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STATISTICAL MODEL OF THE PATIENT DIAGNOSIS BASED ON PARAMETERS OF HIS GDV-GRAMS

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ABSTRACT

A statistical model is presented, based on GDV parameters of the patient, which allows diagnosing the patient disease with a certain probability. To construct the model, with- and without-filter GDV-grams were studied from 177 patients with known diseases. All patients were classified into 6 groups according to their actual diagnoses:

- Group “Normal” (persons with relatively good health)
- Group “Diseases of blood circulation”
- Group “Diseases of endocrine system”
- Group “Diseases of digestive apparatus”
- Group “Diseases of musculoskeletal system”
- Group “Other diseases,” comprising diseases different from listed above.

As the result of processing GDV-grams in the program *GDV Scientific Laboratory*, the average (over all fingers) values of following GDV parameters were obtained:

- Image area
- Coefficient of the image form (measure of the GDV-gram symmetry)
- Average radius of isoline
- Isoline radius deviation from its average value
- Isoline length
- Entropy along the isoline (measure of the image disorder)
- Average intensity
- Number of image fragments
- Fractality along the isoline (measure of the image complexity)
- Fractality deviation from its average value

The same parameters but within 4 sectors of finger image were also calculated, including sectors 1 (-45°, 45°), 2 (45°, 135°), 3 (135°, 225°), and 4 (225°, 315°). This was done to statistically test the hypothesis that various finger sectors could be related to different features of the organism.

The statistical discriminant analysis of the GDV parameters from the patients was performed in the package *Statistica 6.0*, and specific combinations of the parameters from the first sector were found which allow to classify the patients into groups almost coinciding with the actual groups related to their diagnoses. Namely, the classification of the patients by using the model based on the GDV parameters from the first sector has coincided with the actual classification with the accuracy of 75−85%. In other words, taking an arbitrary patient from the groups of known diseases and analyzing only his GDV parameters in the first sector, we can predict his group with the probability of 75−85%.

The constructed statistical model was verified on new 94 patients having the same diseases. No information from these patients was used during the model formation; therefore, the model run on the new patients was a necessary independent test. The classification of the new patients by using the model coincided with the actual classification with the accuracy of 80%. This result can be regarded as good, and it raises the statistical significance of the model.

Using the results of the study, we may conclude that most information about the diseases listed in the beginning is stored in the finger sector (-45°, 45°).

INFLUENCE OF THE HYDROGEN PEROXIDE TREATMENT PROCEDURE ON THE GDV-PARAMETERS OF PATIENTS

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ANNOTATION

The hardware-based research techniques which provide not only authentically evaluated design parameters, but also reliable visual phenomena capable of becoming diagnostically independent, are of great value.

The GDV method (registration of the stimulated electron emission amplified by the gas discharge) is an example of such a technology. Besides, the GDV method allows the indirect estimation of the energy store level of the molecular operational level of the structural-protein complexes. This hypothesis was suggested by K.G. Korotkov and co-authors in 2004 [1].

During the conduction of more than 1500 in-clinic monitoring investigations by use of the GDV method of patients with various chronic pathologies we observed distinctive visual phenomena of the GDV-grams' images of patients who received the ultrasonic hydrogen peroxide inhalations [2].

The hydrogen peroxide is one of the natural organism's metabolites that enable the normal operation of the energy processes [3].

The patented method of treatment and prevention of the immunodeficiency (and therefore energy deficiency) organism's states is the inhalation (aerosol) therapy of the aqueous solution of the medicine. The 0.01-1.5% hydrogen peroxide is used for the medicine, and the aerosol is produced by an ultrasonic inhalator in the vaporization mode at the rate of no more than 0.5 ml per minute. Patients received the inhalation therapy in weekly courses of 5-30 minutes procedures during 1-6 months.

At the beginning of the procedures the hydrogen peroxide concentration was set to the most comfortable level for the patient and was increased by 0.01% after each course up to the maximal endurable dose.

