

Correction of the functional state of persons of hazardous professions based on the integral skin electrometry

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SUMMARY

The aim of the study is to develop scientifically substantiated criteria for identifying periods of stress and fatigue in the body of decoder operators. All subjects were examined using integral electrometry of the skin, the study of the cardiorespiratory system, in conditions of hypodynamia and other extreme factors. A new method for analyzing the functional systems of the human body is described, based on the synthesis of methods of integral electrometry of the skin and the method of system-quantitative analysis of the vegetative-energy sphere. The dynamics of integral electrometry of the skin is a promising mechanism for assessing changes in the state of the human operator and the corrective effects of magnetopuncture.

Key words: electrocutaneous conduction, acupuncture skin zones, magnetopuncture.

RESUME

The purpose of research is the development of scientific criteria for identifying the stress and fatigue periods of decoding operators organisms. All participants have been tested with integral skin electrometry and cardiorespiratory system examination under physical inactivity and other extreme factors. A new method for the analysis of the functional systems of the human body based on the synthesis of skin electrometry and method of quantitative analysis of vegetatively - energy sector is described. The dynamics of integral skin electrometry is a perspective method to assess the state of changes of human operator organism and the corrective effects of magnetopuncture.

Keywords: electro-conductivity of skin, acupuncture skin zones, magnetopuncture.

The development of psychophysiological problems of monitoring the state of persons in dangerous professions and optimizing their activities is one of the topical scientific and practical directions of human physiology and modern medicine [15, 16].

The complexity and insufficient development of this direction are obvious and are associated, first of all, with the variety and various combinations of factors, united by the concept of "operator load". These are, on the one hand, nonspecific - late-static, hypokinetic factors; on the other hand, the neuropsychic, emotional components of the operator load [5, 6, 12, 13]. In full measure, these factors are inherent in the mode of operation of decoder operators, whose professional activity, due to the socio-political significance and responsibility of the tasks being solved, apparently requires priority study and psychophysiological optimization.

If we add to the complex of these factors the influence of daily, as well as weekly, biologically and socially determined rhythms during shift work, characteristic of this contingent of workers, it becomes clear the complexity of developing scientifically substantiated criteria and identifying, on their basis, periods of greater or lesser stress in the body, training, optimization and fatigue. a person during operator activity. To solve these problems, a new methodological approach is needed, based, first of all, on the system-functional principle of organizing the object of research - the whole human body [1]. This approach should ensure the analysis on a single time scale of systemic rearrangements of both the vegetative and psycho-emotional spheres of the human operator in the process of work [10]. Currently, there are certain methodological prerequisites.

The method implements a number of principles of the theory of functional systems, is informative and technically realizable in production conditions [2].

A number of authors have shown that a technically simple and convenient method of recording the electrocutaneous conductivity (EC) of acupuncture skin zones (ACZ) allows dynamically assessing not only autonomic changes in the body, but also the restructuring of the emotional-affective sphere of a person [19]. Many studies indicate a close relationship between changes in the EPA of the ACD with changes in the bioelectrical activity of the human brain under various conditions [3, 4, 9, 14].

Thus, there is reason to believe that the synthesis of the methods of integral electrometry of the skin and the method of systemic quantitative analysis of the vegetative-energy sphere of the body in conditions of increased production activity will be an adequate basis for studying the patterns of psychophysiological rearrangements in a human operator under the influence of load factors and the use of corrective actions in the process of his activities.

To solve the most important problem of correcting the state of a human operator, in recent years, various methods of stimulating ACZ have been increasingly used: acupressure [8, 9], acupuncture, electro- and laser puncture. Magnetopuncture, a method of influencing the ACD of human skin, has so far found application only in the clinic [5]. Meanwhile, magnetopuncture is the most technically simple, anti-traumatic and comfortable way of long-term physiotherapeutic effect on the human body in real production conditions. However, to clarify the effectiveness and direction of its influence on the psychophysiological state of the human operator, special studies are needed, which have not been previously conducted.

In the course of the research, the following tasks were solved:

1. To formulate systemic criteria for assessing psychophysiological rearrangements in a person operator based on parallel recorded physiological parameters and indicators of integral electrometry of the skin of the AKZ system.

