БОЛЕЗНИ ТЕРАПЕВТИЧЕСКОГО ПРОФИЛЯ

ASSENDING THE PREVALENCE OF CARDIOVASCULAR END GENERAL PATHOLOGY BY SCREENING EXAMINATION OF THE POPULATION OF SUDAN ACCORDING TO THE DISPERSION MAPPING

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A study was completed that examined the characteristics of micro fluctuation state of ECG signal during the screening process in Sudan. On a representative sample of 362 individuals surveyed by dispersion mapping (DM), a boundary separating the "norm" and "pathology" was defined as "Myocardium" 17%. A borderline zone with "possible pathology" was established as "Myocardium" from 18% to 21%, which indicates the need for special clinical and instrumental examinations and further follow-ups. To increase the sensitivity of the method in detecting any existing pathology, simple stress tests were performed to determine the electrophysiological changes of the myocardium in patients with normal or borderline changes in "Myocardium". The study was also able to show the differences of DM-ECG individual indicators among Sudanese in comparison with Russians in similar age groups, which should be strongly considered when using this technology. Thus, the use of portable and easy-to-use Russian technology, allows more efficient screening implementation in primary health care, and help expand diagnostic capabilities outside the medical and health facilities.

Key words: effectiveness of screening, method of electrocardiography dispersion mapping.

Actual problem.

The demographic situation in Sudan at present is still quite heavy. An average life expectancy is 57 years. Among the main causes of mortality in the Arab world are cardi-

ovascular and gastrointestinal diseases, as well as all sorts of infections. They now account for about half of all causes of death in Sudan. The high incidence of sudden death is not affected by the continued high level of development of medicine and health care.

In general, the region is well below the average life expectancy of 5—10 years. Yet in the early twenty-first century, the residents of the East Arab region appeared more likely to survive to the age of 70 than it was three decades ago, when the average life expectancy was just over 50 years. Currently, the average life expectancy: in Libya — 76.3 years, Algeria — 73.7, in Oman — 73.1, Lebanon — 71.8, Jordan — 71.5, Sudan — 57.7, in Yemen — 56.0, in Mauritania only 50 years old. And the number of people older than 65 years is small, f.e. in Lebanon — 6.8% of the total population is elderly, in Jordan — 3.4%, in Syria and Yemen — 3%, Kuwait and Oman — 2.5%. in Saudi Arabia — 2.4%, and in Sudan ONLY — 2.2% [1, 2].

In this regard, a strategy is justified by the health care Organization, aimed at identifying myocardial diseases, including clinically asymptomatic individuals in a population by dispersion mapping DM (screening), which allows for early diagnosis, treatment, and ultimately reduction in mortality. In general, mass screening tests help to improve the overall population health.

One of the most recognizable problems of CHD prevention is the task of improving the effectiveness of screening methods, in order to assess the state of the heart. Early diagnosis with the use of Modern Technology. Substantial assistance in these matters would be achieved with a great help of a new diagnostic ECG computer system. Development of computer technology, Modern Methods of Digital Data Processing resulted in the production of a new diagnostic electrocardiographic computer systems. Most importantly, Method of Electrocardiography Dispersion Mapping (ECG-DM) and the device "CardioVisor-06c", which comprise a new technology of the ECG signal. ECG-DM has been in use up to date to study the functional state of the myocardium in patients with myocardial infarction, hypertension and diabetes. Therefore, the task of the actual use of the DM method is to solve one of the significant challenges for the healthcare organization in Sudan — efficiency and efficacy of the screening methods for the evaluation of the overall heart condition and early diagnosis of the primary and secondary lesions of the myocardium [3—5].

The purpose of this study was to determine the possibilities of the ECG Dispersion Mapping to assess the prevalence of cardiovascular diseases and general pathology by screening the population in Sudan.

Materials and methods.

