Elena V. Aleksandrova,Tatiana Margarita N. Kovelkova
Peter V.Strychkov,Ekaterina G. Yakovleva
Konstantin G. Korotkov

Electrophotonic Analysis of Arterial Hypertension

Abstract

Objectives: To study potentials of Electrophotonic Imaging (EPI – previous name Gas Discharge Visualization, GDV) analysis for detecting patients with arterial hypertension of different degree of severity in the course of population screening.

Design: To assess dependence of the most qualitative patient grouping on one of the recognized arterial hypertension (AH) classifications, discriminative functions for detecting patients with different degrees and stages of AH as well as the risk of cardio-vascular complications were calculated. Dependence of discriminative functions on patients' gender was studied. The model of logistic regression for detecting patients with different degrees of arterial hypertension was built. 603 patients, aged from 18 to 83, 265 males and 338 females participated in the study were classified into groups according to degree and stage of arterial hypertension and possible risk of cardio-vascular complications in the nearest 10 years. A set of EPI parameters were analyzed.

Results: The study resulted in calculation of discriminative functions for detecting patients with various degrees, stages of arterial hypertension and risk of cardio-vascular complications. The number of diagnostic parameters increased in accordance with the degree of AH manifestations from 8 to 22, and specificity and sensitivity of the obtained functions made up from 70% to 80%. Classification of patients according to gender increased diagnostic accuracy by 5-9%.

Conclusions: Reliable differences between the control group (healthy patients) and groups with various degrees and stages of AH were calculated with sufficiently high accuracy, which allowed including Electrophotonic Imaging technique into the population screening.
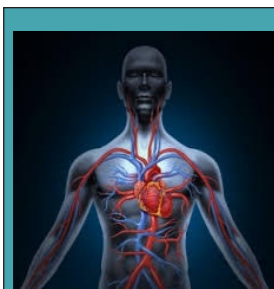
Introduction

Arterial hypertension (AH) is the most common chronic disease in the world and one of the most serious medico-social problems. 30% of adult population of industrial countries present with elevated degree of arterial pressure and only 12-15% of population having stable arterial hypertension. The disease is a common cause of life-endangering acute heart (myocardial infarction) and brain (cerebral stroke) diseases including people of the working age. About 50% of all fatal cases from cardio-vascular diseases fall on arterial hypertension. It is the underlying cause of numerous chronic diseases of the heart, brain, kidneys, eyes and other so-called target organs.

Even today, when doctors have sufficient number of potent antihypertensive at their disposal average life span of the patients with arterial hypertension is not high. Arterial pressure often elevates among adolescents, the disease dramatically getting younger along with most cardiovascular diseases. Hypertension and atherosclerosis are turning into important cause of premature death[1].

There is no doubt that prophylaxis and treatment of arterial hypertension are most effective at its early stages and not at the chronic stage with organic changes. It is disappointing that in many cases the onset of the disease stays unseen as early rises in arterial pressure (AP) are not always associated with subjective symptoms which makes arterial hypertension a disease difficult to diagnose at the early stages. So the early diagnostics of arterial hypertension and a special program of its further development prevention present an important scientific and practical problem[1]. The focus today is on methods allowing detecting early changes characteristic for arterial hypertension. Public health service needs highly sensitive non-invasive screening tests for AH.

One of the major current theories on the etiology of hypertension still remains neurogenic theory[1,2]. As psyco-emotional strain is mainly realized through intense production and liberation of catecholamines, another concept – of raising the tone of sympathetic nervous system as key mechanism of AH development is believed to be significant as well. Indeed, findings of cardio-intervalography prove higher tone of sympathetic nervous system in most hypertensive patients. The authors of EPI technique, on the basis of conducted investigations, believe that BIO-grams reflect the activity of vegetative nervous system (V.N.S.), the balance of its sympathetic and parasympathetic divisions[3,4]. That allows to suggest that EPI images (BIO-grams) evaluation is likely to detect patients with arterial hypertension.

Thus, the objective of the given study was evaluation of EPI potential for detecting patients with different degrees of severity of arterial hypertension in the course of population screening.

Several classifications of arterial hypertension are accepted in medicine. To date, according to UHO recommendations arterial hypertension is classified into three degrees (depending on the degree of AP elevation) and three stages (depending on the involvement of target organs). There are also four categories of arterial hypertension depending on the likelihood of cardio-vascular complications in the nearest 10 years. The complications are related to the presence of the risk-factors, involvement of target organs and/or concomitant (associated) diseases[2].