2. Conduct a combined analysis of the dynamics of the complex of physiological indicators used in operators in different phases of the work shift during the day and night shifts, as well as during the day at the beginning and at the end of the work week.

3. To investigate the comparative effectiveness of the use of long-term application of medical magnets on AKZ based on indicators of integral electrometry of the skin in comparison with standard methods of application on AKZ of general action, used to increase the psychophysiological capabilities of the operator.

Methodology and series of studies of the functional state of the human operator

The studies were carried out on 113 decoder operators (men 25–45 years old) working in extreme conditions in underground control centers characterized by emotional and physical stress, including in the conditions of night shifts. The general structure, nature and scope of the studies carried out are shown in table. 1. As you can see from the table. 1, in the conditions of the day shift, 5 groups were examined: 3 control and 2 - experimental, in the conditions of the night shift - 2 groups: control and experimental.

Table 1

General structure and scope of research

Номер серии	Тип воздействия	Число испытуемых	Количество наблюдений	Число обследований
<b>ДНЕВНАЯ СМЕНА</b>				
1	Без аппликации (контроль)	29	36	144
2	Контрольная серия с дополнительной интегральной электрометрией АКЗ у операторов за 1–1,5 часа до конца рабочего дня	19	19	76
3	Магнитопунктура на основании показаний интегральной электрометрии АКЗ у операторов	16	52	128
4	Магнитопунктура на «общие» точки	8	16	64
5	Аппликация немагнитических аналогов («плацебо»-контроль)	8	16	64
<b>НОЧНАЯ СМЕНА</b>				
6	Без аппликации	17	17	68
7	Магнитопунктура на основании показателей интегральной электрометрии АКЗ у операторов	16	16	64
<b>ВСЕГО по 7-ми сериям</b>		<b>115</b>	<b>152</b>	<b>608</b>

In all series, operators were examined using integral skin electrometry 4 times per shift.

For acupuncture in the 3rd, 4th and 7th series, we experimentally selected symmetrical BAP 5-X (wai-guan) and 6-IV (san-yin-jiao). For 4 indicated AKZ, the operators were fixed to the skin with ferritobarium magnetic "tablets", 10 mm in diameter, 3 mm in height, with a magnetic induction of 35–45 mT (produced by NPO Magnit, Novocherkassk, approved for use in medical practice by Order of the USSR Ministry of Health N1339 dated 12/31/87), or non-magnetized dielectric analogs of the same size and mass in the 5th series ("placebo" control). The "tablets" were fixed to the skin for the operators with adhesive tape for a period of 3-5 days, including the day of the examination.

Application with magnetic "tablets" in the 3rd and 7th series was used on the basis of the data of integral electrometry of the skin, which characterized the adaptive nonspecific reactivity of the organism of various functional systems of the organism. The registration of a complex of physiological indicators, muscle strength and EP in the subjects was carried out at the workplace in a specially equipped room. The recording periods of the entire complex of parameters were the 1st - before work, the 2nd - at the 4th hour of work before the lunch break, the 3rd - at the 5th hour after the break, and the 4th - at the 9th hour at end of the work shift. By the time of day, these periods corresponded to the day shift: 8.00–9.00; 12.00–13.00; 13.30–14.30; 17.30–18.30; and on the night shift: 23.00–24.00; 3.00–3.30; 4.00–5.00; 8.00–9.00.

At the same time, the heart rate (HR), systolic (BP) and diastolic (BP) blood pressure were determined in parallel by the Korotkov method, calculated according to the generally accepted formulas of pulse (BP) and average dynamic (AR) blood pressure, stroke volume of the heart (CV) and minute volume of blood flow (IOC), an indicator of arterial tone (PAT) and total peripheral vascular resistance (OPSS).