During the period from 2008 to 2011 using "Cardivisor-06c", a DM-ECG screening method, was used to screen 362 people, residents of Khartoum and various parts of Sudan (M/F: 177/185) aged 19 to 62 years (mean age 47 ± 5.8 years). Divided by age and sex as follows: 82 people aged 20—30 years (42 of them women, men — 40), 106 people aged 31—40 years (women — 60, men — 46) and 92 people aged 41—50 years (39 women and 53 men) and 82 peopleover the age of 50 years (44 women and 38 men). First, initial evaluation was conducted, along with the registration of the DM results, medical history, physical examination, measurement of heart rate and blood pressure (systolic blood pressure of 130—139 mm Hg, and diastolic BP-85-89 mm Hg,

auscultation of brachial cephalic artery, using the results of previous laboratory and instrumental studies if available, blood and urine tests, blood biochemistry, ECG, X-Ray of the chest, as well as consulting ophthalmologist, endocrinologist, neurologist, surgeon, gynecologist, urologist if available. Group "Norm/Healthy" consisted of 147 people who have no history of any disease, they have no complaints. No data available on any clinical or laboratorial methods of pathology. Group of cardiovascular diseases consisted of 109 people. Among them were 34 patients with arterial hypertension (2a), 31 patients with hypertension and diabetes mellitus (2b) and 44 people with a history of hypertension prior to myocardial infarction (2c). It must be emphasized that all patients with cardiovascular disease (identified in this group at screening) had history or indications of this pathology or were examined earlier in the hospital, and the diagnosis was confirmed by the help of the available methods in the hospital, including Holter monitoring ECG, echocardiography and cycle ergometr. Group of Pathology included 106 people who had been previously diagnosed clinically and confirmed during this survey, "general pathology" (chronic myeloid leukemia, fever of unknown origin, cirrhosis of the liver, etc.)

Exclusion criteria.

The study excluded patients: with severe heart failure (III—IV FC classification NYCHA), end-stage renal and liver failure, cancer, central nervous system, etc.

Testing protocol with load. Isometric test while the patient is lying, an ECG-DM is recorded in the initial state (2-fold to 30 seconds), then the physical is performed with an isometric compression (subject compresses dynamometer with an effort 30% of maximum for 30 seconds, with ECG-DM recording. After the load is carried out, again ECG-DM is recorded for 30 seconds, 1 and 3 minutes at rest. The second option was testing with physical exercise, 20 squats: with electrodes attached to the patient, an initial record is taken, followed by three other ones directly after the test, recorded DM. In addition to all these, vital signs such as blood pressure and pulse are assessed before and after the test. Persons over 65 years were excluded from this procedure.

Method of examination of patients. Dispersion Mapping method.

The device "Cardio-visor Heart-view" works with 4 conventional electrodes imposed by the classical scheme of 3 standard registrations of limb leads. 30 seconds is the measuring time of one procedure. ECG signal is recorded from six standard limb leads: I, II, III, a-VL, a-VF, a-VR, in order to record the low-amplitude electro-signal variations from one cardiac cycle to another, which is the core subject of analysis used in dispersion mapping. The main purpose of the device "Cardio-visor Heart-view" is to analyze the random low-amplitude vibrations of the electro cardiac signal from cycle to cycle — ECG-Dispersion Mapping, followed by calculation and visualization of three-dimensional electromagnetic radiation impact on the parameters of the dispersion amplitude of the standard ECG signal from the extremities (4 electrodes). Thus, the method is based on the information and topological model of small oscillations of the ECG. Amplitude of these oscillations (the dispersion fluctuations) is only 3—5% of the amplitude of wave R. The term corresponds to a common definition used in Cardiology — the difference between the highest and lowest values of the varying magnitude.

The amplitude of the oscillations is very small and their quantitative analysis cannot be analyzed using the standard (dipole) model of surface potentials, so a qualitatively new electro-dynamic model is used. Dispersion characteristics in the "CardioVisor" are calculated by 9 deviation groups (groups G1-G9 analyze). The dispersion, reflecting the severity and location of electrophysiological disturbances in the myocardium of the atria and ventricles, in the phase of de-and re-polarization.

The total value of this area (mV × ms) for all groups of the dispersion variance, in fact, the severity of these abnormalities is estimated by an integrated indicator, which received the name of the index of micro-alternations "Myocardium" (IMM in%). "Myocardium" changes range in a diapason from 0% to 100% and is reflected on a display screen, as a relative measure of the deviation from the norm. "Myocardium" 0% corresponds to the total absence of any significant deviations, meaning, status of dispersion lines within normal range. According to the Russian Federation, in the absence of clinically significant changes "Myocardium "IMM" has a value of 0—15%, the higher the value of indicator, the greater the deviation from the norm.