It seems that the long-term application of such an innovative method as the GDV as a monitoring technique for the observation of a given group of patients according to a developed routine gives the researcher an opportunity to summarize the obtained phenomena of the optical images and attach diagnostic value to some of them. It should be noted that the diagnostics may apply to both the pathology state on the nosologic units' level (being attached to the topical discoveries in the image of the "diagram") and the general functional state of the organism. (The diagnostics was based on the sector map of K.G. Korotkov's fingers and the diagrams created on the basis of the map).

The main discovered features were the following:

1. The image area visibly increased in the BEO-grams taken with filter, the integral area indices reached or exceeded their maximal values.
2. The energy deficient local zones disappeared or decreased during the registration without filter.
3. The area characteristics of the images were equalized in both registration modes.
4. The asymmetry of the images that was present before the introduction of the hydrogen peroxide was reduced, mainly in the registration mode without filter.
5. The diagram image was approaching a regular circle.

Later in this report we will demonstrate that the observed visual phenomena are confirmed by the methods of the statistical analysis.

Application of the algorithms of the statistical analysis showed that certain parameters of the GDV-grams of patients change significantly after a peroxide treatment procedure. The analysis was performed on two groups of patients: with endocrine diseases and with musculoskeletal diseases. We used the following indices as the GDV-parameters: the all-fingers-averaged characteristics of the GDV-grams taken both with and without filter and the corresponding mean-square deviations from the average values. In accordance with the system approach conception the GDV-parameters of both groups behave in the same way when the patients are treated with the procedures, notwithstanding the difference of diseases. This applies to the GDV-grams taken without filter. At the same time, the GDV-grams taken with filter behave differently in the two groups thus providing information on the specific diseases. The statistical analysis

performed on a sampling of patients of a satisfying diversity and number will enable the completion of a representative map of the GDV-parameters' reaction on the application of the hydrogen peroxide. Comparing the individual profile of the generalized patient's reaction on the treatment with this map may be used while estimating the effectiveness of the procedure.

THE OBJECTIVES AND METHODS OF THE RESEARCH

The investigated data included 16 GDV-measurements without filter and 15 GDV-measurements with filter taken before and after the treatment in the endocrine-diseases group, and 10 similar measurements taken with and without filter in the musculoskeletal-diseases group. An example of the GDV-grams of a patient is shown in fig. 1.

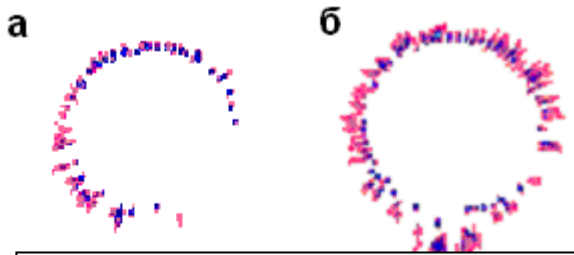

Fig. 1. The GDV-grams of the 2L-finger (fore finger of left hand) of a patient from the endocrine-diseases group taken without filter: (a) before treatment, (б) after treatment.

The GDV-grams were digitally processed and the following image characteristics were chosen as the GDV-parameters for investigation:

- Average (for all fingers) values of the following 10 parameters: glow area, form coefficient, average isoline radius, mean-square deviation (MSD) of the isoline radius from the finger average value, isoline length, entropy along the isoline, average intensity, number of fragments, fractality along the isoline, MSD of the fractality from the finger average value;
- MSD of the values of these parameters for individual fingers from the averages on all the fingers.

Our objective was to estimate the degree of influence of the hydrogen peroxide treatment procedure on the values of the listed GDV-parameters. These parameters are the averaged characteristics of all the fingers; therefore, we studied the influence of the procedure on the general "integral" state of the organism. For that purpose we studied the difference between two independent samplings:

- the sampling of the GDV-parameters' measurements (with and without filter) taken before the procedure and
- the sampling of the measurements (of the same parameters and patients) taken after the procedure.

We used the following nonparametric tests for the dependent samplings as the criteria of the statistical discrepancy of the two groups: the sign test and the Wilcoxon test. These tests allow the determination of the *p*-level of the statistical significance of the difference between the samplings. During the research we considered the difference significant if $p < 0.05$. The advantage of the above-mentioned tests is that they can be correctly applied without the a priori normalcy of distribution of the parameters of the sampling. The tests are realized in the GDV Scientific Laboratory program.

