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APPLICATION OF THE E-HEALTH AND PREVENTION SYSTEM IN PHYSIOTHERAPEUTIC PROCEDURES

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Abstract: *The study presents the application of an e-Health and prevention system in physiotherapy procedures - kinesitherapy and reshaped physical factors and the echo of physical and emotional stress on the patients' electrocardiographic signals and the work of the cardiovascular system. In ambulatory practice, a series of tests aimed at registering changes in individual fragments of the ECG curve were carried out and evaluated by prevention markers supplementing medical markers. The challenges in the application of electronic health care in the prevention of the cardiovascular system, combining technical, clinical, psychological, and social analyzes in order to ensure a normal social and work environment for people, have been studied and evaluated.*

The e-Health and Prevention system provides a reliable environment for evaluating the current state of the examined through flexibility and mobility and provides the possibility of upgrading for application in various spheres of work and life. A functional analysis is given in view of the upcoming increased demands of the body under normal and pathological conditions during physiotherapy activities.

Keywords: *electronic system, electrocardiographic signal, electronic health, prevention, physical therapy*.
JEL Codes: *I10, I11*

INTRODUCTION

The importance of developing and implementing effective methods and technologies in medicine in order to improve the quality of technological operations and the accuracy of the obtained results and conclusions, as well as the preparation of medical conclusions as evidentiary material, is known. The developed innovative system for e-Health and prevention through the application of electronic modeling is related to the health of people to achieve a better lifestyle and aimed at prevention at momentary loads.

Electronic health (e-Health) includes specialized activities in electronic format related to health and its recovery (Clark A., 2012) and combines the following health functions:

- Prevention and promotion of health;
- Medical and health care;
- Governance and management of healthcare;
- Ideology and practice of health policy;
- Trainings for the qualification of the expert team;
- Health cultural, semiotic and moral-ethical practices.

e-Health is characterized as dialogical health – communication is carried out through information products that are derived from the dynamic state of health and is aimed at practicing health care supported by ICT (Frederix I., 2017), (Frederix I., 2019). Through the electronic dialogue dedicated to health, a new health culture is generated for both the patient and the doctor. Computer-enabled communication is used for: health care; self-diagnosis; social support.

The e-Health and prevention system, in its part aimed at cardiovascular diseases, provides a complex assessment of momentary disturbances in the electrocardiographic signals through quantitative digital and visual evaluations in prevention and allows diagnosis of people after physical, emotional or rehabilitation stress (Manukova A., 2020), (Manukova A., 2022). The

repeatability of changes in the electrocardiographic curve of clinically healthy people in everyday life and during exercise is an indicator of temporary risk and the need for consultation with a medical specialist.

For the functional study of the cardiovascular system, with a view to the application of kinesitherapy, the process of adapting the heart to the increased demands of the body under normal and pathological conditions is particularly important (Jelev V., 2011). In order to check the capabilities of the fast ECG system, the equipment was adapted to the work process in an outpatient physiotherapy practice in the diagnostic-consultation center 1 in the city of Ruse.

The purpose of the research is to implement an e-Health and prevention system to establish the current condition of potentially risky patients during physiotherapy procedures and, after consultation with a medical specialist, to prepare a plan for parallel rehabilitation of the musculoskeletal system and the cardiopulmonary systems .

METHODOLOGY

The impact of the living environment and emotional stress are essential factors for the appearance of cardiovascular pathological changes. The increased morbidity of the cardiovascular system among the population creates the need for a thorough study of the factors influencing the functional state of the cardiovascular system in a normal living environment (Ruano-Ravina A, 2016). Studies include the echo of emotional and physical stress on electrocardiogram parameters and assessment by markers of prevention.

Physiotherapy in the form of kinesitherapy (treatment through movement) and reshaped physical factors (apparatus physiotherapy) is applied in specialized centers (ambulatory or under hospitalization conditions) and is a mandatory element for quality recovery in dysfunctions of the musculoskeletal system, peripheral and central nervous system as well as in cardiopulmonary problems (Watanabe, M.A., 2004), (Ward, S., 2004).