Additionally, heart rate variability "Rhythm", is analyzed which in this unit describes a simplified dynamic integral component of heart rate variability, methodologically based on the calculation of the total activity of regulatory systems of the heart rate assessed by Bayckee, PM indicator index "Rhythm", Mo (Mode) relationship between duration RR-max/RR-med and duration RR-min/RR-med.). Indicator index of "Rhythm" is defined as (in%). In Russia for defining indicator "Rhythm" (in%), the following values are used: < 15% — normal, 15—50% — a slight deviation, 51—80% borderline or deviation of the mean > 80% — marked deviation from the norm. That is, if the person is healthy, and the sympathetic and parasympathetic effects on the rhythm are optimally balanced, then indicator "Rhythm" is stable in the range of 0% to 20%. But, in the presence of autonomic dysfunction this index has a value of over 20%.

In addition to the integrated "Myocardium" and "Rhythm" Heart-view device provides automated tabular presentation of the analysis of T-wave alternant in three measuring points: t-Start, t-max, t-end.

Calculation of study results and statistical analysis. The data was processed using the statistical software package Microsoft Excel, Statistica 6.0 for Windows. The results are presented as the mean value of «+» standard deviations of ($M + \sigma$). To determine the significance of differences between the studies obtained from different groups of patient's t-test was used for related and unrelated samples. Differences were considered significant at $p < 0.05$.

The results obtained

One of the main objectives of our study was to investigate the threshold characteristics of the norm of integral "Myocardium "IMM", among selected groups in Sudan. Even in Russia, there are different views on the value of the threshold, and there are some characteristic features peculiar to African Americans even with ECG 12. According to the data obtained by most Russian researchers, a normal value of IMM, should not exceed 15%, and the values attributed to borderline range are from 16 to 20%. However, quite a number of authors consider values from 24—27% as a borderline separating the norm and pathology. Table 1: shows the performance of DM in different age groups, and in a selected range of IMM values among selected population in Sudan. Persons aged 31—40 years comprised the most.

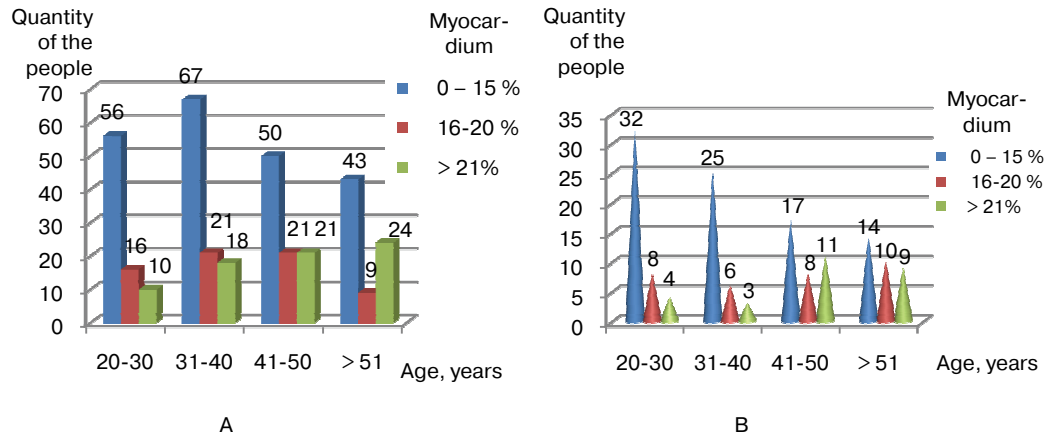

Fig. 1. A: Frequency of registration of selected index "Myocardium" in a selected range of IMM values among study group in Sudan (n = 362). **B:** Registration of diapason of index "Myocardium" in a group of healthy persons in Sudan (n = 147)

The data clearly observed age-related changes of the integral "Myocardium": reduction of the percentage of normal and pathological conditions. "Myocardium" less than 15% showed no heart disease and was observed in 88 (60%) of the patients. Borderline "Myocardium" (from 15% to 20%) was observed in 32 (22%) of the patients and the value of IMM over 21% were observed in 27 (18%). Thus, marked changes of "Myocardium", reflecting the integral characteristic disorders of electrophysiological properties of the myocardium has been identified in almost every 5th surveyed in a group of healthy individuals

Correlation of IMM changes in a group of healthy individuals (n = 147) in Sudan, in comparison with the same level in the Russian Federation for four age. Non-significant trend may be noted here: young individuals (under 40 yrs) had normal IMM values (n = 78,53%), people aged 41—50 years (n = 36) were mostly at borderline IMM (24%), and the elderly had the most prevalent pathological indicators (22%). Analysis of dynamics of IMM changes in the presented sample of healthy individuals, showed an increase in the average values with age. The index "Myocardium" IMM" in the Sudanese group significantly increased with age and was highest (16,4 ± 1,0%) in the group over 51 years. However, the average value of IMM in the healthy Sudanese group over (41 years) amounted to 15,5 ± 0,5%, in the Russian group — 14.4 ± 0.4% ($p < 0.05$).

