*DOI: http://dx.doi.org/10.5281/zenodo.14539097*

*УДК 616.12+ 611.1+ 578.8*
*DOI http://dx.doi.org/10.5281/zenodo.14539153*

# CIRCULATING IN THE BLOOD DESQUAMATED ENDOTHELIOCYTES AT THE CARDIOVASCULAR DISEASES. PRELIMINARY COMMUNICATION

***Pavlega H.E, Gozhenko A.I.***
*Ukrainian Scientific Research Institute of Medicine of Transport, Odessa, Ukraine*

# ЦИРКУЛЮЮЧІ В КРОВІ ДЕСКВАМОВАНІ ЕНДОТЕЛІОЦИТИ ПРИ СЕРЦЕВО-СУДИННИХ ЗАХВОРЮВАННЯХ. ПОПЕРЕДНІЙ ЗВ'ЯЗОК

***Павлега Г.Є., Гоженко А.І.***
*Український НДІ медицини транспорту, Одеса, Україна*

**Summary/Резюме**

*Introduction and aim*. We previously found that diabetic angiopathy is accompanied by an increase in the level of desquamated endothelial cells (CECs) circulating in the blood, commensurate with its severity. In this study, we set ourselves the aim of analyzing the level of CECs in patients with cardiovascular pathology and their relationship with the level of blood pressure and routine clinical indicators.

*Material and methods.* The object of clinical observation were patients with stage II hypertension, who were receiving outpatient treatment. Among them, 23 men (62.3 ± 13.2 ys) and 39 women (65.1 ± 10.6 ys). Concomitant ischemic heart disease was diagnosed in 16 men (70 ± 10 %) and 28 women (72 ± 7 %). The main subject of the study was blood pressure and the level of CECs. In addition, routine general blood analysis and determined metabolic parameters were performed.

*Results.* Using the method of cluster analysis, the sample was divided into 4 homogeneous groups, different from each other. It was found that in 18 patients of the first cluster, the youngest in the sample, the minimum level of hypertension for the sample occurs against the background of unchanged CECs levels and other registered parameters, instead, it is accompanied by moderate increased creatininemia and a significantly increased rate of erythrocyte sedimentation and a reduced level of hemoglobin and color index. In 18 patients of the second cluster, moderately elevated levels of terminally and markedly changed CECs were found in combination with minimally expressed signs of hyperchromic anemia. In the third cluster (n = 16), the levels of terminally and markedly changed CECs are significantly increased in combination with a reduced level of urea and LP index against the background of moderate hyperchromic anemia. Finally, in 10 patients of the fourth cluster, the oldest in the sample, with maximally expressed hypertension, it is accompanied by maximally elevated levels of all three types of CECs against the background of moderate hyperchromic anemia.

*Conclusion.* Desquamated plasma endothelial cells can be one of the criteria for the severity of hypertonic disease.

***Keywords:*** *desquamated plasma endothelial cells, stage II hypertension, ischemic heart disease.*

*Введення і ціль.* Раніше нами було встановлено, що діабетична ангіопатія супроводжується підвищенням рівня десквамованих ендотеліальних клітин (ДЕК), цир-

DOI: http://dx.doi.org/10.5281/zenodo.14539097

кулюючих у крові, порівняно з її тяжкістю. У цьому дослідженні ми поставили перед собою це проаналізувати рівень ДЕК у пацієнтів із серцево-судинною патологією та їх зв'язок з рівнем артеріального тиску та рутинними клінічними показниками.

*Матеріал і методи.* Об'єктом клінічного спостереження були пацієнти з гіпертонічною хворобою II стадії, що знаходяться на амбулаторному лікуванні. Серед них 23 чоловіки (62,3±13,2 років) і 39 жінок (65,1±10,6 років). Супутня ішемічна хвороба серця діагностована у 16 ??чоловіків (70±10%) і 28 жінок (72±7%). Основним предметом дослідження являлись артеріальний тиск і рівень ДЕК. Крім того, проводився рутинний загальний аналіз крові і визначали метаболічні показники.

*Результаты.* Методом кластерного аналізу вибірка була розділена на 4 однородні групи, що відрізняються від другої за віком. Встановлено, що у 18 пацієнтів першого класу, самого молодого у виборі, мінімальний для вибору рівень артеріальної гіпертензії виникає на фоні незмінних рівнів ДЕК та інших зареєстрованих показників, замість цього він супроводжується помірно підвищеною креатинінемією та значно підвищеною швидкістю осідання еритроцитів і зниженим рівнем гемоглобіну та квітів. показателя. У 18 пацієнтів другого кластера виявлені помірно підвищені рівні термінально і виражено змінені ДЕК в поєднанні з мінімально вираженими ознаками гіперхромної анемії. У третьому кластері (n=16) рівень термінально і виражено змінених ДЕК достовірно підвищений у поєднанні зі зниженим рівнем сечовини та індексу ЛП на фоні помірної гіперхромної анемії. Наконец, у 10 пацієнтів четвертого кластера, самого старшого у виборі, при максимально вираженій гіпертензії вона супроводжується максимально підвищеними рівнями всіх трьох типів ДЕК на фоні помірної гіперхромної анемії.

