depress (or raise) the value of V_{max}. With this type of action of the inhibitor (activator) the relative amounts of the free enzyme and the ES complex as a rule will be reduced, and this also leads to a change in the value of K_m.

When using the complete Botts–Morales system it is convenient to examine inhibition and activation of the direct and reversed lactate dehydrogenase reactions by CG together. Since differences between them are quantitative rather than qualitative in character, the same algebraic relationships are valid for both cases.

It can be concluded that CG has a direct action on LDH in vitro. This suggests that this glycoprotein may take on the role in the cell of a nonspecific regulator of the lactate dehydrogenase reaction. Moreover, the character of the effect of CG on the enzyme is that of a noncompetitive mechanism of action.

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NEW APPROACHES TO AN UNDERSTANDING OF THE HEMODYNAMIC NORM

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The norm is nowadays widely regarded as the zone of optimal function of an organism. Normal values of both morphologic and functional parameters are drawn up on the basis of calculation of their mean values in man, assuming homogeneity of the groups. Yet recent investigations have shown that an intrinsic heterogeneity exists for many parameters in healthy individuals. Numerous studies of the state of the cardiovascular system of the healthy human population have shown that maximal and minimal values of many hemodynamic parameters, studied under conditions close to those of basal metabolism, differ from one another by as much as 2-4 times. Facts such as these have been explained, not by certain particular features of the values under consideration, but by technical errors in data collection [10, 11]. It was Savitskii (1974) who first drew attention to typologic differences in the central hemodynamics of patients with essential hypertension. Using the cardiac index (CI) as his basis, he distinguished

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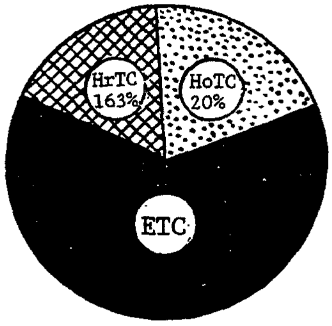

Fig. 1

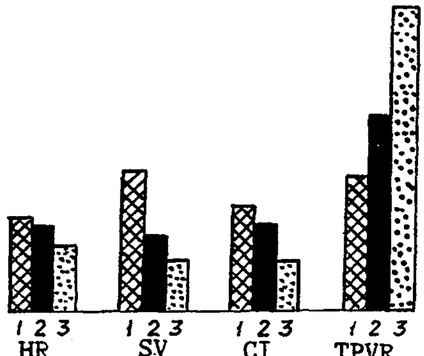

Fig. 2

Fig. 1. Ratio between hemodynamic types of circulation. HrTC) Hyperkinetic, ETC) eukinetic, and HoTC) hypokinetic types of circulation.

Fig. 2. Parameters of hemodynamics of subjects with different types of circulation. HR) Heart rate; SV) stroke volume of the heart; CI) cardiac index; TPVR) total peripheral vascular resistance. 1) HrTC, 2) ETC, 3) HoTc.

three types of circulation (TC): hyperkinetic – with a high value of CI; hypokinetic – with a low value, and eukinetic – with an average value of CI. Savitskii considered that these TC were formed by the disease itself, and that normal healthy individuals are characterized by a eukinetic TC.

At the beginning of 1980s, Shkhvatsabaya and co-workers (1981) and Oganov and co-workers (1983) suggested using the concept of TC to assess the central hemodynamics in healthy individuals; and to solve problems of the hemodynamic norm. These investigators considered that TC are variants of the hemodynamic norm and are genetically determined.

It has been shown that the concept of TC can be used with advantage to elaborate hemodynamic norms and it has been shown that representatives of different hemodynamic types differ in the physiological mechanisms of hemodynamic provision for the needs of the body and, consequently, they differ in their powers of adaptation to many external environmental factors, some of them physiological [2, 7]. Representatives of different TC are therefore characterized by a different course of pathological process. Data in the literature on hemodynamic norms corresponding to different TC are concerned mainly with young people [1, 4, 8].

The aim of this investigation was to study parameters of the central hemodynamics in clinically healthy individuals with different TC, to establish criteria for recognition of TC, and to use them to evaluate hemodynamic disorders in patients with arterial hypertension and for monitoring the quality of treatment.