Assessing the results of screening the Sudanese group, noteworthy, the increase in the average values of the "Rhythm" in alignment with those of the Russian patients in all age groups. A significant increase in dispersion variance G4 and G5 was noted in age group 40—60 years (36,3 ± 5,4 and 30,6 ± 7,7 mkV × ms respectively). Revealed a high percentage of indicators that point to a depolarization disorder of the left atrium (21% for men and 33.4% for women) and right atrium (35% and 38% respectively) (G1, G2) atrial fibrillation as well as for the indicator that points to the start of non-synchronous depolarization (G9) (35% for men and 38% for women).

As shown from the above date, the highest value of dispersion characteristics is observed in the older groups (over 40 years) compared with younger ones in both repre-

sentative groups (the Russian Federation and the Sudan). A significant increase in dispersion variance G2 is noted in both groups (Sudanese and Russian), ages 20—40 years (20,5 ± 4,9 and 11,5 ± 3,8 mV × ms) respectively.

Table 1

Indicators of T-wave alternant in groups of healthy individuals at three points t: t-start, t-max, t-ending (Russia and Sudan)

Group		T-start (mkV)	T-max (mkV)	T-end (mkV)
20—40 yrs	RF (n = 48)	4,2 ± 0,8	6,4 ± 2,1	5,0 ± 1,8
	SUDAN (n = 78)	6,3 ± 0,5*	10,0 ± 1,5*	7,0 ± 1,4
41—60 yrs	RF (n = 46)	7,1 ± 2,4	9,8 ± 2,4	8,5 ± 2,7
	SUDAN (n = 69)	8,7 ± 2,0	13,9 ± 1,8*	10,1 ± 2,4

* ($p < 0.05$) — Significant difference in comparison with the group of 20—40 years.

From the analysis of the above data of the Sudanese sample, there is a significant increase in T wave alternant at the beginning and the maximum point (8,7 ± 2,0 and 13,9 ± 1,8 mkV) and a tendency to increase at tend (10,1 ± 2 4 mkV) in the age group (41—60 yrs). In the group of 20—40 years, these figures were 6,3 ± 0,5; 10,0 ± 1,5 and 7,0 ± 1S, 4 mV, respectively (Table 1).

Closest reproducibility & repeatability with the use of software "CardioVisor Heart-view in the screening process in Sudan.

We analyzed the reproducibility of device by examining 55 healthy subjects (28 men and 27 women) aged 20 to 60 years (mean age 44,3 ± 0,6 years) without any medical history, physical, electrocardiographic indications of heart disease and other organs. In the analysis of the data revealed there was no significant difference between the results of digital data in three consecutive measurements, indicating good reproducibility of the results and method. The index value of IMM "Myocardium" in the first measurement was slightly higher in men (14,0 ± 1,2%), compared to women (13,9 ± 9 ± 0,9%) in the first and subsequent measurements. In addition, it is noteworthy to mention that out the 53 healthy subjects studied, 7 (12%) of identified cases had the first or second of 3 consecutive measurements of index IMM "Myocardium" exceeded the value of 15%. 5 patients (5%) had the value of the IMM indicator above normal in all three subsequent registrations. The comparative analysis of the average values obtained during the initial visit and after three days in 45 healthy subjects also showed good repeatability of the DM results. In this context, we have used the monitoring mode, in order to refine/confirm the identified changes. However, it requires more time (10—15 minutes)

Using the monitoring regimen during the functional tests. It is important to note that the dynamics of the fluctuations of the index "Myocardium" IMM with continuous/non-stop monitoring for 5 minutes (the duration of each measurement — 40 sec) in the recovery period after exercise/load has identified 3 types of vibrations. In most cases (75%) fluctuations of the absolute values of the index "Myocardium" were within 7—9 units (%) and did not exceed the range of the average value of 15% in healthy individuals. In 22% of cases, vibrations from measurement to measurement (40 sec) were greater/higher — from 10 to 17 units. And in two cases (3%) — variations of the absolute values exceeded 20%.

