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Influence of Weather Indices on Water-Mineral Homeostasis in Patients with Cardiovascular Pathology

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Abstract

One hundred hypertensive patients and 70 healthy subjects were on unified regimen. Urine was collected with 4-h portions during 3-5 days. Each specimen was analyzed for electrolytes Na, K, P, Cl, Ca, Mg and microelements Fe, Cu, Zn, Cr, Cd, V. Temporal structure parameters have been estimated by nonlinear least squares method for sinusoidal rhythms and dispersion analysis for nonsinusoidal rhythms. Data of weather indices were received from the hydrometeorological service of the RA. In the healthy subjects in 91% cases of rhythmological investigations urinary excretion macro- and microelements statistically significant rhythms were observed. Acrophases of rhythms were mostly individual. In early stage of hypertension, the rhythms of macro- and microelements were statistically nonsignificant in 22% of cases. Among significant rhythms the infradian ones 46% prevailed. In late stage of hypertension, the rhythms of macro- and microelements were statistically nonsignificant in 32% of cases. In hypertensive patients statistically significant correlative connections between rhythms of water-mineral homeostasis and rhythms of weather indices differ in comparison with the results of practically healthy subjects.

Keywords: Biorhythm; Mesor; Amplitude; Acrophases

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Introduction

Chronostructure and dynamics of biological rhythms evolved in the process of evolution under the influence of environmental factors [1-10]. The role of electrolytes and trace elements in human nutrition as well as their function in health and disease were extensively reviewed [1,2,4,5,7,10). Convincing data about metallic elements metabolism disturbance in patients with hypertensive diseases on different stages of its development are obtained by different authors [1,7]. Nevertheless, the results of these investigations are contradictory. It was partly connected with the absence of unification of methods, conditions of investigation, patients' grouping and normal values. Besides these investigations were mostly carried out without taking into account the temporal structure of the organism [1]. In the given paper, the rhythms of water-mineral homeostasis and their correlative connections with the rhythms of weather indices in cardiovascular pathology and healthy subjects studied.

Patients and Methods

Seventy practically healthy subjects (25 female and 45 male) and 100 patients with hypertension (H) were investigated. Fifty patients with H were on first stage (H1) and 50 patients with H were on II, II-III stages (H2). The average age of healthy subjects was 49.2 ± 2.0 years and 54.2 ± 3.0 years for patients.

The healthy subjects and patients were in united regimen of diet, sleep and wakefulness (from 07:30 until 22:30). Urine was collected with 4-hour portion during 72-120 hour (3-5 days) in the healthy subjects and patients. Total Na, K, Ca, Mg, Fe, Cu, Zn, Cr, Cd, V were analyzed on Perkin-Elmer (USA) atomic absorption spectrophotometer (AAS). P was analyzed with "Phosphorus" kits (Viola LLS, Armenia), Cl was analyzed on Cobas b 121 system (Germany). The rhythm parameters were estimated by dispersion analysis for non-sinusoidal rhythms and by nonlinear least squares method for sinusoidal rhythms [3]. The rhythms were grouped in accordance with the glossary of chronobiology which was subjected to some changes [3,6,11,12]. The rhythms with a period ranging from 3 to 20 hours were considered to be ultradian, from 20 to 28 hours–circadian and from 28 to 96 hours-infradian [2,3,5,7]. From hydrometeorological service of RA at 3-h intervals were received the data of hydrometeorological indices (HMI).

1. The temperature of the air (TA, °C)
2. The relative humidity of the air (RHA, %)
3. The deficit humidity of the air (DHA, hPa)
4. The atmospheric pressure (AP, hPa)
5. The speed of wind (SW, m/s)
6. The general cloudiness (GC, mark)

Rhythmological analyses of TA, RHA, DHA, AP, SW, GC were conducted for the disclosure ultradian, circadian and infradian rhythms during 7-10 days.