The study was aimed at:

1. Calculating discriminative functions to detect patients with different degrees and stages of arterial hypertension as well as the risk of cardio-vascular complications; assessing dependence of the most qualitative patient grouping on one of the recognized AH classifications.

2. Assessing the influence of patients gender on calculation discriminative functions.

3. Building the model of logistic regression to detect patients with different degrees of AH severity.

Materials and methods

603 patients aged from 18 to 83, 265 males and 338 females served as participants. All were divided into groups according to AH degree and stage and degree of cardio-vascular complications risk in the nearest 10 years. Groups were divided as follows:

Control group –136 people (47 men and 89 women) and experimental group– 467 people (218 men and 249 women).

Experimental group was in its turn divided in different ways: According to the degree of AH: AH1 of the 1st degree – 92 persons (38 men and 54 women); AH2 of the 2nd degree – 185 people (89 men and 96 women); AH3 of the 3d degree – 190 peopl(91 men and 99 women).

According to the AH stage: AH1 of the 1st stage – 103 people (40 men and 63 women); AH2 of the 2nd stage – 283 people (130 men and 153 women); AH3 of the 3d stage – 81 persons (48 men and 33 women).

According to the likely risk of cardio-vascular complications: low risk (risk 1) – 56 people (24 men and 32 women); moderate risk (risk 2) – 88 people (33 men and 55 women); high risk (risk 3) – 114 people (51 men and 63 women); extremely high risk (risk 4) – 209 people (110 men and 99 women).

A promising method already utilized in sixty-two countries to great success is bioelectrography, based on the Kirlian effect. This effect occurs when an object is placed on a glass plate and stimulated with current; a visible glow occurs, the gas discharge. With EPI bioelectrography cameras, the Kirlian effect is quantifiable and reproducible for scientific research purposes. Images captured (BIO-grams) of all ten fingers on each human subject provide detailed information on the person's psycho-somatic and physiological state[3]. The EPI camera systems and their accompanying software are currently the most effective and reliable instruments in the field of bioelectrography[4-7]. Electro-diagnostic techniques such as Electro-encephalogram and Electro-cardiogram are widely used in medical practices worldwide[6]. EPI applications in other areas are being developed as well[8-13].

Through investigating the fluorescent fingertip images, which dynamically change with emotional and health states, one can identify areas of congestion or health in the whole system. Each generated fingertip photograph is analyzed by sector division, according to acupuncture meridians. Dr. Peter Mandel, in Germany[14], and Dr. Voll, over many decades, have developed this intricate and well-defined method of seeing into the entire body through the fingertips. EPI technique researchers created a diagnostic table based on years of their own clinical field-testing, the sector basis of which differs slightly from that of Dr Mandel[15].

The parameters of the image generated from photographing the finger surface under electrical stimulation creates a neurovascular reaction of the skin, influenced by the nervous-humoral status of all organs and systems. Due to this, the images captured on the EPI register an ever-changing range of state[16]. In addition, most healthy people's EPI readings vary only 8-10% over many years of measurements, indicating a high level of precision in this technique. A specialized software complex registers these readings into parameters which elucidate the person's state

of wellbeing at that time[17]. Commercially available EPI instruments (www.ktispb.ru and www.Bio-Well.com) was used in this study.

In addition to the EPI technique for measuring stress levels in these studies, blood pressure, pulse and interference electromyogram were also taken. For all tests done with the volunteers, they were provided a relaxing environment and clear, simple instructions. Blood pressure readings are consistently used to evaluate the effectiveness of medicines and stress reduction methods[18].

In the course of the study the following BIO-gram parameters were analyzed: image area, normalized area, intensity, spectrum width, brightness and fractality. According to these parameters we analyzed images of all 10 fingers as a whole as well as of separate sectors selected in accordance with Korotkov's Diagnostic Table[4]: cerebral cortex, cerebral vessels, the right and left heart, vascular system, coronary vessels, hypophysis, hypothalamus, epiphysis, thyroid, suprarenals, kidneys, the nervous system. Organs and systems of organs which were involved in the onset and progress of arterial hypertension were under consideration.

All data were processed with the "GDV-Processor" program to calculate above mentioned parameters; discriminative functions were calculated with the help of step by step discriminative analysis in «SPSS Statistics 17.0» and «Statistica 6.0» programs.