These data obtained on the dynamics of the average value of dispersion mapping when using load testing, indicate that the method can be used to monitor the initial disorders of the electrophysiological properties of the heart. Evaluation of indicators of these diagnostic tests can be considered as a new methodological approach for the early detection of these disorders, justifying the need for subsequent follow-up and monitoring the effectiveness of therapy.

We assessed the dynamics of DM changes during stress tests. The test was considered positive if the "Myocardium index IMM" increased more than 15% and thus higher than the initial value by 10% in 2 out of 3 consecutive measurements. The results of the test with squatting in those with normal value "myocardium" — less than 15% (n = 88).

IMM was first monitored and further analyzed retrospectively, along with groups of analyzed (G1-9) dispersions, which were consistently recorded and calculated in 30 second interval during monitoring time and according to the registration technology of electrical micro alternations. The highest index of micro-alternations "Myocardium" IMM was identified in groups with liver cirrhosis (35.5 ± 3.1%) and arterial hypertension in combination with post-infarction cardiosclerosis (28.7 ± 0.4%).

Table2

The index of "Myocardium "IMM" and indicator "Rhythm" of the outcome and dynamics after stress test, in the examined control group
(n = 147 Sudan and Russia n = 94)

Group	Data			
	outcome	load	After exercise	
			1st min	5th min
	IMM, % (RF) n = 94			
20—40 yrs (n = 48)	13,6 ± 3,3	20,7 ± 2,3#	15,8 ± 3,0 <	12,7 ± 3,3
40—60 yrs (n = 46)	14,6 ± 3,6*	26,4 ± 3,21 #	17,2 ± 4,5* #	16,2 ± 5,4*
	IMM, % (SUDAN) n = 147			
20—40 yrs (n = 78)	13,4 ± 3,7	23,7 ± 4,3#	18,8 ± 3,0	13,8 ± 3,3
40—60 yrs (n = 69)	13,8 ± 3,6	25,4 ± 4,0* #	19,2 ± 4,5 #	17,2 ± 5,4
	RHYTHM indicator, % (RF)			
20—40 yrs (n = 48)	21,0 ± 6,6	58,9 ± 6,3 #	29,4 ± 7,7	20,3 ± 5,7
40—60 yrs (n = 46)	30,3 ± 5,7*	59,3 ± 4,5* #	28,4 ± 9,4	32,6 ± 8,3
	RHYTHM indicator, % (SUDAN)			
20—40 yrs (n = 78)	36,2 ± 4,5	55,9 ± 6,3 #	77,9 ± 10,7	39,1 ± 10,2
40—60 yrs (n = 69)	49,3 ± 5,4	59,3 ± 4,5	81,0 ± 9,2 #	44,5 ± 8,3

* — (p < 0.05) — significant differences compared with 20 to 40 years old, # — (p < 0.05) — significant differences compared with the outcome.

Dispersion characteristics in groups of healthy individuals in the Russian Federation and the Sudan during the exercise test.

By analyzing the values of IMM and "Rhythm" it is noteworthy to admit the significantly higher value in the age group of 40—60 years, in the outcome of (14,6 ± 3,6%) and the load (IMM 26,4 ± 3,2% and Rhythm 59,2 ± 6,3%, p < 0.05) with a tendency of "Myocardium index IMM" to increase after finishing the stress test and close to the end of the 5th min. (Table 2).

Analysis of the results of the dynamics of changes of the "Myocardium index IMM" in the control group (Sudan) has shown that in the age range of 20 to 40 years, the original values of the index were smaller and significant increase in the immediate recovery period has not been identified. At the same time, in the older age group (40—60 years) immediately after exercise (60 seconds) there was an increase in the index of IMM) to 25,4 ± 8,0% and remained high enough for up to 4—5 minutes. Significance proved ($p < 0.05$)

The dynamics of indicators of T-wave alternant in healthy subjects at three points. According to information received the highest response of the T-wave alternant to the load observed in the older age group, and after the termination of the test, the parameters returned to baseline values. The same group also marked initially high T-start, T-max, T-end (5,2 ± 5,3 mkV, 10,0 ± 6,1 mkV, 10,0 ± 6,1 mkV, respectively). According to the study, values of T-wave alternant (onset/start, peak/max, end) were significantly higher in the age group 40—60 years at the three-points of T-wave parameters. In both groups (RF and Sudan) T-wave alternant values increased significantly with load and were highest in patients of older age group. At the same time the group of 20—40 years at the end of the stress test, T alternant values returned to baseline levels, in contrast to groups (40—60 yrs) where the tendency to an increase retained for 5 minutes after stopping the load testing.

