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PROGNOSTIC STRATIFICATION OF PATIENTS BY RISK OF DEVELOPMENT OF CARDIOVASCULAR PATHOLOGY

Abstract

Cardiovascular diseases remain one of the leading causes of mortality in the world, which necessitates the improvement of methods of risk assessment and prevention. The aim of this study was to develop a prognostic map of risk factors for cardiovascular diseases, taking into account a wide range of biological, behavioral, social and clinical factors. Based on the analysis of demographic data, lifestyle characteristics, heredity, comorbidity, as well as diagnostic indicators (blood pressure, electrocardiography, cholesterol level), prognostic coefficients for each factor were determined.

The results obtained confirm the significant negative impact of such factors as older age, the presence of chronic diseases (diabetes, thyrotoxicosis, chronic lung diseases), hereditary predisposition, smoking and excessive alcohol consumption. At the same time, regular nutrition, moderate physical activity, a stable psycho-emotional state and systematic medical supervision have a positive protective effect.

Keywords: *cardiovascular diseases, risk factors, prognostic map, prognostic coefficients, primary prevention, risk assessment, risk stratification, behavioral factors, clinical and anamnestic data*

Introduction. Cardiovascular diseases (CVD) remain one of the leading causes of mortality and disability worldwide, including Ukraine, which imposes a significant socio-economic burden on society and the health care system [1, 2]. According to the World Health Organization (WHO), CVD accounts for approximately 31% of all deaths in the world, which amounts to more than 17 million annual deaths [3]. Ukraine also has a high incidence and mortality from heart and vascular diseases, which requires the implementation of effective measures for early diagnosis and prevention [1, 4].

The causes of CVD are multifactorial and include both immutable factors—age, gender, genetic predisposition—and modifiable factors—lifestyle, nutrition, physical activity level, smoking, alcohol, and psychoemotional state [5, 6]. The interaction of these factors complicates the accurate assessment of individual risk and creates challenges for clinical practice.

Today, there is a wide range of models for assessing CVD risk, including well-known tools such as Framingham Risk Score, SCORE, and QRISK, which integrate key risk factors and allow predicting the likelihood of events [7–9]. However, the use of these models has certain limitations, including insufficient adaptation to regional population characteristics and a limited range of factors taken into account [10, 11].

In Ukraine, the issue of developing and implementing local prognostic tools that would take into account the characteristics of the national population and socio-cultural factors is in the focus of researchers [2, 4]. Such approaches contribute to a more accurate risk assessment and increase the effectiveness of preventive and treatment strategies.

Thus, the development of a prognostic map that encompasses biological, behavioral, social, and clinical CVD risk factors is an urgent task for improving primary prevention and reducing the prevalence of cardiovascular disease in Ukraine. The proposed tool can enhance the individualization of medical care and contribute to the optimization of healthcare resources.

Presenting the main material.

The proposed map allows for the quantitative assessment of the individual risk of developing cardiovascular diseases by summing the corresponding coefficients.

The purpose of the article: development and validation of a prognostic map of cardiovascular disease risk factors taking into account biological, social, behavioral and clinical indicators.

Materials and methods: The study material was the data of medical examinations of 500 patients aged 20 to 85 years, who underwent preventive examinations in the city's polyclinics. The sample included individuals of both sexes with varying degrees of risk of developing cardiovascular pathology. The collected information covered demographic characteristics, heredity, concomitant diseases, lifestyle (diet, smoking, alcohol consumption), level of physical activity, psycho-emotional state, as well as blood pressure, electrocardiography and laboratory data.

The study was conducted using retrospective and prospective analysis of clinical data. Correlation and multiple regression analyses were used to assess the impact of each risk factor on the development of cardiovascular diseases. Based on the obtained coefficients, predictive coefficients for each factor were formed.

The patient's individual risk was determined as the sum of the prognostic coefficients of the factors identified in him. For validation of the prognostic map, internal verification using cross-validation and comparison with clinical data was used. Statistical processing of the

results was carried out using the SPSS version 25.0 and R software packages.

Calculation algorithm:

1. Identify all the patient's characteristics (gender, age, behavior, physical activity, etc.). For each characteristic, find the corresponding PC in the prognostic table.

2. Add all the PCs.

3. The obtained value of the individual risk prediction (IPR) is compared with the conditional limits for risk stratification (determined empirically or by ROC analysis).

A very low IPR value indicates an extremely high risk of CVD.

To create a prognostic map of cardiovascular disease risk factors, a comprehensive analysis of clinical, demographic, behavioral, and social characteristics of patients was conducted. Data were obtained from medical examinations of different age groups, taking into account information on heredity, comorbidities, lifestyle, and psycho-emotional state. Each factor was assigned a prognostic coefficient that reflects the degree of its influence on the risk of developing cardiovascular pathology, based on correlation and regression analysis. Negative coefficient values indicate an increased risk, and positive ones indicate a protective effect.