Results and Discussion

The results showed that in healthy subjects 91% of electrolytes and trace elements excretion rhythms were statistically significant. Among the significant rhythms of electrolytes and trace elements excretion the circadians 92% prevailed. In the cases when the healthy subjects' significant sinusoidal rhythms were not observed non-sinusoidal rhythms were obtained by the program of dispersion analysis. The results showed that in the healthy subjects 3.8% of electrolytes and trace elements excretion rhythms were non-sinusoidal. Circadian variation in the urinary excretion of electrolytes and trace elements had been reported by Kanabrocki et al. [10]. These authors had investigated circadian changes by observing each subject 27 hour and using cosinor analysis. By that approach, one could answer only the question whether or not there was a circadian sinusoidal fluctuation. Nevertheless, our data of electrolytes and trace elements excretion rhythms in healthy subjects were different from the data reported by Kanabrocki et al. which were connected with the ecological and biogeochemical peculiarities. Thus, healthy subjects were characterized with the circadian rhythms and with definite value of mesor and amplitude Acrophases of rhythms were mostly individual. Our data witnessed that in the early stage of H (H1) the electrolytes and trace elements excretion rhythms 22% were statistically non-significant. Among the significant rhythms of electrolytes and trace elements excretion infradian prevailed (46%). Mesors of Na, P, Cu, Zn, Cr, Cd excretion rhythms statistically significantly higher than in the healthy subjects. The results showed that in early stage of H (H1) amplitude of coefficient Na/K, P, Zn, Cd were significantly higher than in the healthy subjects. Mesors of Mg and amplitudes of coefficient Na/K, Ca, Mg significantly lower than in the healthy subjects **(Table 1)**. Statistically significant rhythms of electrolytes and trace elements excretion were not revealed in most of the patients in the late stage H (H2 - 32%). However, among statistically significant rhythms the circadians prevailed (48%). In the H2 mesors of K, P, Zn, Cr, Cd, V and amplitudes of P, Zn excretion rhythms were significantly higher than in the healthy subjects. In the H2 mesor of Mg and the amplitudes of volume of

Table 1 Mesors and amplitudes of urinary excretion of the electrolytes and trace elements and ultra-(U), circa – (C), and Infradian distribution (%) of the statistically significant rhythms (S) in H1.

Indices	S	U	C	I	Mesor ± SE	Amplitude ± SE
Volume of urine	75*	10	67	23	48.21 ± 1.94	10.02 ± 1.11*
Wa	83*	18	58	24	6.94 ± 0.41***	2.08 ± 0.17
K	93	8	46	46	2.37 ± 0.24	0.67 ± 0.08
Wa/K	76	23	27	50	3.41 ± 0.30	0.76 ± 0.10**
Cl	82	0	43	57	9.08 ± 1.06	3.24 ± 0.69
Ca	92	0	42	58	93.94 ± 5.82	33.88 ± 0.50*
Mg	83	0	40	60	48.93 ± 6.08**	14.28 ± 1.53***
P	56**	10	40	50	2.17 ± 0.27***	0.65 ± 0.08*
Fe	64**	11	33	56	134.4 ± 10.16	44.16 ± 4.41
Cu	50**	14	43	43	73.28 ± 4.23*	24.10 ± 4.10
Zn	69	0	45	55	0.41 ± 0.04***	0.20 ± 0.03***
Cr	100	0	43	57	34.37 ± 4.08*	15.23 ± 1.70
Cd	100	0	33	67	22.98 ± 2.52**	6.74 ± 0.79*
V	67	0	0	100	24.71 ± 0.74	10.32 ± 2.11
Total %	78***	9	45	46		

Note: x P-<0.05; xx P-<0.01; xxx P-<0.001they were calculated comparably with data of the healthy subjects.
Mesors and amplitudes were calculated by the following unites: volume of urine-ml/h; Na, K, P, Cl-mmol/h; Ca, Mg, Zn – µmol/h; Fe, Cu, Cr, Cd, V-nmol/h.

Table 2 Mesors and amplitudes of urinary excretion of the electrolytes and trace elements and ultra-(U), circa – (C), and infradian distribution (%) of the statistically significant rhythms (S) in H2.