*Заключення.* Десквамовані плазматичні ендотеліальні клітини можуть бути одним із критеріїв тяжкості гіпертонічної хвороби.



***Ключові слова:*** *десквамовані плазматичні ендотеліальні клітини, гіпертензія II стадії, ішемічна хвороба серця.*

## Introduction

We previously found that diabetic angiopathy is accompanied by an increase in the level of desquamated endothelial cells (CECs) circulating in the blood, commensurate with its severity[1-7]. In this study, we set ourselves the goal of analyzing the level of CECs in patients with cardiovascular pathology and their relationship with the level of blood pressure and routine clinical indicators.

## Material and methods

### *Ethics approval*

Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. During realization of tests from all parent of participants the informed consent is got and used all measures for providing of anonymity of participants. For all authors any conflict of interests is absent.

### *Participants*

The object of clinical observation were patients with stage II hypertension, who were receiving outpatient treatment at the Center for Primary Health Care No.3 (Odessa) in 2019. Among them, 23 men (62.3 ± 13.2 ys) and 39 women (65.1 ± 10.6 ys). Concomitant ischemic heart disease was diagnosed in 16 men (70 ± 10 %) and 28 women (72 ± 7 %).

### *Study design and procedure*

The main subject of the study was blood pressure and the level of desquamated endothelial cells circulating in the plasma (CECs).

CECs were determined by the method of J. Hladovek.[8] Platelet-rich plasma (PRP) was prepared by centrifugation (1000 g for

DOI: http://dx.doi.org/10.5281/zenodo.14539097

10 min). After the addition of 0.2 ml of Adenosine-Diphosphate to 1 ml of PRP the mixture was shaken mechanically for 10 min. Another centrifugation (1000 g for 10 min) served to remove platelet aggregates. The supernatant was centrifuged at 3000 g for 15 min and the very scanty sediment was carefully suspended in 0.1 ml of 0.9 % NaC1 by stirring with a glass rod. From the suspension two platforms of a Goryaev's chamber were filled and cells were counted by the method of phase contrast microscopy using a Micromed XS-3320 binocular microscope, Plan 10 Ph/0.25 lens (10 fold) and eyepieces WF 16X. CECs are well characterized by their size and shape and cannot be mistaken for anything else [8-9]. The cells represent polygonal objects approximately 30-50 мм in diameter. They often show folded or roiled margins suggesting an extreme thinnes of less than 1 мм. Considering the ratio between the number of cells in platforms and the volume of the Goriaev's chamber, the volume of the resulting suspension and the volume of blood plasma, we calculate the number of CECs in 1 ml of blood plasma [10-16].

In addition, routine general blood analysis were performed and determined metabolic parameters in serum: triglycerides (by a certain meta-periodate method); total cholesterol (by a direct method after the classic reaction by Zlatkis-Zack) and content of him in composition of б-lipoproteins (HDLP) (by the enzyme method after precipitation of notб-lipoproteins); pre-в-lipoproteins (VLDLP) (expected by the level of triglycerides); в-lipoproteins (LDLP) (expected by a difference between a total cholesterol and cholesterol in composition б-and pre-в-lipoproteins); creatinine (by Jaffe's color reaction by Popper's method); urea (urease method by reaction with phenolhypochlorite); glucose (glucose-oxidase method).

The analysis carried out according to instructions[10] with the use of analyzers "Reflotron" (BRD) and "Pointe-180" (USA) and corresponding sets of reagents.

*Statistical analysis*

Statistical processing was performed using a software package "Microsoft Excell" and "Statistica 6.4 StatSoft Inc" (Tulsa, OK, USA).

**Results and discussion**

For the purpose of correct comparison, registered variables (V) expressed as Z-scores calculated by formula:

$Z = (V/N — 1)/Cv$, where

N is Mean of Normal (reference) Variable, Cv is Coefficient its variation.

Reference values of routine variables, taking into account sex and age, are borrowed from the handbook [11]. The norms of CECs are taken from the database of our laboratory.

It turned out (Fig. 1) that most variables fluctuate in a wide range, which indicates the heterogeneity of the sample.