It is assumed that the performance of various physiotherapy procedures - physical exertion and apparatus manipulations - can lead to a change in the electrocardiographic recording, therefore the patients were examined before and after their application.

A number of diseases of the cardiovascular system are absolutely or relatively contraindicated for sports activities. This especially applies to training loads of high volume and intensity (Slantchev P., 1998). In patients with diagnosed pathologies, routine measures are taken, expressed in functional tests (Jelev V., 2011; Slantchev S., 1998), control of blood pressure, pulse, ECG, etc. (Perchev I., 2000). But often in practice, patients with a leading diagnosis other than cardiovascular, and thus a large percentage of hidden and potential problems remain. These patients need to be rehabilitated under special control and attention.

In the presence of signal flags based on the indications, the risk of cardiac arrest (cardiac arrest) increases, especially during physical exertion. This represents a sudden interruption of the pumping function of the heart, which can be restored with rapid medical intervention within minutes (Cholakov O., 2008).

Today, cardiac rehabilitation is accepted as a multidisciplinary approach for the rapid recovery of the heart patient and instigating lasting long-term lifestyle changes that eliminate risk factors (Pertchev I, 2000).

For the purposes of the study, a Prince 180B portable electronic device, Fig. 1, was used, which records the electrical conductivity of the heart by reading electrodermal activity. The device registers a 30-second single-channel recording and provides a preliminary analysis of the waveform of the electrocardiographic signal.

Fig. 1. Prince 180B portable electronic device

The Prince 180B portable electronic device includes baseline noise reduction filters - EMG Low Pass, Baseline High Pass and 50/60 Hz Interference Filter.

Experimental studies of the e-Health and prevention system

In 2022, a series of experimental studies were conducted in outpatient settings at the Medica Expert Medical Center - Ruse, related to the expected increase in work efficiency. The study group was between the ages of 20 and 75 and was tested under the same initial conditions and informed consent.

Part of the data obtained from the conducted research is systematized in tabular form in Table 1, in two conditions - normal and stress, at different ages of the objects.

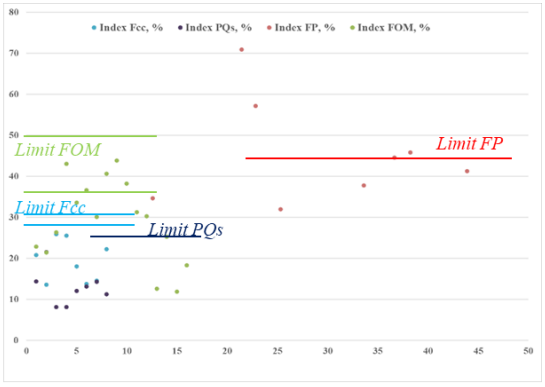
Table 1. Experimental results of laboratory studies by the KRM group