While using different diagnostic methods, one should know how reliable it is, taking into account its specificity and sensitivity for practical evaluation of different health problems. Specificity implies the share of healthy people found healthy in the course of diagnostics from the total number of healthy.

Sensitivity implies the share of ill patients found ill in the course of diagnostics from the total number of ill patients.

Results and discussion

AH degree	specificity	sensitivity
AH1	67,6 %	62,0%
AH2	68,4%	66,5%
AH3	72,8%	77,9%

Table 1. Grouping according to degree of AH. Results for all patients

The first stage of the work included step by step discriminative analysis including the control group and each of the three groups of arterial hypertension (according to degree of severity) separately. Results are presented in Table 1. The given figures are the result of cross-testing. The latter implies that each test is classified according to functions obtained in all test but the particular one.

As an example we present discriminative function between the control group and the group of the 1st degree of AH severity. Eight parameters were included into the obtained discriminative function, among them were spectrum width of the images of the right thumb, sector of the head (cortex and vessels), suprarenals, thyroid and kidneys. Discriminative function for the control group and diagnosed AH1 group looks as follows:

$$D=0.017*X_1+5.538*X_2-0.476*X_3+0.426*X_4+0.001*X_5-1.720*X_6+4.171*X_7+4.595*X_8-8.979$$

If X_1, X_2 etc are substituted in the course of the screening by values of measured parameters for the particular person, the tested patient either with 67.6% accuracy is being referred to the group of healthy, or with 62.0 % accuracy having the 1st degree of arterial hypertension and should undergo an additional testing.

From stage to stage of arterial hypertension the number of diagnostic parameters increases from 8 up to 19, which is understandable as it coincides which the degree of involvement of target-organs. All group proved to have the following sectors in common: cerebral cortex, thyroid and kidneys and starting with Group 2 (diagnosed AH2 of the 2nd degree) – the heart sector. Specificity and sensitivity increased along with higher degree of arterial hypertension.

It is known that EPI parameters are dependent of the patient's gender and arterial hypertension takes a different course in males and females[5-8]. Discriminative functions were calculated for all three degrees of arterial hypertension for males and females separately (Table 2).

Common diagnostic parameters were found for all groups, they included sectors of the cerebral cortex, vascular system, heart, thyroid and kidneys. Specificity and sensitivity of the functions obtained in groups divided on the basis of patients' gender were 5-9 % higher than for the mixed group.

The number of diagnostic parameters used and percentage of difference for females with AH1 and AH2 were found higher than that for males. Men are known to have a tendency for higher arterial pressure against women of reproductive age. Differences on AP between men and women disappear after women's menopause or ovarioectomy. AH incidence is lower in women below 60 and higher over 60 against men of similar age.

AH degree	Females		Males	
	Specificity	Sensitivity	Specificity	Sensitivity
AH1	76,4%	77,8%	80,9%	73,7%
AH2	74,2%	81,3%	63,8%	70,8%
AH3	75,3%	74,7%	78,7%	80,2%

Table 2. Grouping according to AH degree. Results for males and females.

The next stage of the investigation was comparison of data obtained for patients of the control group and groups with different stages of arterial hypertension.

Specificity and sensitivity values of calculated discriminative functions increased from the first stage of arterial hypertension to the third. Increase in specificity from stage to stage amounted to 67-80 %, and sensitivity to 70-77%. The number of diagnostic parameters increased from stage 1 to stage 3 from 7 to 22. For all stages sectors of the cerebral cortex, heart, suprarenals and thyroid were involved in calculation.

Discriminative functions were also calculated for men and women separately (Table 4).

For this classification mean percentage of correct placements for men exceeded the one for women by 6-8%. It is likely to be associated with specific involvement of target organs for men and women.

Arterial hypertension is one of the main risk factors of

AH stage	Specificity	Sensitivity
Ahs1	66,9 %	70,9%
Ahs2	67,6%	73,5%
AHs3	80,1%	76,5%

Table 3. Grouping according to AH stages. Results for the whole group

AH stage	females		males	
	Specificity	Sensitivity	Specificity	Sensitivity
Ahs1	80,9%	64,1%	80,9%	79,5%
Ahs2	68,1%	81,3%	75,3%	75,8%
AHs3	72,3%	67,3%	83,1%	84,4%

Table 4. Grouping according to AH stages. Results for males and females.

cardiovascular diseases in women. Though the level of arterial pressure for women of the pre-menopause period is lower then for men of the corresponding age, AH incidence for elderly women is higher.