Parameters of tidal volume (RV), respiratory rate (RR), minute respiratory volume (RV) and minute consumption of O<sub>2</sub> organism (PO<sub>2</sub>) was determined using the "Metatest-2" device. In addition, to assess the functional oxygen supply system (FSCO) of the human body [15], to characterize its effectiveness, the following derived indicators were used:

- oxygen utilization factor  $KIO_2 = \frac{ON_2}{MOD}$ , where  $ON_2$  - oxygen consumption in ml in 1 min., MOD - minute volume of respiration in liters per 1 min.;
- arteriovenous oxygen difference  $ABO_2 = \frac{ON_2}{IOC}$ , where IOC is the minute volume of blood in l in 1 minute;
- average dynamic arterial pressure  $ABP-1 = IOC / \text{heart rate}$ ,
- integral indicator of the efficiency of the oxygen supply system  $IPE = 1604 \times KIO_2 \times ADsr-1$ .

To characterize the balance of the work of the executive mechanisms of the oxygen supply system, the indices VR / HR and DO / RR (volume-frequency balance of the functions of the heart and external respiration) and ADp / BPd (balance of the tone of large arteries and arterioles) were calculated. An increase in these indicators indicates more favorable modes of operation of the cardiorespiratory system in the absence of a pronounced effect of physical activity and other

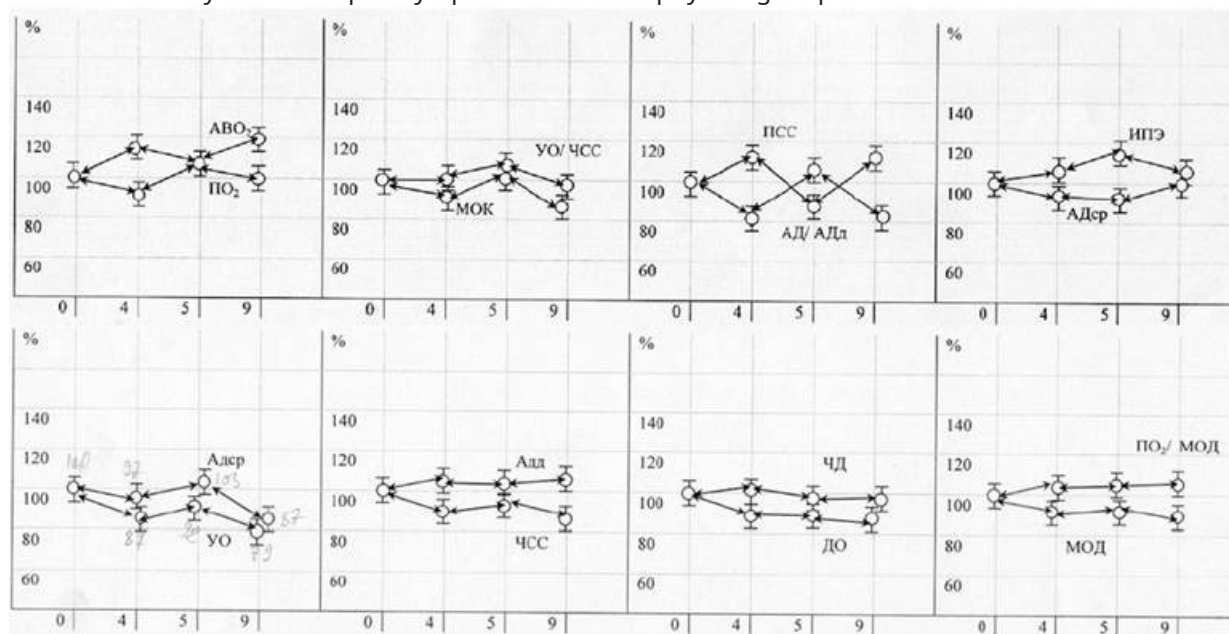
extreme factors. In addition, integral electrometry of the ACC and measurement of the muscle strength of the wrist of the non-working left hand using a serial hand-held dynamometer were carried out, which made it possible to indirectly evaluate the level of psychoemotional stress in the operators.

#### Comparison of the results of psychophysiological and electrometric examination during assessment of the functional state of the operator

Studies carried out in various series have revealed the same type of repeating phase dynamics of a number of physiological indicators in all operators both in the first - before lunchtime, and in the second half of the working day. The data obtained from the operators during the day shift is shown in Fig. 1.

As follows from the given graphs, the level of aerobic energy exchange of the body, assessed by the parameter  $PO_2$ , practically did not change from the beginning to the end of the work shift, which indicated a fairly pronounced adaptation of the body to the psychophysiological load. By the end of the first and, especially, the second half of the working day, the operators showed physiological shifts in the opposite direction.