Therefore, at the next stage, the sample was divided into groups homogeneous in terms of CECs and blood pressure parameters. Use of Cluster analysis makes possible the simultaneous consideration of all the signs. Considering the totality of characteristics of persons undertaken in their relationship and conditionality of some of these (derivatives) other (main determinants) allows as to make a natural classification that reflects the nature of things, their essence. It is believed that knowledge of the essence of the object is to identify those of its quality properties that actually define the object, distinguish it from other. Clustering cohort of persons was realized by iterative k-means method. In this method, the object belongs to the class Euclidean distance to which is minimal. The main principle of the structural approach to the allocation of uniform groups consists in the fact that objects of same class are close but different classes are distant. In other words, a cluster (the image) is an accumulation of points in n-dimensional geometric space in which average distance between points is less than the average distance from the data points to the rest points.

We have identified 4 clusters.

Members of Cluster No 1 (Contains 18 cases) and Distances from Respective Clus-

DOI: http://dx.doi.org/10.5281/zenodo.14539097

ter Center
C1 C2 C3 C4 C5 C7 C8 C9 C13 C16 C19 C28 C32 C35 C36 C38 C40 C60
Distance
61, 130, 137, 115, 41, 125, 172, 59, 86, 152, 43, 75, 79, 91, 60, 125, 94, 147
Members of Cluster No 2 (Contains 18 cases) and Distances from Respective Cluster Center
C6 C10 C11 C12 C14 C17 C18 C20 C21 C23 C24 C25 C30 C37 C39 C41 C43 C50
Distance
149, 158, 195, 91, 214, 147, 94, 21, 101, 162, 111, 168, 129, 63, 113, 59, 104, 130
Members of Cluster No 3 (Contains 16 cases) and Distances from Respective Cluster Center
C15 C27 C33 C34 C42 C45 C46 C49 C52 C53 C54 C55 C56 C57 C59 C62
Distance
133, 103, 89, 109, 108, 58, 55, 93, 123, 15, 99, 196, 88, 79, 134, 64
Members of Cluster No 4 (Contains 10 cases) and Distances from Respective Cluster Center
C22 C26 C29 C31 C44 C47 C48 C51 C58 C61
Distance
184, 173, 178, 121, 131, 113, 180, 129, 102, 28



| Cluster Number | Euclidean Distances between Clusters (End_BP.STA) Distances below diagonal Squared distances above diagonal | | | |
|---|---|---|---|---|
| | No. 1 | No. 2 | No. 3 | No. 4 |
| No. 1 | 0 | 36020 | 131120 | 274792 |
| No. 2 | 190 | 0 | 30955 | 113213 |
| No. 3 | 362 | 176 | 0 | 27761 |
| No. 4 | 524 | 336 | 167 | 0 |

In the next stage carried Analysis of Variance and ranking variables for coefficient

$$з^2 = Sb^2/ (Sb^2+Sw^2),$$

$$R = з,$$

$$F = [Sb^2 (n-k)]/[Sw^2 (k-1)],$$ where

$Sb^2$ is Between Variance; $Sw^2$ is Within Variance; n is number of persons (62); k is number of groups-clusters (4).

It was found (Table 1) that the most characteristic feature of clusters is the level of Markedly altered circulating endotheliocytes (ACEC). Terminally ACEC and systolic BP make much smaller but significant contributions to the distribution of the sample into clusters. Instead, the contribution of Initially ACEC is meager and diastolic BP is insignificant.

Clustering, by definition, minimized the variability of variables. It was found that in the patients of the first cluster, the youngest in the sample, hypertension occurs against the background of unchanged CECs levels and other registered parameters, instead, it is accompanied by moderate increased creatininemia and a significantly increased rate of erythrocyte sedimentation and a reduced level of hemoglobin and color index. In the patients of the second cluster, moderately elevated levels of terminally and markedly changed CECs were found in combination with minimally expressed signs of hyperchromic anemia. In the third cluster, the levels of terminally and markedly changed CECs are significantly increased in combination with a reduced level of urea and LP index against the background of moderate hyperchromic anemia. Finally, in patients of the fourth cluster, the oldest in the sample, with maximally expressed hypertension, it is accompanied by maximally elevated levels of all three types of CECs against the background of moderate hyperchromic anemia (Fig. 2).

Further, the registered variables were condensed into 8 patterns (Fig. 3).

