24-hour curves plotted on the basis of the average figures from all the tests. As is seen, the extent of the urinary excretion of the microelements in dogs changes rhythmically in the 24 hour period; the character of these changes are identical, although the concentration of microelements in the urine is different. What does attract attention is the fact that the content of manganese, silicon, aluminum, titanium and copper is higher in the daytime urine than in the urine of the night hours.

Maximal urinary excretion of microelements was observed in the period of the greatest excretion of urine, i.e., at 9 oclock in the morning (in four tests the maximum occurred at 12 oclock). In the course of the day the urinary excretion of microelements decreases, arriving at a minimum in the period of the least excretion of urine, i.e., from 9 oclock in the evening until 3 oclock in the night.

Our results agree with the literature reports referred to above where the output of water and organic mineral microelements in the urine was greater in the daytime than at night. The existence of a 24-hour periodicity in the urine excretion of the microelements depends, apparently, on the periodicity of the activity of the vegetative nervous

system (the domination of the function of the sympathetic nervous system during the course of the day being replaced at night by the domination of the function of the parasympathetic nervous system).

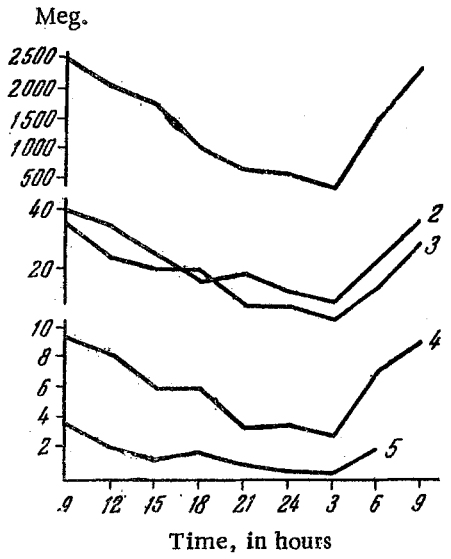

Fig. 2. Excretion of microelements in the urine in dogs at different times of the day (in γ per quantity, in milliliters, of urine excreted in 3 hours). 1) Silicon; 2) titanium; 3) aluminum; 4) copper; 5) manganese.

Our assumption agrees with the literature findings on the 24-hour periodicity in the content of organic and inorganic components in the blood. Thus, for example, the research of V. V. Koval'skii [4] and I. A. Pleteneva, Balzer, [11] Wetzel [23], Stohl, [21] et al., showed that high content of certain organic and inorganic constituents in the blood is observed during the day, when the domination of the function of the sympathetic nervous system occurs, and a low level at night, when the function of the parasympathetic nervous system is strengthened.

According to the findings of one of the authors of the present report, [6] the blood of animals (dogs) and humans shows a 24-hour periodicity in the content of manganese, silicon, aluminum, titanium and copper, which is characterized by a large quantity of these elements in the daytime, and a low level at night.

We are inclined to assume that the 24-hour periodicity in the urinary excretion of the microelements studied reflects the 24-hour dynamics of the microelements in the blood, and a change in metabolism occurring during the course of 24 hours, under the control of the central nervous system.

According to the reports of G. A. Belykh [2] and V. R. Soroka [8] the excitation of the central nervous system is accompanied by an increase in the content of the microelements in the blood— inhibition is accompanied by a decrease.

All of this supports the assumption that, in the daytime, when the tonicity of the central nervous system in dogs is raised and the function of the sympathetic nervous system is strengthened, the dissimilation phase of metabolism and a high content of microelements in the blood and urine predominate. At night, when weakening of the tonicity of the central nervous system sets in and the function of the parasympathetic nervous system is increased the assimilation phase of metabolism and a low content of microelements in the blood and urine predominate.

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