To sum it up, the course of arterial hypertension for women of the post-menopause period has the following characteristics:

- the disease is frequently manifested in pre-menopause period (from the onset of initial climacteric symptoms to one year after the least menstruation);

- higher sensitivity to table salt;
- low-renin forms of arterial hypertension;
- narrower diameter of the aorta;
- characteristic rise in systolic arterial pressure;

the concentric type.
- more frequent complications.

Elevated arterial pressure and higher incidence of arterial hypertension in post-menopause are believed to result from other factors as well e.g. increase in the volume of circulating blood, higher body mass and higher non adrenalin level in the blood.

Discriminative functions were calculated to detect patients with different risk of cardio-vascular complications after arterial hypertension. Specificity and sensitivity of calculated functions amounted to 64 – 73.5% and 62.2 – 76% respectively which correlates with values for the groups classified on the basis of AH degree of severity. The number of diagnostic parameters increased depending on the risk group. Sectors reflecting the heart and kidneys were

Risk of cardio-vascular complications	Specificity	Sensitivity
Risk 1	73,5 %	62,5%
Risk 2	69,9%	72,7%
Risk 3	64,0%	64,0%
Risk 4	69,9%	76,1%

Table 5. Grouping according to the risk of cardio-vascular complications. Results for the mixed

Risk of cardio-vascular complications	females		males	
	Specificity	Sensitivity	Specificity	Sensitivity
Risk 1	82,0%	75,0%	76,6%	58,3%
Risk 2	78,7%	74,5%	70,2%	66,7%
Risk 3	74,2%	77,8%	74,5%	78,4%
Risk 4	76,4%	75,8%	68,1%	72,7%

Table 6. Grouping according to the risk of cardio-vascular complications. Results for males and females.

- high rate of heart contractions;
- menopause associated with increase in cardiovascular response induced by stress and rise in arterial pressure registered during 24-hour monitoring of arterial pressure;
- more frequent involvement of target organs;
- more frequent hypertrophy of the left ventricle mostly of

found as the most common for all groups (Tables 5,6).

Feasibility of detecting patients with different AH degrees was tested with the help of logistic regression. Specificity and sensitivity were found close in values to those obtained by discriminative analysis but values of specificity

AH degree	specificity	sensitivity
AH1	79,4 %	70,6%
AH2	68,3%	61,0%
AH3	58,1%	83,7%

Table 7. Grouping according to AH degrees. Results calculated by logistic regression

calculated by logistic regression were somewhat lower than those calculated by discriminative analysis which determined our choice of the latter in our investigations (Table 7).

Our findings correlate well with those obtained earlier by other investigators with the help of neuron network method[15] as well as during comparison of the diagnosis made with the help of EPI and other diagnostic methods widely used in modern medicine[16].

Conclusions

Discriminative functions were calculated to detect patients with various degrees, stages and risk of cardio-vascular complications in case of arterial hypertension. The number of diagnostic parameters increased with higher degree of AH manifestation from 8 to 22 while specificity and sensitivity of calculated functions made up about 70%.