At the same time, it was in the second half of the day that the greatest decrease in heart rate, blood pressure, IOC, and MO was observed with an increase in OPSS (Fig. 1), which can be interpreted as the initial reactions of the human body to hypokinesia, which were combined with unfavorable shifts in cardiorespiratory indicators of the efficiency of the oxygen system. provision. In particular, by the end of the shift, there was a decrease in the operator's volumetric-frequency balance of the heart ( $VV / HR$ ) ( $p < 0.001$ ), a decrease in the AP / BP index ( $p < 0.001$ ), indicating a decrease in the functional reserves of the heart relative to the arteries and an increase in peripheral vascular tone, which is also confirmed by a significant increase in TPR ( $p < 0.01$ ) by the end of the work shift. An indicator of a decrease in the effectiveness of cardiovascular interaction in an operator is a decrease in Adv and VOS ( $p < 0, 01$ ) also at the end of the working day. During the afternoon rest, the "optimization syndrome" of the interaction of cardiorespiratory mechanisms was revealed, which was characterized by an increase in the volumetric-frequency balance of cardiac functions ( $VV / HR$ ) and the equilibrium of arterial vascular tone ( $BP / BP$ ). This optimization was also expressed in an increase in IOC with a decrease in TPR, in a decrease in the ABO indicator<sub>2</sub>, in increasing the efficiency of external respiration in terms of  $KIO_2$  and IPE. Parallel measurement of the electrical parameters of the ACR showed that at the end of the first half of the shift and an hour and a half before the end of the second half of the shift in the 2nd series, the operators showed a significant decrease in EP ( $p < 0.05$ ). According to the literature [2], this indicates the influence of the factors of monotony and hypokinesia in a sitting position on the state of the human operator, which is also confirmed by the above parasympathetic shifts of physiological parameters.



Rice. 1. Dynamics of indicators of the oxygen supply system of the body from decoder operators during the day shift.



After the lunch break and at the end of the working day, the operators, on the contrary, showed an increase in the average (EP) investigated AKZ. At the same time, the increase in EP after lunch is explained by a positive emotional background among operators as a result of satisfying motor and nutritional needs. An increase in the conductivity of AKZ against the background of the effects of "hypokinetic" and mental fatigue at the end of the shift may be associated with a positive attitude of the operators in connection with the completion of work and the forthcoming rest, which was confirmed by the data of verbal reports of the subjects. At the same time, the more dynamically reacting electrodermal parameters of the ACD with an advance in comparison with the physiological indicators reflect this state.

In addition, the operators of the night shift showed significantly higher values of the EP and dynamometry indices, which indicates an increased neuropsychic tension in the operators during the night shift as a result of desynchronization of the biological and social rhythms of sleep and vigorous activity.

A similar comparison of the average daily change of values of the same indicators for operators in different periods of the weekly cycle (Table 2) indicates that work at the beginning of the week is accompanied by a greater intensity of cardiovascular interaction and slightly increased psychoemotional stress ( $p > 0.05$ ) versus the end of the working week. This, at first glance, paradoxical fact is consistent with the data of some researchers [2], who showed an increase in students' mental performance on Friday and a decrease in it on Monday, and the decrease in performance was correlated with an increase in MAP. It is possible to make an assumption about a certain disorganization among the operators over the weekend of the working stereotype of activity that has developed by the end of the week, possibly due to incoming unfavorable factors.