In order to identify among the registered parameters, those for which the ACEC&BP clusters differ from each other, a discriminant analysis was performed. The program forward stepwise included in the discriminant model 8 parameters. In addition to CECs and systolic BP by default, the following variables were identified as char-

DOI: http://dx.doi.org/10.5281/zenodo.14539097

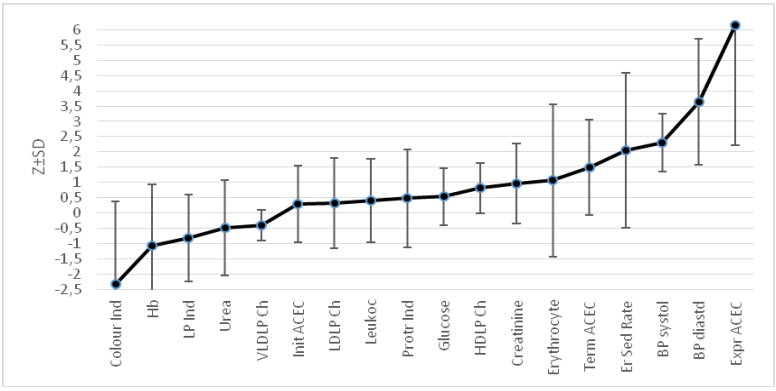


**Fig. 1.** Profile of registered sample parameters as a whole

of the patients of IV cluster reflects combination of maximum for sampling BP and CECs levels as well as age and glycaemia with maximum decrease in LP index. At the opposite pole are localized patients of I cluster, the youngest in the sample, in whom the severity of hypertension is minimal, the levels of markedly and terminally altered CECs are in the lower normal zone, and initially altered CECs as well as glycemia are quite normal, that is, minimal for the sample. Instead, the LP Index is quite normal, that is, the maximum for the sample. The intermediate positions of the members of the other two clusters reflect, as a rule, the intermediate levels of the listed variables.

acteristic: HDLP Cholesterol, Hemoglobin, Erythrocytes Sedimentation Rate, and Trombocytes level. The rest of the variables were left out of the model, but some of them still carry identifying information (Tables 2 ).

Next, the 8-dimensional space of discriminant variables transforms into 3-dimensional space of a canonical roots. For Root 1 r* = 0,968 (Wilks' Л= 0,0297; $Ч^2_{(24)}$ = 193; $p < 10^{-6}$), for Root 2 r* = 0,656 (Wilks' Л = 0,4770; $ч^2_{(14)}$ = 40,7; p = 0,0002), for Root 3 r* = 0,403 (Wilks' Л = 0,838; $Ч^2_{(6)}$ = 9,7; p = 0,136). The first root contains 94,1 % of discriminative opportunities, the second 4,7 %, the third 1,2 % only.

Table 3 presents raw and standardized coefficients for discriminant variables. The calculation of the discriminant root values for each person as the sum of the products of raw coefficients to the individual values of discriminant variables together with the constant enables the visualization of each patient in the information space of the roots (Fig. 4).

Table 4 shows the correlation coefficients of discriminant variables with canonical discriminant roots; the cluster centroids of roots; and Z-scores of the discriminant variables. It also includes variables that carry identifying information but were not included in the discriminant model due to duplication/redundancy of information, such as a child's age almost unmistakably indicating his school class.

The localization along the first root axis in the extreme right (positive) zone (Fig. 4)

Additional demarcation of members of II cluster occurs along the axis of the second root. Their lowest position reflects the maximally increased levels of HDLP Cholesterol and Leukocytes and the minimally decreased levels of urea, erythrocytes, and the color index, i.e., in general, the maximum for the sample. On the other hand, in these patients, the Erythrocytes Sedimentation Rate is increased to the smallest extent, the levels of Thrombocytes and Prothrombine Index are normal, and VLDLP Cholesterol is maximally reduced, that is, these parameters are generally minimal for the sample.

In general, all clusters on the planes of two roots are clearly delineated, which is documented by calculating the Mahalanobis distances (Table 5).

The same discriminant parameters can be used to identify the belonging of one or another person to one or another cluster. This purpose of discriminant analysis is realized with the help of classifying functions (Table 7). These functions are special linear combinations that maximize differences be-

DOI: http://dx.doi.org/10.5281/zenodo.14539097

*Table 1*

**Analysis of Variance**

| Variables | Between SS | Within SS | $\eta^2$ | R | F | signif. p |
|---|---|---|---|---|---|---|
| Markedly ACEC | 24633148 | 1817820 | 0,931 | 0,965 | 262 | $10^{-6}$ |
| Terminally ACEC | 814331 | 1536153 | 0,346 | 0,589 | 10,2 | $10^{-4}$ |
| BP systolic | 2748 | 9916 | 0,217 | 0,466 | 5,36 | 0,003 |
| Initially ACEC | 206824 | 1155111 | 0,152 | 0,390 | 3,46 | 0,022 |
| BP diastolic | 135 | 11712 | 0,011 | 0,107 | 0,222 | 0,881 |