RESULTS

Table 1 presents the results of the investigation of the endocrine-diseases group; the measurements were taken without filter. The table shows only those GDV-parameters that changed after the procedure on a statistically significant level. Second column shows the percentage of patients whose corresponding GDV-parameter's value increased after the procedure. The difference of the values of the parameter before and after the procedure is considered statistically significant if this percentage is either close to 0 (the procedure results in the decrease of the parameter) or close to 100 (the procedure results in the increase of the parameter). For some parameters one test indicated their significant difference in the "before the procedure" and "after the procedure" samplings ($p < 0.05$), while the other test indicated no significant difference ($p > 0.05$). Such parameters are set off in italics. It should be noted that the Wilcoxon test is considered more sensitive and therefore more significant than the sign test due to the fact that the sign criterion considers only the sign of the difference of the parameter value in the two samplings while the Wilcoxon criterion considers the relative value of the difference as well.

Table 1. The GDV-parameters that demonstrated significant difference in the "before the procedure" and "after the procedure" dependent samplings and were measured in the endocrine-diseases group without filter.

GDV-parameter	v < V, %	*p*-level (sign test)	*p*-level (Wilcoxon test)
Area	94	0.001	0.001
Average radius	75	*0.080*	0.004
Radius std	13	0.006	0.001

Isoline length	69	*0.211*	0.015
Entropy	88	0.006	0.001
Number of fragments	13	0.006	0.001
Intensity std	31	*0.211*	0.034

Similar results (though in different form) for other samplings are shown in the summary table (table 2) which is discussed later. Fig. 2 shows examples of the distribution of two parameters mentioned in table 1 in the "before the procedure" and "after the procedure" samplings. One can see that the distributions are significantly displaced relative to each other.

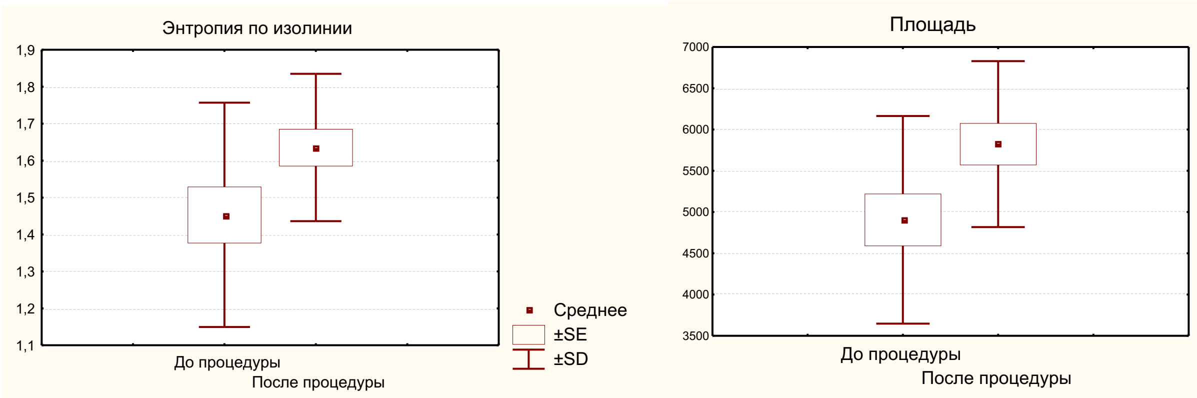

Fig. 2. Range diagrams for the Area and Entropy parameters along the isoline in the endocrine-diseases group measured without filter before and after the treatment procedure. A rectangular region corresponds to the limits of the parameter values which are calculated by adding ± the standard error (SE) to the mean value. The intervals are calculated by adding ± the standard deviation (SD) to the mean value.

Fig. 3 displays the changing of the Glow Area parameter (all-fingers average value) for all patients from the musculoskeletal-diseases group during the treatment procedure. One can see that for 90% of the patients the value of the parameter increases. For most patients there is a margin of increase, i.e. though the average value increases it falls into the mean-square error interval.