EXPERIMENTAL METHOD

Parameters of the central hemodynamics were studied in 80 clinically healthy individuals aged from 25 to 26 years (40 men and 40 women). Of the total number, 52 did physical work, 21 did mental work, and six had retired. The blood pressure (BP), height, and body weight of all subjects were measured and the mean hemodynamic pressure (MHDP) was determined [6]. Synchronized recordings were made of the basic and differential rheograms by the tetrapolar thoracic rheogram method [5] in recumbency, the phonocardiogram (PCG), and electrocardiogram, using instruments of USSR/CIS origin: "Elkar," RPG-2-02, and phonocardiographic attachments. Next, using all these data, the heart rate (HR), the stroke volume of the heart (SV), cardiac output (CO), and the stroke and cardiac indices of the heart (SI, CI), the total peripheral and specific peripheral vascular resistance (TPR, SPR), the useful work of the left ventricle (A), the power of contraction of the left ventricle (PCLV), the volume velocity of blood ejection from the left ventricle (VE), and the coefficient of rationality of energy expenditure in systole (K_{rat}) were determined.

Mean values of CI (M ± m) were determined by analysis of variance, and TC was determined by the interval distribution method.

EXPERIMENTAL RESULTS

The scatter of values of CI of the subjects tested ranged from 0.99 to 4.25, with a mean value (M ± m) of 2.33 ± 0.085 liter/min/m^2, $\sigma = 0.76$. Values of CI of 1.59 liter/min/m^2 or below were taken as a hypokinetic TC (HoTC, values from 1.60 to 3.09 liter/min/m^2 as a eukinetic TC (ETC), and 3.10 liter/min/m^2 and higher as a hyperkinetic TC (HrTC). Persons with HrTC formed a group of 13 subjects (16.3%), those with ETC numbered 51 (63.7%), and those with HoTC numbered 16 (20%) subjects of the 80 tested; thus the ratio between the numbers of persons with the different types of TC was about 1:2:1 (Fig. 1). This ratio, according to data in [8], for healthy men and women was 21.1-26.3%: 43.9-49%: 29.8% respectively, 20-25%: 40-45%: 24-30% according to data in [1], and 21.7: 55.1: 23.2% according to [4]. The results of the study of parameters of the central hemodynamics in subjects with different TC are shown in Table 1 and Fig. 2.

The results in Table 1 show that the levels of systolic and diastolic BP (SBP, DBP) and of MHDP were within normal limits in the groups studied. HR for individuals with HrTC (group 1) was the largest, and averaged 74.1 ± 2.27 beats/min, whereas its value in subjects with HoTC (group 3) was the least, namely 64.6 ± 2.11. Under these circumstances a significant difference was found in the value of this parameter between the groups mentioned. The mean HR in subjects with ETC (group 2) occupied an intermediate position. The value of SV was greatest in subjects of group 1, in whom it averaged 85.02 ± 3.09 ml/min, it was less in subjects of group 2, and least in those of group 3: 56.87 ± 2.18 and 35.57 ± 1.87 ml/min respectively. Differences in the mean values of SV in the groups studied, moreover, were statistically significant. The same pattern also was found in relation to CO, SI, and CI in all three groups. Values of TPVR and SPVR, on the other hand, were least in subjects with HrTC (1302.0 ± 61.72 dynes·sec·cm^{-5} and 724.5 ± 33.23 dynes·sec·cm^{-5}/m^2). The level of these parameters was significantly higher in subjects with ETC, namely 1998.5 ± 59.75 and 1204.8 ± 50.01, and reached a maximum in subjects with HoTC (3366.1 ± 214.3, and 1911.9 ± 146.7), the variations in the values of the parameters between all the groups of subjects being statistically significant. Mean values of A, PCLV, and VE in subjects of group 1 were 0.107 ± 0.005, 3.68 ± 0.22, and 286.5 ± 13.95 respectively; 0.070 ± 0.008, 2.46 ± 0.09, and 197.3 ± 7.72, in group 2, and 0.048 ± 0.002, 1.71 ± 0.09, and 139.9 ± 6.84 respectively, $p < 0.01$ between all groups. This pattern was not found in the case of the coefficient of rationality of energy expenditure in systole ($p > 0.05$).