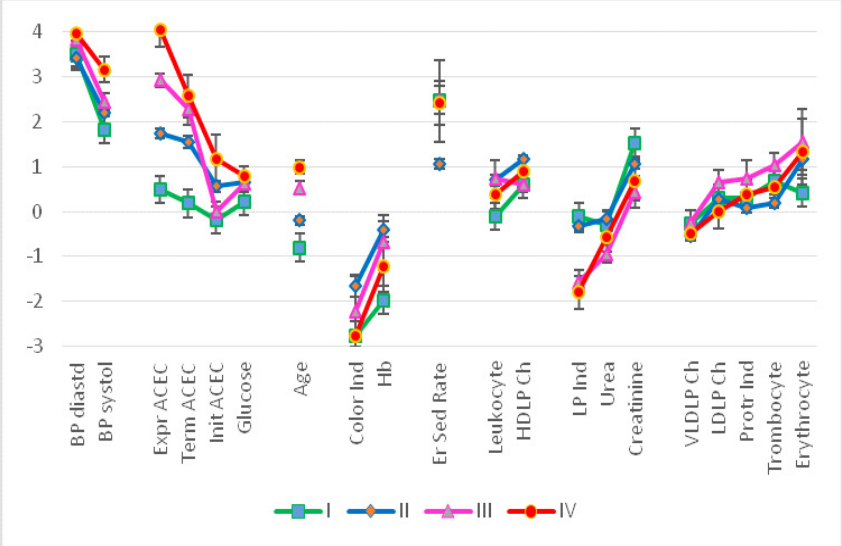


**Fig. 2.** Profiles of registered parameters of CEC&BP cluster members. Y axis: Z ± SE



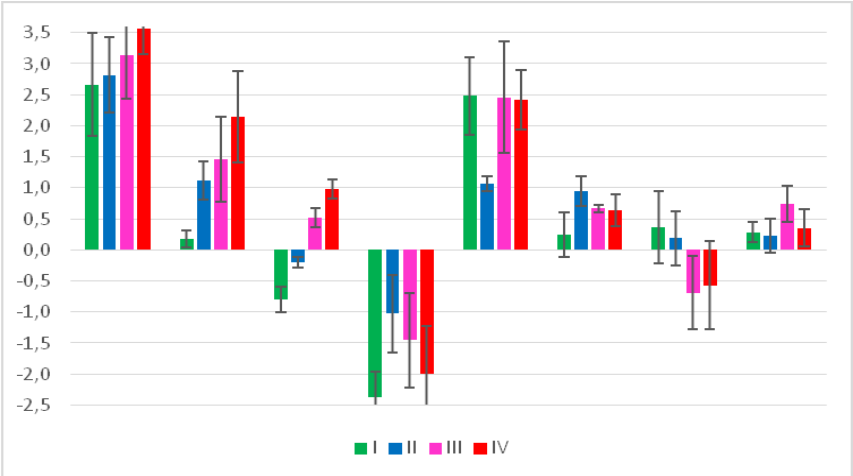


**Fig. 3.** Patterns of registered parameters of CEC&BP cluster members. Y axis: Z ± SE

tween groups and minimize dispersion within groups. An object belongs to a group with the maximum value of a function calculated by summing the products of the values of the variables by the coefficients of the classifying functions plus the constant. In this case, we can retrospectively recognize patients with one mistake only (in II cluster). Overall classification accuracy is 98,4 %.

## Conclusion

Desquamated plasma endothelial cells can be one of the criteria for the severity of hypertonic disease.

## Funding

No funding

## Conflicts of interest

The authors declare no competing in-

DOI: http://dx.doi.org/10.5281/zenodo.14539097

terests.

## Data availability

The datasets used and/or analyzed during the current study are open from the corresponding author on reasonable request.

## Ethics approval

Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. The study protocol was approved by the Ethical Committee of Ukrainian Scientific Research Institute of Medicine of Transport (protocol No 9/15; 05.08.2024). During realization of tests from all participants the informed consent is got and used all measures for providing of anonymity of participants.

*Table 2*

**Summary of Stepwise Analysis for Variables, ranked by criterion Lambda**

| Variables currently in the model | F to enter | p-level | Λ | F-value | p-value |
|---|---|---|---|---|---|
| Markedly altered endotheliocytes, c/mL | 262 | $10^{-6}$ | 0,069 | 262 | $10^{-6}$ |
| Hemoglobin, g/L | 3,3 | 0,028 | 0,059 | 59 | $10^{-6}$ |
| HDLP Cholesterol, mM/L | 2,1 | 0,116 | 0,053 | 36 | $10^{-6}$ |
| Erythrocytes Sedimentation Rate, mm/h | 2,6 | 0,059 | 0,046 | 27 | $10^{-6}$ |
| Terminally altered endotheliocytes, c/mL | 2,2 | 0,096 | 0,041 | 22 | $10^{-6}$ |
| Trombocytes, $10^9$/L | 2,7 | 0,052 | 0,036 | 19 | $10^{-6}$ |
| Initially altered endotheliocytes, c/mL | 1,8 | 0,163 | 0,032 | 16 | $10^{-6}$ |
| Blood Pressure Systolic, mmHg | 1,5 | 0,231 | 0,030 | 15 | $10^{-6}$ |