table 2

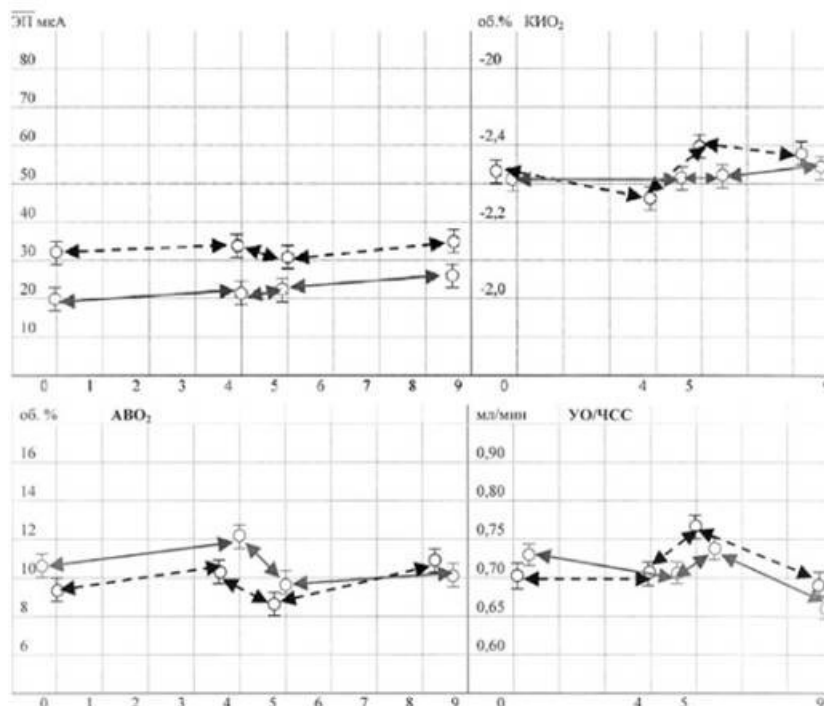
The value of the main indicators of the psychophysiological state of operators on average per shift depending on the time of day and day of the week ( $M \pm n$ )

Показатель	Дневная смена (n = 4x36)	Ночная смена (n = 4x17)	Начало недели (n = 4x16)	Конец недели (n = 4x16)
Минутный объем кровотока, л/мин.	3,45 ± 0,068	3,09 ± 0,070*	3,56 ± 1,08	3,38 ± 0,90
Периферическое сопротивление сосудов, дин с/см <sup>5</sup>	2246 ± 76,5	2713 ± 10,3*	2468 ± 111,3	2419 ± 114,2
Диастолическое АД, мм.рт.ст	78,5 ± 0,99	83,2 ± 1,19*	81,4 ± 1,45	77,4 ± 1,44*
Индекс Адп/Адд, центили	0,55 ± 0,012	0,49 ± 0,016*	0,50 ± 0,016	0,54 ± 0,016
Минутный объем дыхания, л/мин.	14,5 ± 0,24	14,3 ± 0,42	14,7 ± 0,39	14,4 ± 0,37
Индекс ДО/ЧД, мл/мин.	86,4 ± 4,32	79,3 ± 5,91	84,3 ± 5,60	91,7 ± 7,92
Среднединамическое АД, мм.рт.ст	96,3 ± 1,11	100,0 ± 1,36*	100,3 ± 1,77	94,3 ± 1,46*
Коэффициент использования O <sub>2</sub> , об.%	2,34 ± 0,048	2,32 ± 0,063	2,32 ± 0,060	2,35 ± 0,085
Интегральный показатель эффективности O <sub>2</sub> -обеспечения организма, центили	39,6 ± 0,92	37,6 ± 1,12	37,7 ± 1,14	40,4 ± 1,50
Средняя сила кисти левой руки, кг	47,9 ± 1,03	52,8 ± 0,84*	53,0 ± 0,96	51,3 ± 0,98
Средняя электрокожная проводимость (ЭП)	32 ± 12	23 ± 17	35 ± 3	30 ± 15
Асимметрия латеральная (Ад)	90	65	95	60
Асимметрия поперечная (Ад)	85	70	80	75
Асимметрия поверхностная (А)	95	140	95	120
Разница между максимальной и минимальной величинами электропроводности АКЗ (ЭП)	31 ± 4	43 ± 12	52 ± 6	38 ± 14

Примечание:

\* – достоверность (не ниже  $p < 0,05$ ) различий средних значений показателей в столбцах «дневная смена – ночная смена» и «начало – конец недели»; n – число усредненных значений.

Of the derived indicators characterizing the body's oxygen supply system, two were identified with dynamics independent of daily and weekly biorhythms, as well as of the social rhythm "work-rest-work". The first of them is the SV / HR index, which increased among operators during the lunch break and significantly decreased in all series by the end of the work shift (Fig. 2).