The basis for constructing a prognostic map is a comprehensive analysis of factors that influence the risk of developing CVD.

The main principles of its construction include:

1. Selection and classification of factors: demographic (gender, age), constitutional, behavioral (diet, smoking, alcohol consumption), professional working conditions, psycho-emotional characteristics, hereditary factors, as well as the presence of concomitant diseases are taken into account.

2. Quantitative assessment of impact: Each factor is assigned a predictive coefficient (PC), which reflects the degree of its impact on the risk of developing CVD. Negative PC values indicate an increased risk, and positive ones indicate a protective effect.

3. Validity of the data: the value of the PC is determined based on statistical analysis of data from clinical observations and epidemiological studies.

4. Individual approach: the total sum of the PC according to the patient's factors allows calculating the individual risk of developing cardiovascular diseases.

5. Dynamic assessment: the risk assessment can change depending on changes in risk factors, which makes it possible to monitor the effectiveness of preventive measures.

6. Practical applicability: a prognostic map is a convenient tool for medical professionals, contributing to rational planning of prevention and treatment.

7. Calculation of predictive coefficients.

8. To determine the predictive coefficients of each risk factor, statistical analysis was performed using correlation and multivariate regression modeling. First, univariate analysis was performed to assess the association of each individual factor with the presence of cardiovascular disease. Then, multiple logistic regression analysis was used to clarify the influence of factors and exclude interdependencies.

9. The obtained regression coefficients (β) were interpreted as a measure of the influence of the corresponding factor on the risk of developing pathology. For ease of integration into the prognostic map, the coefficients were normalized and converted into predictive coefficients (PCs), which reflect the degree of increase or decrease in risk.

10. Negative PC values indicate increased risk, and positive PC values indicate a protective effect of the factor. The sum of the PCs of all factors present in a patient was used to quantify individual risk.

11. To verify the reliability of the model, adequacy testing was applied using the coefficient of determination (R^2), as well as an assessment of its predictive ability through ROC curves and sensitivity and specificity indicators.

Table №. 1.

Prognostic map of risk factors for cardiovascular diseases

Group No.	Group of features	Sign №.	Name of the feature	PC
1	Sex	1	males	-4.9
			famales	6.1
2	Age	2	Up to 30 years old	x
		3	30–39 years old	-4.9
		4	40–49 years old	-5.8
		5	50–59 years old	-5.7
		6	60–69 years old	-7.3
		7	70+ years	-122.1
3	Construction type	8	Normostenic	9.7
		9	Asthenic	13.9
		10	Hypersthenic	-12.5
4	Type of behavior	11	Type A (hot-tempered, unrestrained)	-23.9
		12	Type B (calm, phlegmatic)	5.2
5	Features of work	13	Physical	28.4
		14	Mental	-6.7

Group No.	Group of features	Sign №.	Name of the feature	PC
		15	Night shifts	-4.3
		16	Overtime	-43.2
		17	Frequent business trips	-24.2
		18	Contact with chemicals	-42.8
6	Physical activity	19	High	-90.2
		20	Medium	2.3
		21	Low	30.1
7	Nervous and mental stress	22	High	-12.0
		23	Medium	-5.6
		24	Low	1.6
8	Frequent job changes	25	—	-22.3
9	History of closed TBI	26	—	-47.2
10	Family relationships	27	Conflicting	-21.6
		28	Good	13.9
11	Comorbidities	29	Gastrointestinal (GI) disease	-1-111.9
		30	Gallstone disease	-142.5
		31	Urinary system	-116.0
		32	Lungs (CHN)	-116.8
		33	Thyrotoxicosis	-163
		34	Diabetes mellitus	-129
		35	ENT organs	-59.8
		36	Cerebral circulation disorders	-139.3
12	Blood pressure	37	130/80 mm Hg.	17.5
		38	140/90 mm Hg.	-8.9
		39	140–154 mm Hg.	-16.0
		40	≥160/95 mm Hg.	-52.3
13	CVD in relatives	41	Father	-34.2
		42	Have	-26.5
		43	Brother	-12.1
		44	Sister	-8.3
14	Rhythm disturbances in relatives	45	Father	-142.4
		46	Have	-117.4
		47	Brother	-139.0
		48	Sister	-141.2
15	Food	49	Regular	31.8
		50	Irregular	-32.1
16	Smoking	51	Does not smoke	8.1
		52	Up to 10 cigarettes	-11.2
		53	Up to 20 cigarettes	-35.9
		54	Up to 30 cigarettes	-61.2
		55	Up to 40 cigarettes	-97.8
17	Alcohol	56	Does not use	8.4
		57	Moderately	-26.1
		58	Abuses	-142.3
18	Sleep	59	Regular	20.2
		60	Irregular	-41.1
		61	Insomnia	-44.9