*Table 3*

**Standardized and Raw Coefficients and Constants for Variables**

| Coefficients | Standardized | | | Raw | | |
|---|---|---|---|---|---|---|
| Variables currently in the model | Root 1 | Root 2 | Root 3 | Root 1 | Root 2 | Root 3 |
| Markedly altered endotheliocytes 0, c/mL | 0,969 | 0,136 | 0,050 | 0,0055 | 0,0008 | 0,0003 |
| Terminally altered endotheliocytes 0, c/mL | 0,227 | - 0,591 | 0,127 | 0,0014 | - 0,0036 | 0,0008 |
| Blood Pressure Systolic 0, mmHg | 0,227 | 0,030 | - 0,491 | 0,0174 | 0,0023 | - 0,0376 |
| Initially altered endotheliocytes 0, c/mL | 0,107 | - 0,321 | - 0,584 | 0,0008 | - 0,0023 | - 0,0041 |
| HDLP Cholesterol 0, mM/L | 0,075 | - 0,725 | - 0,180 | 0,2438 | -2 0,368 | - 0,5895 |
| Hemoglobin 0, g/L | 0,073 | - 0,434 | 0,615 | 0,0057 | - 0,0335 | 0,0475 |
| Erythrocytes Sedimentation Rate 0, mm/h | - 0,033 | 0,842 | - 0,107 | - 0,0047 | 0,1218 | - 0,0154 |
| Trombocytes 0, $10^9$/L | - 0,014 | 0,535 | 0,243 | - 0,0004 | 0,0138 | 0,0063 |
| | | | **Constants** | -13 0,98 | 3 0,078 | - 0,446 |
| | | | **Eigenvalues** | 15 0,06 | 0,756 | 0,194 |
| | | | **Cumulative proportions** | 0 0,941 | 0 0,988 | 1 |

*Table 4*

**Correlations Variables-Canonical Roots, Means of Roots and Z-scores of Variables**

| Variables currently in the model | Correlations Variables-Roots | | | I (18) | II (18) | III (16) | IV (10) |
|---|---|---|---|---|---|---|---|
| **Root 1 (94,1 %)** | **R 1** | **R 2** | **R 3** | **-4.77** | **-0.78** | **+2.54** | **+5.92** |
| Markedly altered endotheliocytes | **0,948** | 0,123 | 0,026 | **+0.49** | **+1.43** | **+2.92** | **+4.03** |
| Terminally altered endotheliocytes | **0,181** | - 0,135 | 0,353 | **+0.18** | **+1.55** | **+2.29** | **+2.52** |
| Blood Pressure Systolic | **0,131** | 0,009 | - 0,305 | **+1.83** | **+2.21** | **+2.44** | **+3.16** |
| Initially altered endotheliocytes | **0,075** | - 0,220 | - 0,544 | **-0.19** | **+0.56** | 0.00 | **+1.18** |
| Blood Pressure Diastolic | | | | **+3.50** | +3.42 | **+3.83** | **+3.97** |
| Glucose | | | | **+0.23** | +0.64 | **+0.63** | **+0.80** |
| Age | | | | **-0.80** | **-0.20** | **+0.52** | **+0.98** |
| LP Index | | | | **-0.11** | **-0.33** | **-1.56** | **-1.80** |
| **Root 2 (4.7 %)** | **R 1** | **R 2** | **R 3** | +0.68 | **-1.30** | +0.49 | +0.34 |
| HDLP Cholesterol | - 0,018 | **- 0,366** | - 0,231 | +0.60 | **+1.18** | +0.60 | +0.90 |
| Hemoglobin | 0,052 | **- 0,350** | 0,573 | -1.97 | **-0.40** | -0.69 | -1.23 |
| Color Index | | | | -2.76 | **-1.65** | -2.22 | -2.77 |
| Urea | | | | -0.31 | **-0.17** | -0.94 | -0.58 |
| Leukocytes | | | | -0.11 | **+0.70** | +0.70 | +0.38 |
| Erythrocytes Sedimentation Rate | 0,002 | **0,312** | - 0,077 | +2.48 | **+1.06** | +2.46 | +2.42 |
| Trombocytes | 0,012 | **0,285** | 0,346 | +0.69 | **+0.19** | +1.03 | +0.53 |
| Protrombine Index | | | | +0.29 | **+0.08** | +0.73 | +0.38 |
| VLDLP Cholesterol | | | | -0.28 | **-0.55** | -0.25 | -0.49 |