Indices	S	U	C	I	Mesor ± SE	Amplitude ± SE
Volume of urine	62***	6	78	16	42.23 ± 2.14	10.35 ± 1.07*
Wa	62***	6	51	43	6.26 ± 54	2.17 ± 0.22
K	73**	16	41	43	2.62 ± 0.16***	0.95 ± 0.10
Wa/K	72	25	35	40	3.18 ± 0.18	0.81 ± 0.06**
Cl	64**	22	61	17	8.00 ± 0.65	2.94 ± 0.41
Ca	60***	7	40	53	100.80 ± 6.24	28.71 ± 2.34***
Mg	77	26	44	30	38.82 ± 3.66***	11.58 ± 1.62***
P	53***	21	42	37	2.85 ± 0.25***	1.16 ± 0.22***
Fe	83*	5	84	11	147.01 ± 10.36	50.79 ± 6.41
Cu	64***	29	14	57	44.40 ± 3.59	17.00 ± 2.81
Zn	70	29	14	57	0.49 ± 0.04***	0.26 ± 0.07**
Cr	60*	16	42	42	32.94 ± 2.41*	10.03 ± 1.91
Cd	79*	18	64	18	17.49 ± 0.98*	5.79 ± 0.65
V	67	50	17	33	36.58 ± 4.22*	13.58 ± 2.82
Total %	68***	17	48	35		

Note: x P-<0.05, xx P-<0.01, xxx P-<0.001, they were calculated comparably with data of the healthy subjects.
Mesors and amplitudes were calculated by the following unites: volume of urine-ml/h; Na, K, P, Cl-mmol/h; Ca, Mg, Zn – µmol/h; Fe Cu, Cr, Cd, V-nmol/h.

urine, coefficient Na/K, Ca, Mg were significantly lower than in the healthy subjects **(Table 2)**. Our data witnessed that the patients with the cardiovascular pathology beginning from the early stages (H1) electrolytes and the trace elements excretion rhythms changes took place, which were expressed in the alterations of the period, mesor and amplitude in compassion with the data of the healthy subjects. The synchronization by rhythms period was inherent for normal functions of the organism. Our results showed that in cardiovascular pathology beginning from the early stages (H1) electrolytes and trace elements excretion rhythms changes took place in comparison with the data of the healthy subjects. Thus, the new neuroendocrine status of the organism re-organized the circadian rhythms of water-mineral internal system for preservation of relative stationary of the electrolytes and trace elements composition in the internal environment at the early stage of cardiovascular pathology. Those protective reactions went out slowly in the late stage of H (H2). The results also showed that in the patients with H depending upon the gravity of pathological state in 32% statistically significant rhythms of electrolytes and trace elements excretion were not revealed. We could not compare our data with the results of other authors, as similar investigations in cardiology patients had not found in the available literature. Thus, the change of period, mesor and amplitude of the rhythms of the electrolytes and trace elements excretion in urine obtained early diagnostic significance. Those data could also help in the organization of pathogenetic therapy of the hypertensive patients taking into account the temporal structure of water-mineral homeostasis [11-15].

For realization of correlative investigation, within 3-5 days, at 3-h intervals, measuring volume of the urine, macro-and microelements were used, sliding them with the same 3-5 days, previous and following 2-days at 3-h intervals measuring of HMI. Investigations were carried out by Spirmen's method with sliding data of each mineral with the data of each HMI at 3-h intervals. The presence of correlative connection between curves was considered statistically significant with coefficient of correlation 0.5 and more. Sines the data of HMI was registered at 3-h intervals 4-h data of urine and minerals were corrected with the plan of interpolation. Correlative conjunctions of indices were investigated taking into account the outstrip or delay of the acrophases of biorhythms relative to the acrophases of the HMI rhythms. The results of patients with H1 have shown a 37% statistically nonsignificant correlative connections between their water-mineral homeostasis and the rhythms of HMI. In patients with H correlative connections between rhythms of Fe, Cd (H1), Zn, Cr (H2) and TA; Na, K, Cd, V (H1), Cu, Zn, Cr (H2) and RHA; Ca, Fe, Cd, V (H1) and DHA; Cd (H1, H2), Cu, Zn, Cr (H2) and AP; Zn (H1), Cd (H2) and SW; Zn, Cd (H1) and GC were statistically significant. Our results indicated that in patients with H, acrophases of the rhythms of water-mineral excretion outstripped 35% (H1) and 32% (H2) to the acrophases of the HMI rhythms [16-21].

Conclusion

These data obviously were statistically significantly smaller in comparison with results of the healthy subjects ($P < 0.01$). In patient with H, acrophases of biorhythms often were simultaneous 24% (H1), 21% (H2) or delayed 17% (H2) relative to the HMI rhythms. That data indicated the direct influence on temporal structure of organism by the HMI and decrease of adaptive possibilities of water-mineral homeostasis in patients with H.

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