Group No.	Group of features	Sign №.	Name of the feature	PC
19	Climax/menopause (women)	62	—	-36.1
20	Hypofunction of the gonads (men)	63	—	-9.1
21	Cholesterol	64	Reduced	11.9
		65	Normal	7.9
		66	Increased	-93.6
22	ECG	67	Normal	5.7
		68	T wave is modified	-18.8
		69	ST segment shifted	-22.2
23	Acute mental trauma	70	—	-31.1
24	Frequent mental trauma	71	—	-36.1
25	Frequent psycho-emotional traumas	72	—	-33.9
26	Atherosclerosis of cerebral vessels	73	—	-13.9
27	Solitude	74	—	-11.8
28	Dispensary supervision	75	Regular	32.6
		76	Irregular	-42.8

The presented prognostic map identifies a number of factors that significantly affect the risk of developing cardiovascular diseases (CVD). Each factor is characterized by a predictive coefficient (PC), which reflects the degree of its influence: negative values indicate an increased risk, positive values indicate a protective effect.

Patient gender is a moderate risk modifier: male gender is associated with a moderate increase in risk (PR = –4.9), while female gender has a protective effect (PR = +6.1). Age shows a progressive increase in risk with aging, in particular the 70+ age category is characterized by a sharply increased risk (PR = –122.1).

Body constitution type affects risk: asthenic (PC = +13.9) and normosthenic (PC = +9.7) types have a protective effect, while hypersthenic type has an increased risk (PC = –12.5).

Impulsive behavioral type A significantly increases the risk (PC = -23.9), in contrast to calm type B (PC = +5.2). Work characteristics also matter: physical work appears to be protective (PC = +28.4), while overtime (PC = -43.2), frequent business trips (PC = -24.2) and contact with chemicals (PC = -42.8) are associated with increased risk.

Excessive physical activity is characterized by a significant risk (PC = –90.2), while low and medium activity have a moderate protective effect (PC +30.1 and +2.3, respectively). High levels of neuropsychiatric stress increase the risk (PC = –12.0).

Concomitant chronic diseases of internal organs have a pronounced negative impact on the risk of CVD: thyrotoxicosis (PC = –163), cerebrovascular accident (PC = –139.3), diabetes mellitus (PC = –129), chronic lung diseases (PC = –116.8) and others - indicate a significant increase in risk.

Blood pressure is a key risk modifier: an increase in blood pressure above 140/90 mm Hg is correlated with an increase in risk (PC from -8.9 to -52.3). Similarly, a family history of cardiovascular disease and cardiac arrhythmias significantly increases the risk, with a family history of arrhythmias having a particularly pronounced negative impact (PC up to -142.4).

Regular eating and sleeping have a significant protective effect (PR +31.8 and +20.2, respectively), while irregular eating, sleep disturbances, and insomnia sharply increase the risk (PR up to -44.9). Quitting smoking and alcohol is a significant protective factor, while smoking (especially more than 30 cigarettes per day) and alcohol abuse are associated with a sharp increase in risk (PR up to -142.3).

Elevated cholesterol levels are associated with a high risk (PR = –93.6). Pathological changes on the electrocardiogram (T wave changes, ST segment displacement) also increase the risk (PRs –18.8 and –22.2, respectively).

Acute and chronic mental trauma, frequent psycho-emotional stress, and social isolation (loneliness) have a noticeable negative impact on the risk of developing CVD (PC approximately from -30 to -40).

Regular outpatient surveillance demonstrates a protective effect (PC = +32.6), which probably reflects improved control and prevention in such patients, in contrast to irregular surveillance (PC = –42.8).

The developed prognostic map allows for a comprehensive assessment of the impact of various factors on the risk of cardiovascular disease. The greatest negative impact is observed in the elderly, with the presence of chronic comorbidities, such as diabetes mellitus and thyrotoxicosis, as well as in patients with hereditary predisposition and bad habits, in particular smoking and excessive alcohol consumption. These results coincide with the data of previous studies, confirming the significance of these factors as the main determinants of risk.

The positive coefficients observed with regular nutrition, moderate physical activity, stable psycho-emotional state and systematic medical control emphasize the role of a healthy lifestyle person of life in the prevention of CVD. It is worth noting that the map helps to take into account the individual characteristics

of patients and can be used to adapt preventive and therapeutic measures. To increase the accuracy of prediction, further research is needed on larger samples with the involvement of additional biomarker methods.

Thus, the implementation of a prognostic map into clinical practice may improve early detection of cardiovascular disease risk and contribute to reducing morbidity through timely modification of risk factors.

Conclusion.

The constructed prognostic map allows for the quantitative assessment of the individual risk of developing cardiovascular diseases based on a combination of demographic, behavioral, clinical, and social factors, which provides the basis for a personalized approach to prevention.

The application of this system in practice makes it possible to identify individuals at high risk at the preclinical stage, which will contribute to early intervention, reduce the frequency of cardiovascular complications, and increase the efficiency of the medical surveillance system.

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