DOI: http://dx.doi.org/10.5281/zenodo.14539097

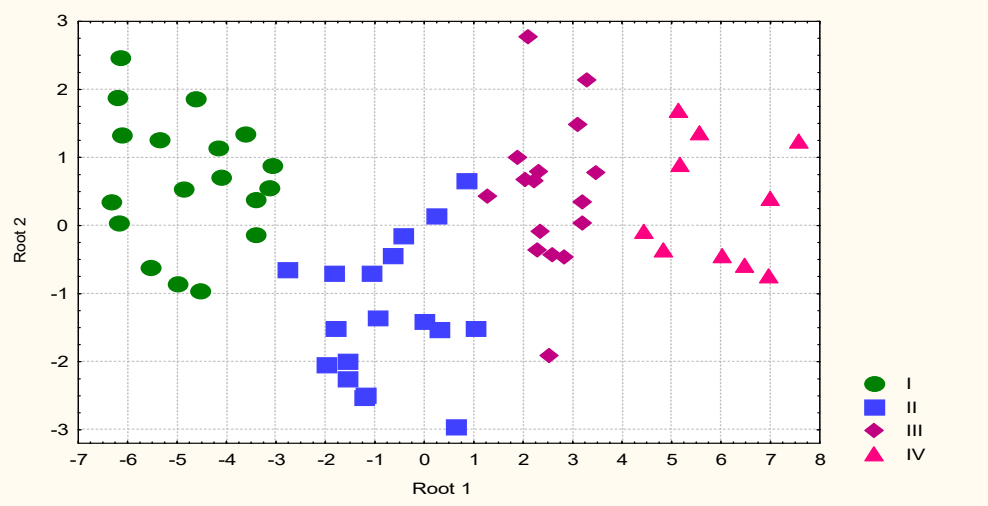


**Fig. 4.** Scattering of individual values of the first and second discriminant roots of patients of different CEC&BP clusters

*Table 5*

**Squared Mahalanobis Distances between Clusters and F-values (df = 8.5); p for all < $10^{-6}$**

| Clusters | I (18) | II (18) | III (16) | IV (10) |
|---|---|---|---|---|
| I (18) | 0 | 21 | 58 | 123 |
| II (18) | 20 | 0 | 16 | 51 |
| III (16) | 51 | 14 | 0 | 14 |
| IV (10) | 79 | 33 | 9 | 0 |

*Table 6*

**Coefficients and Constants for Classification Functions for Clusters**

| Endotheliocytes&Blood Pressure Clusters | I | II | III | IV |
|---|---|---|---|---|
| Variables currently in the model | p = 0,290 | p = 0,290 | p = 0,258 | p = 0,161 |
| Markedly changed endotheliocytes, c/mL | 0,0399 | 0,0603 | 0,0800 | 0,0980 |
| Hemoglobin 0, g/L | 0,6260 | 0,7247 | 0,7115 | 0,6744 |
| HDLP Cholesterol 0, mM/L | 23,66 | 29,10 | 25,34 | 27,29 |
| Erythrocytes Sedimentation Rate 0, mm/h | 0,4861 | 0,2169 | 0,4129 | 0,3978 |
| Terminally changed endotheliocytes 0, c/mL | 0,0069 | 0,0199 | 0,0185 | 0,0227 |
| Trombocytes 0, $10^9$/L | 0,1691 | 0,1402 | 0,1679 | 0,1564 |
| Initial changed endotheliocytes 0, c/mL | 0,0175 | 0,0241 | 0,0200 | 0,0283 |
| Blood Pressure Systolic 0, mmHg | 1,009 | 1,068 | 1,107 | 1,214 |
| **Constants** | -182,8 | -234,0 | -277,7 | -339,6 |



## References

1. Gozhenko AI, Kuznetsova HS, Kuznetsova KS, Kuznetsova OM, Byts TM, Zukow W. Morpho-functional basis of endothelial dysfunction in diabetes mellitus. Journal of Education, Health and Sport. 2017; 7 (6): 516-524. http: // dx.doi.org/10.5281/zenodo.822050.
2. Gozhenko AI, Kuznetsova H S, Kuznetsov SH, Kuznetsova KS, and Byts TM. The number of circulating endotheliocytes in the blood plasma of the patients with diabetes mellitus increases. Pharmacologyonline. 2017; 3: 23-26.
3. Gozhenko Anatoliy, Pavlega Hanna, Badiuk Nataliia, Zukow Walery. Circulating in the blood desquamated endotheliocytes at the cardiovascular diseases. Preliminary communication. Quality in Sport. Online. 20 May

*DOI: http://dx.doi.org/10.5281/zenodo.14539097*

2024. Vol. 19, p. 51571.

4. Ендотеліальна дисфункція в патогенезі ускладнень цукрового діабету. Доповідь I. Ендотеліальна дисфункція: етіологія, патогенез і методи діагностики. Гоженко А. І., Кузнєцова Г. С., Кузнєцова К. С., Биць Т. Н., Сусла О. Б. Ендокрінологія. 2017; 22 (2): 171-81.