Rice. 2. Dynamics of indicators of efficiency and balance of cardiorespiratory functions and electrocutaneous conduction for operators during day and night shifts.

An increase in this index, which characterizes the optimization of the mode of operation of the heart, arises, as is known, as a result of dynamic muscular physical activity, while a decrease in SV / HR is characteristic of static muscle tension [9]. Thus, the increase in this indicator among operators during the lunch break may be associated with physical activity, since of the 2.0–2.5 km that the operator travels in a 9-hour shift, about 40% falls on an hour during the lunch break. The decrease in this index in the subjects by the end of the shift probably reflects an increase in late-static fatigue of the organism.

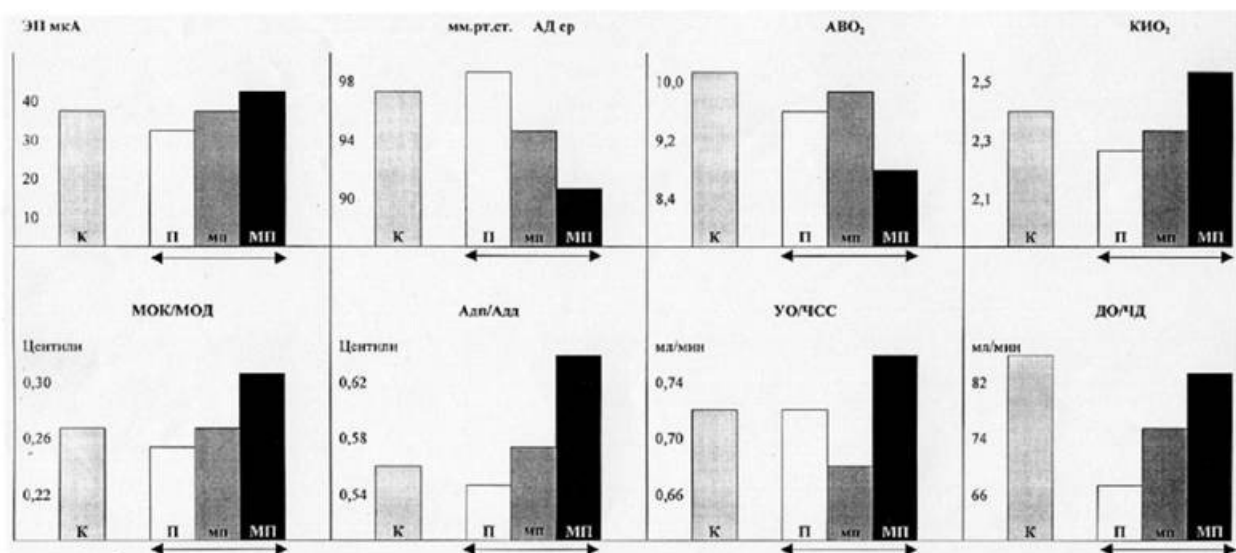
The second indicator that does not respond to biological and social rhythms in the process of operator activity is KIO<sub>2</sub> (fig. 1). The dynamics of this indicator is directly related to changes in the degree of synchronicity of the rhythms of the heart and respiration, carried out at the level of the "centers" of the medulla oblongata [4]. Activation of the higher integrative structures of the central nervous system during information load, causing desynchronization of the rhythmic "commands" of the respiratory and cardio-inhibitory bulbar centers, is thus accompanied by a decrease in IRO<sub>2</sub>, and the inhibition of these structures (during sleep, rest) - by an increase in the synchronization of the rhythms of the heart and respiration and, accordingly, an increase in CIO<sub>2</sub>... However, inhibition of the integrative structures of the brain can also occur as a result of mental fatigue of a person during informational activity. The above considerations, as well as data on the decrease in the coordination of heart and breathing rhythms in operators at the beginning of work with the subsequent synchronization of these rhythms at the end of the shift, allow us to explain the characteristic dynamics of CIO<sub>2</sub> among decoder operators (Fig. 1), connect the increase in KIO observed by the end of the shift<sub>2</sub> with an increase in inhibitory processes in the central nervous system. At the same time, a significant interindividual variability of the dynamics of CRO<sub>2</sub> can be explained by varying degrees of intellectual stress and fatigue by the end of the shift among operators solving tasks of different complexity.