Table 2 displays the summary chart of the reaction on the treatment procedure summarizing the effects of the procedure on all GDV-parameters in both groups of patients and in both registration modes (with and without filter). "MSE" notation stands for the mean-square error on all the fingers. The radius MSE1 and fractality MSE1 parameters are the averaged (on all fingers) mean-square errors of the radius along the isoline and the fractality along the isoline, where the errors themselves refer to individual fingers. "MSE2" notation stands for the mean-square error of these parameters through all the fingers. The "+" sign signifies that both the sign and the Wilcoxon tests indicate statistically significant change of the corresponding parameter in the corresponding sampling during the treatment procedure, whereas the "≈" sign means that only one of the tests produced reliable p-level. The "↑" sign means the increase of the parameter during the treatment procedure, while the "↓" sign – the decrease. The cells of the table containing identical or similar information for both groups are marked grey. For example, the Area parameter (measured without filter) is sensitive to the procedure and increases both for the patients with endocrine disorders and the patients with musculoskeletal diseases.

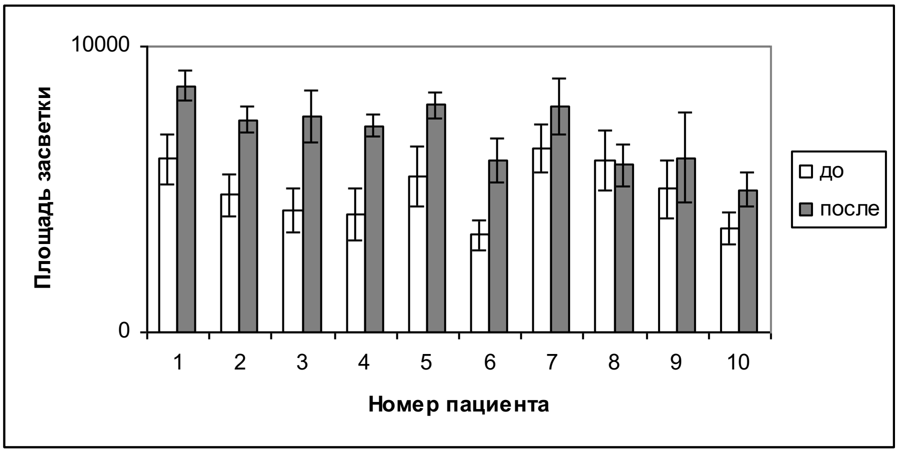

Fig. 3. The Average Glow Area parameter values in the musculoskeletal-diseases group before and after the treatment procedure. The intervals on the diagram columns show the limits of the mean-square deviation (on 10 fingers) from the average value.

On the basis of table 2 we can conclude that most of the parameters of the GDV-grams taken without filter that proved sensitive to the treatment procedure in one group of patients are procedure-sensitive in the other group as well, and the nature of their reaction on the procedure (increase or decrease) is the same for both groups. However, there are exceptions to this rule: the Average Intensity and the Fractality MSE1 parameters change in the musculoskeletal-diseases group and remain unchanged in the endocrine-diseases group. At the same time only one of the procedure-sensitive parameters of the GDV-grams taken with filter behaves uniformly for both groups. Therefore, we may draw the following conclusion: the changes without filter correspond to the treatment reaction mechanisms that are common for different diseases, whereas the measurements taken with filter hold disease-specific information.

Table 2. Summary chart of the reaction on the treatment procedure (see annotation in the text).

Parameters	Sensitivity to the procedure in all the samplings			
	Endocrine system (without filter)	Musculoskeletal system (without filter)	Endocrine system (with filter)	Musculoskeletal system (with filter)
Area	+ , ↑	+ , ↑		+ , ↑
Form coefficient				
Average radius	≈ , ↑	+ , ↑		
Radius MSE1	+ , ↓	+ , ↓		
Isoline length	≈ , ↑	+ , ↑		
Entropy	+ , ↑	+ , ↑		≈ , ↓
Average intensity		+ , ↓		
Number of fragments	+ , ↓	+ , ↓		+ , ↑
Fractality				
Fractality MSE1		+ , ↓		
Area MSE				
Form coefficient MSE				
Average radius MSE2				
MSE2 of the radius MSE1				
Isoline length MSE				
Entropy MSE			+ , ↑	
Average intensity MSE	≈ , ↓	+ , ↓		≈ , ↓
Number of fragments MSE				
Fractality MSE2				
MSE2 of the fractality MSE1			+ , ↑	≈ , ↑