   Endothelial dysfunction in the pathogenesis of diabetes complications. Report I. Endothelial dysfunction: etiology, pathogenesis and diagnostic methods. Gozhenko A. I., Kuznetsova G. S., Kuznetsova K. S., Byts T. N., Susla O. B. Endocrinology 2017; 22 (2): 171-81.

5. Ендотеліальна дисфункція в патогенезі ускладнень цукрового діабету. Доповідь II. Ендотеліальна дисфункція в патогенезі ускладнень цукрового діабету I і II типу. Гоженко А. І., Кузнєцова Г. С., Кузнєцова К. С., Биць Т. Н. Ендокрінологія, 2017; 22 (4): 381-9.

   Endothelial dysfunction in the pathogenesis of complications of diabetes mellitus. Report II. Endothelial dysfunction in the pathogenesis of complications of diabetes mellitus type I and II. Gozhenko A. I., Kuznetsova G. S., Kuznetsova K. S., Byts T. N. Endocrinology, 2017; 22 (4): 381-9.

6. Ендотеліальна дисфункція в патогенезі діабетичної хвороби нирок. Гоженко А. І., Кузнєцова Г. С., Кузнєцова К. С., Биць Т. Н. Почки. 2018; 7 (1): 18-24.

   Endothelial dysfunction in the pathogenesis of diabetic kidney disease. Gozhenko A. I., Kuznetsova G. S., Kuznetsova K. S., Byts T. N. Kidneys. 2018; 7 (1): 18-24.

7. Gozhenko AI, Kuznetsova HS, Kuznetsova KS, Byts TM, Gozhenko EA, and Shevchenko NO. Circulating in the blood desquamated endotheliocytes at the diabetic nephropathy. Fiziol Zh. 2018; 64 (2): 34-39. https: //doi.org/10.15407/fz64.02.034.

8. Kuznetsova HS, Kuznetsova KS, Olenovych OA, Gozhenko OA, Kuznetsov SH, and Gozhenko AI. The desquamation of the endothelium due to normalization of glycemia decreases in patients with diabetes mellitus. Pharmacologyonline. 2018; 2: 74-81.

9. Kuznetsova HS, Kuznetsova KS, Byts TM, Bobryk LM, Kuznetsova OM, Gozhenko AI. Mechanisms of regeneration of the endothelium at diabetes mellitus. Endokrynologia. 2018; 23 (4): 384-390. https: //doi.org/10.31793/1680-1466.2018.23-4.384

10. Kuznetsova HS, Gozhenko AI, Kuznetsova KS, Shukhtin VV, Kuznetsova EN, and Kuznetsov SH. Endothelium. Physiology and Pathology: monograph. Odessa: Feniks; 2018: 284.

11. Gozhenko A, Kuznetsova H, Kuznetsova K, Stroi D, Kuznetsov S. Dynamics of Endothelial Desquamation in Patients with Diabetic Kidney Disease. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2019; 18 (8): 16-20. doi: 10.9790/0853-1808061620

12. Hladovec J, Prerovsky I, Stanek V, Fabian J. Circulating Endothelial Cells in Acute Myocardial Infarction and Angina Pectoris. Klin Wochenschr. 1978; 56 (20): 1033-1036.

13. Gao Y, Liu C, Zhang X, Gao J, Yang C. Circulating Endothelial Cells as Potential Markers of Atherosclerosis. Canadian J Neurolog Sci. 2008; 35 (5): 638-642 https: //doi.org/10.1017/S0317167100009446.

14. Goryachkovskiy AM. Clinical Biochemistry. Odessa: Astroprint; 1998: 608.

15. Khmelevskyi YV, Usatenko OK. Basic Biochemical Constants of Humans at Norm and at. Kyïv. Zdorovya; 1987: 160.

16. Характеристики ендотеліальної дисфункції у хворих на цукровий діабет. Кузнєцова Г. С., Кузнєцова К. С., Биць Т. Н., Кузнєцова Е. Н., Демідов С. М., Повєткіна Т. Н., Гоженко А. І. Актуальні проблеми транспортної медицини. 2018; 2 (52): 116-22.

   Characteristics of endothelial dysfunction in patients with diabetes. Kuznetsova G. S., Kuznetsova K. S., Byts T. N., Kuznetsova E. N., Demidov S. M., Povetkina T. N., Gozhenko A. I. Current problems of transport medicine. 2018; 2 (52): 116-22.

*Вперше надійшла до редакції 07.05.2024 р.*
*Рекомендована до друку на засіданні редакційної колегії після рецензування*