In the analysis of T-wave alternant indicators in the Sudanese group, a significant increase in the age group 40—60 years in 2 points — T-max and T-start was noted. In the group of 20—40 years there was no significant increase in the alternation of the sample, while in the older age group, the increase was significant and persisted for 4—5 minutes after exercise. As observed from the data obtained, there was a significant difference in DM values between age groups of healthy individuals. With increasing age, there was a significant increase in the average values of the IMM and "Rhythm". The highest index of micro-alternations "Myocardium" indicator and "Rhythm" at rest was observed in the oldest age group (40—60 years among Sudanese) and were 14.6 ± 3,6% and 49.3+5.4% respectively. Reliable indicators of the dynamics of dispersion during exercise testing was observed in the older age group of 40—60 years, and carried the highest value of DM with load (tensor test) that remained sufficiently high up to 5 minutes after the end of the test. Also, in these group high micro-alternations T-wave (T-start, T-max, T-end mV) in the outcome, during the tensor/stress and treadmill test was recorded. Deterioration of DM values after load test is not a direct indication of ischemia, and reflects changes of electrophysiological properties of the myocardium, which may be a consequence of both its functional and organic changes.

Shows the percentage distribution of "Myocardium" IMM in the three comparison groups: "normal", "general pathology" and "cardiovascular disease". The largest percentage of the surveyed (69%) among the Normal/Healthy group (RF) had a "Myocardium" index IMM up to 15%. In the similar group (Normal) in Sudan, this percentage was 60%. In the zone of 16—20% IMM is approximately equal to the percentage of "normal", the general and cardiovascular disease (border zone). Cases that fall in this zone require special attention.

Based on the values of IMM indicators, groups "norm" and "pathology" shared a sensitivity and specificity values, 75.6% and 80.3% respectively. Based on the normal threshold of 15%, groups (Normal) and "pathology" had a sensitivity of 81.5%, 6 and specificity of 60.1%. For the record, "Myocardium" with a threshold value of 20%, also had a sensitivity of 82.6% and specificity of 60.5%.

For the first time with this study, a clinical application of DM method was introduced in the screening of the population of the Sudan, to identify and record disorders of the electrophysiological properties of the myocardium and allocate the associated risk factors. A comparative analysis of DM variances, in different characteristic age groups, and possible risk factors was performed. Introducing the method of dispersion mapping in practice, in addition to identifying disorders of the electrophysiological properties of the myocardium, allows the use of additional diagnostic possibilities of the method (in addition to the standard electrocardiogram), by the population in the East African region.

The efficiency of heart screening using innovative Russian technology was proved to be accurate and could be implemented by primary health care facilities in Sudan for the early diagnosis of heart diseases, taking into consideration the likely characteristic ethnic featured of ECG among the people of Africa. Even with these existing features of ECG signal, depending on sex and race, the further spread of this method in Africa is still appropriate and convenient. Perhaps, with further accumulation of facts, this method of technology will be adapted and added to the existing ECG features of the inhabitants of Africa.

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ОЦЕНКА РАСПРОСТРАНЕННОСТИ СЕРДЕЧНО-СОСУДИСТОЙ И ОБЩЕЙ ПАТОЛОГИИ ПРИ СКРИНИНГОВОМ ОБСЛЕДОВАНИИ НАСЕЛЕНИЯ СУДАНА ПО ДАННЫМ ДИСПЕРСИОННОГО КАРТИРОВАНИЯ

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В работе представлен анализ микрофлуктуаций ЭКГ-сигнала при скрининговом обследовании населения Судана. Анализ проведен у 362 лиц, на базе результатов определены пороги разграничения, разделяющие «норму» и «патологию» для ключевого интегрального показателя микрофлуктуаций всего кардиоцикла «Myocardium», который составил 17%. Зона пограничных значений — с «возможной патологией» — определена как величина индекса микроальтернаций от 18% до 21%, что указывало на необходимость в специальных клинических и инструментальных обследованиях для исключения патологии. Для увеличения чувствительности метода использовались простые пробы с нагрузкой. Проведенное сопоставление с пороговыми значениями показателей микроальтернации у лиц в Российской Федерации выявило определенные различия, что целесообразно учитывать при анализе. Использование новой технологии может оказать значительную помощь в диагностике поражения миокарда при проведении скрининговых обследований.

Ключевые слова: эффективность скрининга, электрокардиографический метод отображение дисперсии.