Fig. 4 shows an example of the graphic representation of the individual profile of the generalized reaction to the treatment procedure of one of the patients from the musculoskeletal-diseases group (the measurements were taken without filter). The figure indicates the extent of the increase or decrease during the treatment course of the values of the parameters that are defined by table 2 as procedure-sensitive. Similar diagrams of the statistically significant parameters of the GDV-grams taken with filter can be plotted for the patients from the endocrine-diseases group.

After completing the chart of the table 2 for the representative sampling of patients one may use individual diagrams similar to the diagram of fig. 4 for the control of the procedure effectiveness for each new patient. The evaluation of the effectiveness degree is based on two factors. First, one should make sure that all the parameters on the individual diagram behave (increase or decrease) accordingly to the chart. Secondly, the degree of change of each parameter must be close to the average change in the investigated representative sampling. If one or both conditions are seriously violated the effectiveness of the procedure for the given patient is undecided and must be verified by independent methods.

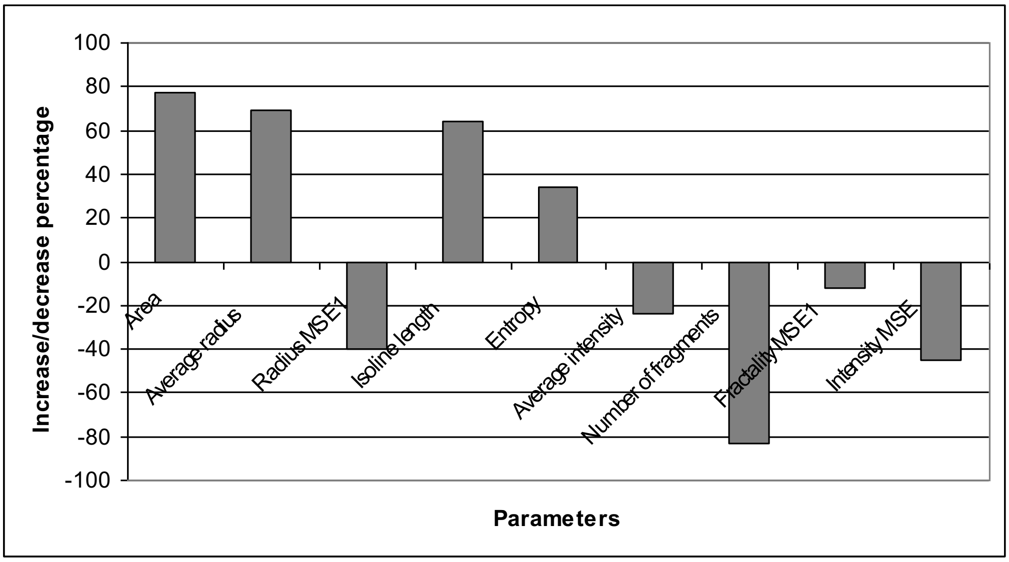

Fig. 4. Individual profile of the generalized reaction to the treatment procedure of the patient №6 from the musculoskeletal-diseases group of statistically significant parameters (measurements without filter). The percentage of the decrease of the parameter's value during the procedure is shown as negative for better clearness.

SUMMARY

We have shown by means of the statistical analysis that the hydrogen peroxide treatment significantly influences the GDV-grams parameters. If we compare the results for two groups of patients (with endocrine and musculoskeletal diseases) we can conclude that the GDV-grams taken without filter change under the influence of the procedures according to the mechanisms that are common for different diseases, whereas the GDV-grams taken with filter change in a special for every disease way. The individual profiles of the reaction to the procedure of a patient of statistically significant GDV-parameters (see fig. 4) may help to control the individual peculiarities of the influence of the treatment on the patient.

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