Substantiation of the effectiveness of magnetopuncture based on the electrometric characteristics of the skin to increase the psychophysiological capabilities of the operator Using the criteria for the systemic assessment of the operator's PPS, it is possible to more accurately substantiate the methods for correcting unfavorable functional shifts in the operator's body in order to improve his professional activity. For this, an analysis of the effectiveness of the multi-day application of permanent magnets on the AKZ of general action and to another group of operators on the AKZ according to the integral electrometry of the AKZ, as well as non-magnetized analogs to some AKZ "general action" by the decoder operators working in different shifts, was carried out.

As shown by the statistical analysis of the data obtained, the nature and severity of the observed physiological changes significantly depended on the "recipe" for magnetized ACCs. Thus, a significant increase in MVV was observed in operators when exposed to ACZ according to skin electrometry data due mainly to an increase in SV ( $p < 0.01$ ) relative to an increase in heart rate ( $p < 0.01$ ). This is evidenced by a significant increase in the SV / HR index ( $p < 0.01$ ). Thus, the increase in MOC in the subjects allowed us to state the activation of cardiodynamics. The same optimizing effect of long-term magnetopuncture, according to electrometric data, was observed in terms of vascular-hemodynamic reactions. Significant decrease in PAT and PSS, BPd and Adv, significant increase in the arterial tone equilibrium index (ADp / BPd) (Fig. 1) - all this characterizes the improvement of hemodynamic regulation in subjects for whom long-term magnetopuncture was carried out on the basis of the data of the integral electrometry of the AKZ. These data testified to a decrease in the tension of the interaction of autonomic support systems and thereby to prevent the growing fatigue of the human operator during the work shift.

With prolonged magnetopuncture for "common" points, as in the control groups with and without placebo, no reliable positive dynamics of cardiodynamic interaction indicators was found (Fig. 3).

Comparative analysis of systemic indicators also showed that the integral indicator of the efficiency of oxygen supply IPE significantly increased in operators with magnetopuncture based on the data of integral electrometry of the skin, while with magnetopuncture for "common" points, it remained at the control level. The optimizing effect of magnetism in the first case was also confirmed by a significant decrease in AVO<sub>2</sub> and an upward trend in KIO<sub>2</sub>... At the same time, the trend towards an increase in KIO<sub>2</sub> in the subjects, as well as a number of other physiological effects, were statistically significant in comparison with magnetopuncture on the ACZ of the "general" action and with the "placebo" control. As seen from Fig. 2, the "placebo" effect caused a number of independent statistically significant physiological changes in the subjects' bodies, which made it possible, to a certain extent, to differentiate the effects of prolonged application of the "pill" on the ACZ, on the one hand, and the actual local effect of the magnetic field, on the other. So, the effects of "placebo" explain some of the apparent effects on the AKZ "general" action, in particular, a slight decrease in IRO<sub>2</sub> and DO / BH, at the same time, the above-described optimizing effects of magnetopuncture in terms of integral electrometry of the skin becomes possible to explain precisely the selective, through specific skin-visceral relationships, the energy influence of the magnetic field on the functional systems that are in disturbed equilibrium.



Rice. 3. Influence of long-term application of magnets and placebo analogs on efficiency and normalization cardiorespiratory functions and electrocutaneous conduction in operators.

Average values of indicators for the day shift ( $M \pm n$ ).

Legend: K - control without applications; P - placebo control; MP - magnetopuncture according to the indicators of integral electrometry of the AKZ; mp - magnetopuncture for general AKZ.

During magnetopuncture during the day, based on the data of the integral electrometry of the ACC, the subjects showed a significant ( $p < 0.01$ ) increase in the mean electrical conductivity (EP), which indicates an increase in the neuro-emotional status of the operators, the relief of the effects of hypokinesia and monotony. This was also consistent with a significant increase in the muscle strength of the subjects according to dynamometry data.

Application of magnetic "tablets" to "general" ACZ led to an increase in EP during the day shift, less pronounced and less reliable ( $p < 0.05$ ) than in the first series. The increase in muscle strength in the left hand was the same as with the placebo effect. The given data emphasize the essential importance of magnetopuncture, carried out on the basis of the indicators of the integral electrometry of the AKZ.