Legend	M	male	CA	Calm
	F	famale	ST	Stress

Age	Date	Hour	Weight	Height	BMI	№	Name	HR	RR Interval	P Duration	PQ Segment	PQ Interval	QRS Duration	ST Segment	T Duration	ST Interval	TP Segment	QT Interval	PT Interval	P Amplitude	Q Amplitude	R Amplitude	S Amplitude	T Amplitude	U Amplitude
			kg	cm				bpm	s	s	s	s	s	s	s	s	s	s	s	mV	mV	mV	mV	mV	mV
71	18.07.22	10:35	72	153	30,76	1	KRM-01-CA-1	76	0,789	0,119	0,02	0,139	0,099	0,166	0,205	0,371	0,152	0,304	0,443	0,15	0,03	0,64	0,08	0,38	0,05
		10:47					KRM-01-ST-1	69	0,869	0,073	0,02	0,093	0,133	0,311	0,146	0,457	0,424	0,279	0,372	0,05	0,07	0,44	0,01	0,03	0,02
	20.07.22	11:12					KRM-01-CA-2	74	0,811	0,113	0,02	0,133	0,113	0,245	0,106	0,351	0,185	0,219	0,352	0,1	0,02	0,56	0,02	0,03	0,08
		11:26					KRM-01-ST-2	77	0,779	0,073	0,02	0,093	0,179	0,119	0,053	0,172	0,272	0,232	0,325	0,05	0,04	0,53	0,05	0,03	0,02
30	18.07.22	13:55	82	188	23,20	2	KRM-02-CA-1	84	0,714	0,113	0,01	0,123	0,139	0,053	0,159	0,212	0,258	0,298	0,421	0,08	0,14	0,36	0,04	0,32	0,04
		15:04					KRM-02-ST-1	79	0,759	0,113	0,01	0,123	0,099	0,06	0,199	0,259	0,232	0,298	0,421	0,08	0,05	0,38	0,05	0,23	0,01
	26.07.22	13:54					KRM-02-CA-2	89	0,674	0,093	0,02	0,113	0,106	0,053	0,199	0,252	0,238	0,305	0,418	0,06	0,05	0,47	0,02	0,21	0,04
		15:40					KRM-02-ST-2	70	0,857	0,099	0,02	0,119	0,132	0,079	0,179	0,258	0,351	0,311	0,43	0,08	0,07	0,33	0,01	0,2	0,02
71	18.07.22	12:20	68	156	27,94	3	KRM-03-CA-1	73	0,822	0,073	0,01	0,083	0,139	0,073	0,166	0,239	0,384	0,305	0,388	0,07	0,01	0,92	0,02	0,16	0,11
		13:28					KRM-03-ST-1	67	0,895	0,066	0,01	0,076	0,159	0,119	0,199	0,318	0,258	0,358	0,434	0,03	0,05	0,56	0,07	0,11	0,1
	20.07.22	12:42					KRM-03-CA-2	75	0,800	0,073	0,02	0,093	0,159	0,079	0,219	0,298	0,258	0,378	0,471	0,04	0,01	0,79	0,09	0,19	0,01
		13:28					KRM-03-ST-2	73	0,822	0,106	0,01	0,116	0,185	0,06	0,238	0,298	0,265	0,423	0,539	0,06	0,02	0,96	0,04	0,17	0,01
28	18.07.22	11:04	75	185	21,91	4	KRM-04-CA-1	109	0,550	0,06	0,01	0,07	0,166	0,04	0,205	0,245	0,079	0,371	0,441	0,02	0,02	0,55	0,06	0,08	0,01
		11:49					KRM-04-ST-1	112	0,536	0,079	0,01	0,089	0,152	0,04	0,119	0,159	0,159	0,271	0,36	0,01	0,01	0,76	0,08	0,07	0,01
	26.07.22	10:47					KRM-04-CA-2	118	0,508	0,093	0,01	0,103	0,159	0,06	0,126	0,186	0,119	0,285	0,388	0,02	0,02	0,4	0,1	0,05	0,01
							KRM-04-ST-2	115	0,522	0,09	0,01	0,1	0,154	0,05	0,122	0,172	0,123	0,276	0,376	0,02	0,015	0,45	0,015	0,04	0,01

For the measured indicators of four of the investigated objects from the KRM group, a representation by markers and a visual interpretation is made in Fig. 2a for four of the markers for which statistical significance was proven. The dark columns of the graphs represent Calm states and the light ones Stress. Parameter limits are plotted. Fig. 2b shows the scatter of the same markers by the object index metrics. From the graph in Fig. 2b, it is found that the markers Index FP (estimating the state of the contractile function of the myocardium) and Index FOM (index of the resting phase of the myocardium, which gives the ratio of the resting phase of the myocardium to the entire cardiac cycle) are significant by relation to expressed pathology – their values vary widely and can express a strong change in the current state. The remaining two markers change within narrower limits.

a) Visual interpretation of results for four subjects



б) Visual interpretation of the scatter of individual indices

Fig. 2. Experimental data for KRM group under stress and relaxed joint mode

a) Calm mode - before physical activity

b) Stress mode - after physical activity

Fig. 3. Experimental resting and stress ECG data for KRM group

The dialog interface of the e-Health and Prevention system is divided into three zones, Fig. 3. In the left part, 18 parameters are entered or visualized for each fragment of the ECG curve and the control buttons are located. In the middle part is the graphic field and below it is written a

text with the analysis according to medical criteria. On the right, the markers are calculated according to the prevention methodology.