Sectors of cerebral cortex, heart, thyroid, suprarenals and kidneys proved to be the most frequent diagnostic parameters. We believe that patients' grouping was most qualitative under classification according to AH stages, which may be explained by the fact that in grouping according to AH stages both degree of AP elevation and involvement of target organs were taken into account. Classification according to patients' gender increased the accuracy of diagnostics by 5-9% which was due to differences in development and course of arterial hypertension in women and men.
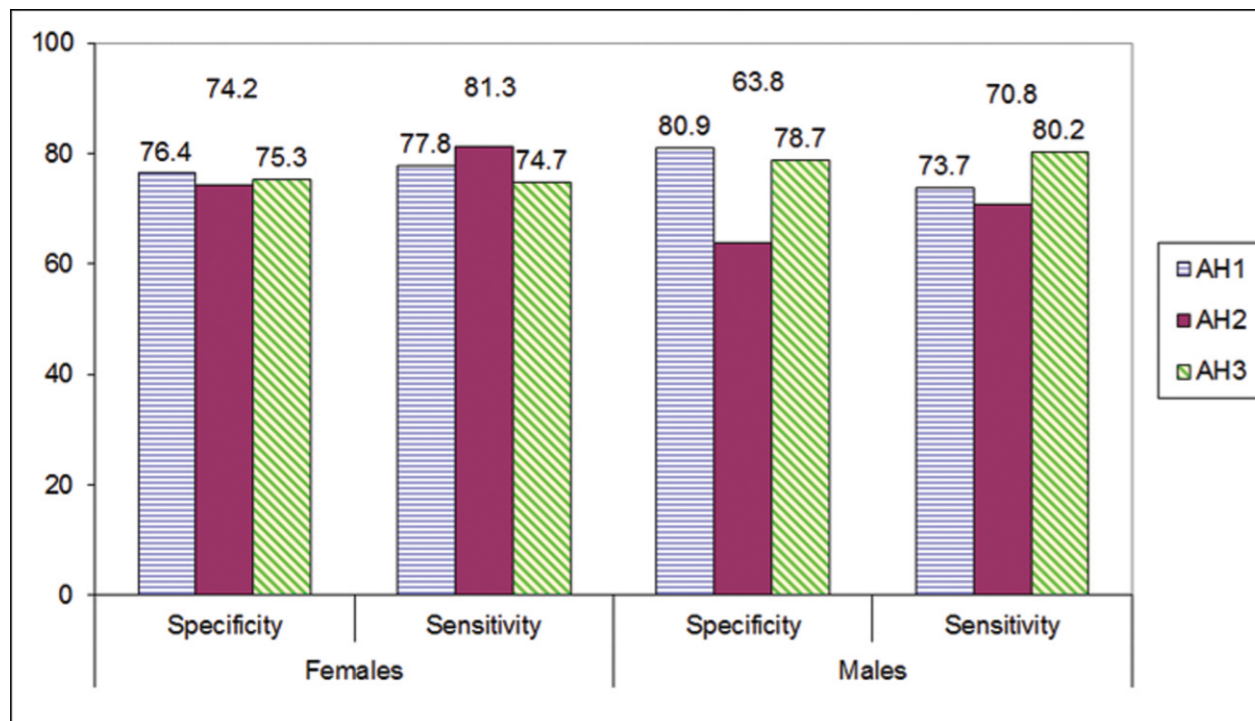

Figure 2. Grouping according to the stage of AH.
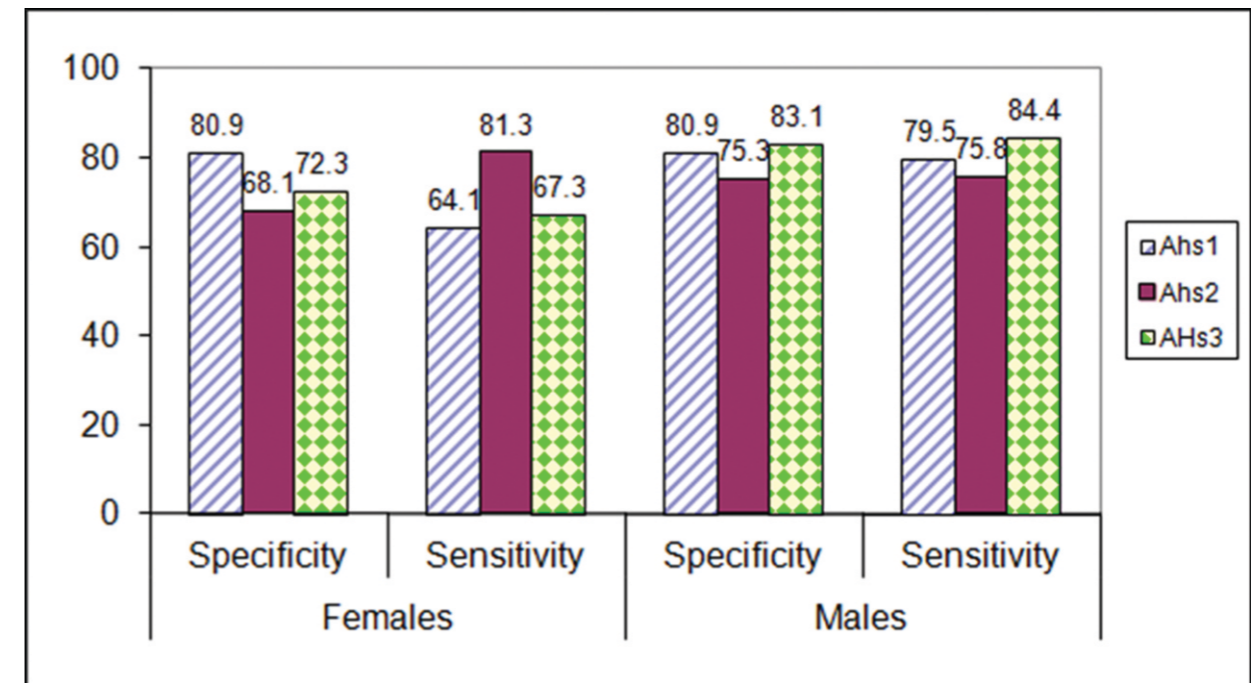