Thus in HrTC the leading mechanism ensuring optimal MHDP was a relatively high level of CI, with significantly higher values of SI and PCLV, and low values of TPVR and SPVR. In HoTC the most important factor for maintenance of the necessary MHDP is relatively high TPVR and SPVR accompanied by low values of CI, SI, and TCLV. An intermediate position is occupied by subjects with ETC. The broad range of the parameters studied, according to data in the literature, is not accidental, for the conditions of human life are extraordinarily varied. It can be assumed that hemodynamic types reflect constitutional heterogeneity. Values of scatter of CI and SPVR make the population hemodynamically flexible and more reliable. According to data in [4], the character of distribution of the hemodynamic TC in athletes was completely different. In them, an HoTC was found most frequently (67.4%). The author cited considers this to be the result of adaptive changes in the cardiovascular system, formed under the influence of regular physical exercise. These changes are in accordance with the concept of economy of function of the cardiovascular system at rest, i.e., that the economically most suitable TC is formed by athletes.

The distinction of three hemodynamic TC in clinically healthy persons, namely hyperkinetic, eukinetic, and hypokinetic, adequately maintaining the optimal level of MHDP, is thus substantiated. In the study of hemodynamic heterogeneity in patients with arterial hypertension, the initial heterogeneity of the hemodynamics in normal individuals must not be ignored. Depending on this factor the clinical assessment of some phenomena of great practical importance may vary. It may be emphasized that investigators at the present time are not limiting their attention to the distinguishing of TC in clinically healthy individuals and drawing up norms. The conclusion given above regarding the importance of the concept of the norm as a zone of optimal function of the body must in turn be considered from the standpoint of chronobiology. In that case, this concept is widened and made more complex. The concept of the "chronodesma," introduced by the American chronobiologist F. Halberg in 1984, deserves particular attention

TABLE 1. Parameters of Central Hemodynamics in Clinically Healthy Subjects with Different Types of Circulation

Parameter	HrTC, group 1 (n = 13)	ETC, group 2 (n = 13)	p_1	HoTC, group 3 (n = 16)	p_2	p_3
SBP, mm Hg	123,8±3,97	119,4±1,39	>0,05	123,8±3,01	>0,05	>0,05
DBP, mm Hg	74,4±2,6	75,8±0,9	>0,05	76,6±1,5	>0,05	>0,05
MHDP, mm Hg	96,2±7,67	94,3±0,98	>0,05	98,9±1,72	>0,05	<0,05
HR, beats/min	74,1±2,27	73,6±1,51	>0,05	64,6±2,11	<0,01	<0,01
SV, ml/min	85,02±3,09	56,87±2,18	<0,01	35,57±1,87	<0,01	<0,01
CO., liters/min	6,09±0,18	3,94±2,18	<0,01	2,27±0,11	<0,01	<0,01
SI, ml/min/m²	47,38±0,089	32,53±1,18	<0,01	19,87±1,08	<0,01	<0,01
CI, liters/min/m²	3,48±0,089	2,33±0,066	<0,01	1,27±0,059	<0,01	<0,01
TPVR, dynes·sec·cm^{-5}	1302,0±61,72	1998,5±59,75	<0,01	3366,1±214,3	<0,01	<0,01
SPVR, dynes·sec·cm^{-5}·m^{-2}	725,4±33,23	1204,8±50,01	<0,01	1911,9±146,7	<0,01	<0,01
A, kg-m	0,107±0,005	0,070±0,003	<0,01	0,048±0,002	<0,01	<0,01
PCLV, W	3,68±0,22	2,46±0,09	<0,01	1,71±0,09	=0,05	<0,01
VE, ml/sec	286,5±13,95	197,3±7,72	<0,01	129,9±6,84	<0,01	<0,01
K_{rat}, W/ml	0,043±0,008	0,045±0,001	>0,05	0,048±0,002	>0,05	>0,05

Legend. p_1) comparison of values for first and second groups, p_2) for first and third, p_3) for second and third groups.

from this standpoint. By this term he implies confidence intervals of fluctuations of any functional parameter with time. If we plot a graph and draw two lines on it to show the upper and lower limits of normal for a particular parameter, on superposition of the chronodesma it can be seen that circadian fluctuations of normal values of this parameter are wavelike in character. The point A on the graph may lie within the limits of normal fluctuations, but may be assessed as being above or below the norm. It may be wrongly regarded as normal, but in fact, it is below or above normal. The creation of normal standards for BP during the 24-hour period, which Halberg undertook, undoubtedly marks a new step forward in practical biorhythmology.

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