The selected subject, Fig. 3, was examined before and after kinesitherapy procedures. The study itself also induced emotional stress before exercise and markers of prevention through indices PQd, PQs and MK gave a temporary risk to functional changes. After the physical activity, the warnings from the medical criteria and additionally Index Fcc have been added. A consultation with a cardiology specialist was recommended at the site and treatment was prescribed after an examination.

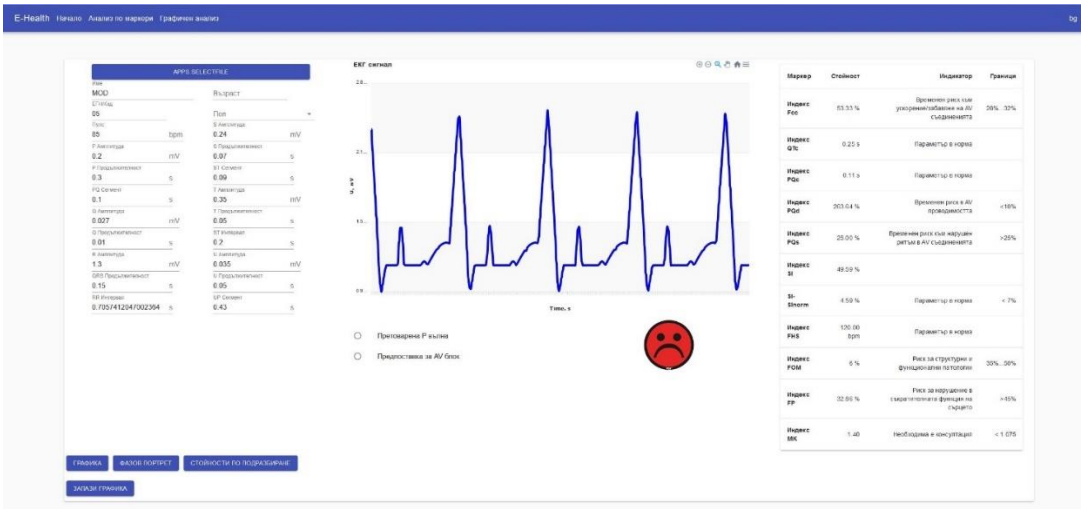


Fig. 4. Experimental resting and stress ECG data for MOD group

Fig. 4 presents a modeled object with the e-Health and prevention system with overload in the P wave and AV block disorders according to medical criteria. Prevention markers through the indices Fcc, PQd, PQs, SI, FP and MK reflect a general risk for structural and functional changes and subsequent consultation with a physician.

This capability of the eHealth system is extremely useful for the training of medical professionals because it allows playing out practice situations with the advanced analysis of prevention markers. The system was tested in 2020 by 2nd year medical students who expressed the usefulness of this mode of operation for training.

CONCLUSION

The challenges in the application of electronic health care in the prevention of the cardiovascular system, combining technical, clinical, psychological and social analyzes in order to ensure a normal social and work environment for people, have been studied and evaluated.

ECG studies within a 30-second recording identify as potentially at risk patients performing physical therapy procedures and this requires further detailed cardiac consultations and investigations and subsequent work under close supervision. After establishing pathologically changed cardiac indicators, patients need to carry out parallel rehabilitation of the musculoskeletal system and the cardiopulmonary systems.

The e-Health and Prevention system provides a reliable environment for evaluating the current state of the examined through flexibility and mobility and provides the possibility of upgrading for application in different spheres of work and life.

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