During the night shift, the physiological effects of magnetopuncture were in the same direction towards the optimization of the state as in the case of magnetopuncture during the day.

Significant quantitative expression of these effects confirm data analysis of variance given in table. 3. At the same time, the force of the influence of magnetism according to the indicators of electrometry of the skin, both day and night, on the values of a number of physiological parameters (IOC, PSS, UO, AVO<sub>2</sub>, index Adp / BpD) was compared with the strength of the influence of the factor of labor rhythm, and for some parameters (IPE - during the day, BEF / RR - at night, VV / HRH, PAT, Adav - day and night) - significantly exceeded the latter. It can be seen from the table that at night the magnets had a slightly less optimizing effect. In particular, the subjects in this series did not show a significant increase in IPE, there was a decrease in the DO and the DO / RR index. At night, under the influence of magnetopuncture, there was also a small but significant ( $p < 0.05$ ) decrease in the initially higher than in the daytime EF values, which indicates a decrease in increased tension in workers working on the night shift. Dynamometry indicators remained practically unchanged. Thus, it was established that the physiological effect of local magnetism, which is optimizing in nature and different in strength, according to the indicators of the integral electrometry of the ACZ at different times of the day, is less pronounced at night than during the day. This phenomenon can be explained by the different hemodynamic component of the skin in the diurnal biorhythm. Analysis of the results obtained in this section of the work allows us to draw the following conclusions:

1. A systematic approach to assessing the psychophysiological state of the operator's body, taking into account dynamics of integral electrometry of the ACR, dynamometric and cardiorespiratory parameters is a promising direction in the problem of multivariate characteristics of both functional mechanisms and the severity and nature of changes in the state of the human operator at different periods of the working cycle, as well as in assessing the effect of corrective influences.

2. Influence of operator load factors among decoders during the work shift manifests itself in a decrease in psycho-emotional tone, characterized by a decrease in EP, at the end of the first and in the middle of the second half of the work shift. On the other hand, at the end of the shift, the operators have an increase in electrical conductivity. The indicated shifts in psychoemotional tone are more pronounced among the operators of the night shift, as well as at the beginning of the working week, which creates the danger of a decrease in professional reliability during the indicated periods.

3. The studies have established a more pronounced effect of magnetopuncture used with the use of indicators of integral electrometry of AKZ in comparison with magnetopuncture for "general" AKZ, used to restore the initial functional state of the human operator.

Table 3

The strength of the influence of factors: A - operator load ("work-rest-work") and B - long-term magnetopuncture according to the indicators of the integral electrometry of the AKZ on the values of the main and derived respiratory-cardiohemodynamic indicators in male operators during the day and night work shifts (data of two-way ANOVA)



Фактор	Значение и достоверность (*) показателей силы влияния факторов А и Б на физиологические параметры							
	днем	ночью	днем	ночью	днем	ночью	днем	ночью
А Б	Минутное потребление кислорода		Минутный объем дыхания		Минутный объем кровотока		Периферическое сопротивление сосудов	
	3,9 0,1	4,9* 0,3	2,4 1,2	0,4 0,8	15,9* 9,9*	16,8* 4,9*	10,0* 10,1*	13,1* 7,4*
А Б	Дыхательный объем		Частота дыхания		Ударный объем сердца		Частота сокращений сердца	
	1,3 0,5	0,7 3,6*	0,1 0,3	0,1 0,7	8,6* 8,4*	7,3* 5,7*	16,4* 4,1*	13,9* 0,2
А Б	Интегральный показатель эффективности		Коэффициент использования кислорода		Артерио-венозная разница		Среднединамическое артериальное давление	
	0,8 3,4*	3,0 1,8	1,0 0,4	2,9 0,1	5,6* 7,5*	4,6* 3,9*	1,3* 8,8*	0,4* 6,4*
А Б	Показатель артериального тонуса		Индекс ДО/ЧД		Индекс УО/ЧСС		Индекс АДп/АДд	
	0,8* 4,5	0,5* 3,0	0,2 0,1	0,6* 3,7*	0,7 3,2*	1,7 2,9*	14,8* 5,9*	10,9* 2,3*

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