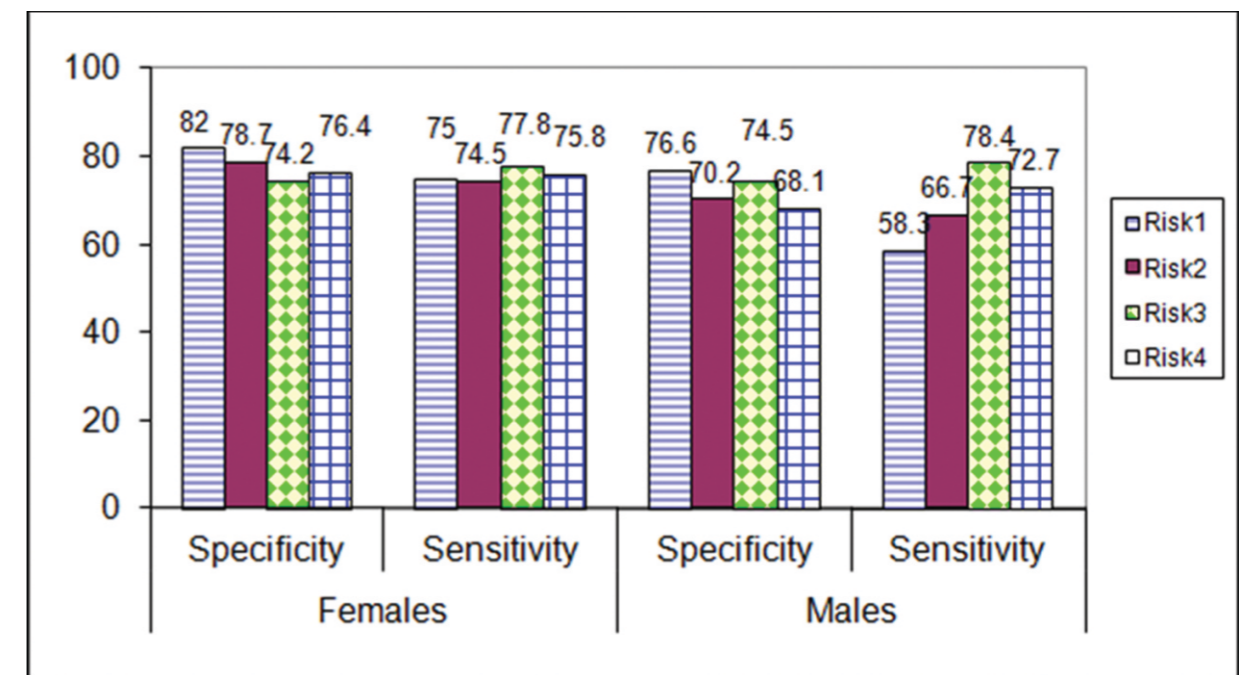Figure 1 Grouping according to degree of AH.

Figure 3 Grouping according to the risk of cardio-vascular complications.

Thus, reliable differences between the control group of healthy patients and groups with various AH degrees and stages were calculated with sufficiently high degree of accuracy, which allows including Electrophotonic Imaging technique into the population screening.

Disclosure Statement

The authors state that no competing financial interests exist.

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Elena V. Aleksandrova[1], Tatiana V. Zarubina1, Margarita N. Kovelkova1, Peter V.Strychkov[2], Ekaterina G. Yakovleva1 M.D., Ph.D., Konstantin G. Korotkov[3] Ph.D.,
1 Pirogov Russian National Research Medical University, Moscow, Russia
2 Institute of Advanced Education, Moscow, Russia;
3 Federal University of Informational Technologies, Mechanics and Optics, Saint Petersburg, Russia.