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Predictive Modeling of the Probability of Developing Periodontal Diseases in Patients with Cardiovascular Disease

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Relevance. Currently, the forecast of the development of pathology is an important part of all branches of healthcare. [3,4,5]. However, despite the importance and scientific and practical significance of forecasting in dentistry, at present we have not found information about predictive models of individual risk of developing periodontitis in patients with hypertension.

In these conditions, individual assessment and prediction of the risk of developing periodontitis in patients with cardiovascular failure is relevant. Such studies will serve as the basis for identifying patients at high risk of developing periodontal diseases, grouping them for the purpose of dental monitoring and implementing measures to neutralize the negative consequences of periodontal diseases on the course of cardiovascular failure. The need to solve this problem served as the basis for conducting this study.

The goal is to develop and evaluate the effectiveness of a model for individual prediction of the risk of developing periodontitis in patients with cardiovascular failure.

Materials and methods. The study was conducted at SamSMU clinics. A retrospective-prospective case-control study was conducted. We examined 162 patients with hypertension aged from 36 to 65 years (average age 45.32±0.22 years), admitted for inpatient treatment in the department of maxillofacial surgery. The diagnosis of cardiovascular failure and periodontitis was made according to WHO criteria and recommendations, in in accordance with the International Classification of Diseases, 10th revision. Inclusion criteria were patients who had previously been diagnosed with cardiovascular failure, receiving antihypertensive therapy over the past 6 months with a recorded blood pressure level > 140 90 mm Hg. Art. at the time of the examination. After diagnosis of hypertension, all patients underwent office blood pressure screening as well as a complete dental examination. To identify the degree of hypertension, patients underwent control A/D measurements after the first visit within 3–14 days after the visit. Oral fluid and blood samples were collected. After a complete dental examination, a dental patient's medical record (form 043/y) was filled out for each patient, and data was copied from the inpatient medical record (form 003/y). Taking into account the purpose of the study, patients with hypertension were divided into two groups: the main one - with the presence of periodontitis (patients) and the control group (patients) - and without periodontitis. In accordance with the principles of evidence-based medicine, when compiling the main and control groups, individuals identical in gender and age composition were selected. All patients signed informed consent to participate in the study. The study protocol was reviewed and approved by the

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ethics committee. When determining risk factors, we took into account the multifactorial nature of hypertension and periodontitis and their dependence on a complex of medical and social risk factors and metabolic disorders of the body's most important homeostatic systems. In this regard, medical risk factors and the nature and changes in the lipid profile were studied, with the determination during the research of indicators that have the most significant impact on the course of both pathologies studied. The severity of periodontal damage was assessed using the indices of inflammation and periodontal destruction and oral hygiene (PMA, PI, Muhlemann, OHI-S). The assessment of the prognostic significance of risk factors for the development of periodontal diseases in patients with hypertension was carried out using the Kullback information measure with determination of the Ji (K) value. Considering that the dependent variable, the presence or absence of periodontal disease, can be characterized by only two values from 0 to 1 (periodontitis present/no periodontitis present), the probability of developing periodontitis in patients with arterial hypertension was assessed based on a prognostic model constructed using the binary logical regression method. For statistical processing and analysis of the obtained data, MS Excel 2007, MS Access 2007, Statistica 8.0 and Statgraphics Centurion XVI (Version 16.2.04) programs were used.

Results: Significant but statistically unrelated risk factors were selected as dependent variables. The selection of risk factors was carried out by the "discrete correlation pleiades" method, which takes into account the main feature (pleiad) with the maximum significance of the impact on the risk of periodontitis compared to other indicators of the same type.

That is why the model did not include many parameters that have a significant impact on the severity of the pathology, but arose as a result of the existence of the disease, and do not initiate its development 8.

As a result of the calculations, the following indicators were selected to build a risk model for the development of periodontitis in patients with arterial hypertension: X1 - age; X2 - hereditary history of hypertension; X3 – presence of a bad smoking habit; X4 – stage of hypertension; X5 – presence and number of chronic diseases; X6 – total cholesterol content; X7 – triglyceride level and X8 – atherogenic index (AI).

$$P = \frac{1}{1 + e^{-y}}$$

P - probability of developing generalized periodontia;

e - base of natural logarithms 2.71 and

Y is the result of calculating the regression equation.

The following model was obtained for assessing the probability of developing periodontitis in patients with arterial hypertension (Y):

$Y = - 1.2069 + 0.1074X_1 + 0.02415X_2 + 0.2782X_3 + 0.1037X_4 + 0.2156X_5 + 0.1703X_6 + 0.0569X_7 + 0.02737X_8$.

Scale for assessing the likelihood of developing periodontitis: 0-0.39 - low, 0.40-0.69 - medium, 0.70-1.00 - high. The unification of studies and the uniformity of scaling of indicators included in the model made it possible to carry out a comparative assessment of their contribution to the risk of developing periodontal diseases in patients with arterial hypertension. According to the obtained coefficients, all of these factors contribute to an increase in the risk of generalized periodontitis in patients with hypertension. The statistical significance of the equation was tested using the coefficient of determination and Fisher's test. It was found that in the situation under study, 96.98% of the total variability in Y is explained by changes in factors Xj. The resulting model is a tool for assessing the prognosis of the probability of developing periodontitis in patients with hypertension, taking into account medical characteristics and blood lipid profile indicators.

Examples of forecasting. Patient A. Age - 46 years (X1 = 2); the father suffers from hypertension (X2 = 3); smokes at least 20 cigarettes a day (X3 = 3); diagnosis of hypertension – stage 2 (X4 = 3); has chronic pyelonephritis (X5 = 3); Cholestenin level

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increased 2 times (X6 =2); the level of triglycerides is increased three times (X7 = 3) and the atherogenic index is increased by 2 times (X8 = 2);

As a result of the calculations we get: Y = - 1.2069+ 0.1074 x 2 + 0.02415 x 3 + 0.2782 x 3 + 0.1037 x 3 + 0.2156 x 3 + 0.1703 x 2 + 0.0569 x3 + 0.02737 x 2 = 1,4369

Putting the value Y = 1.4369 into the formula

$$P = \frac{1}{1 + e^{-y}}$$

we get 1/ 1 + 2.71 to the power -1.4369 = 1 / 1 +0.369 = 0.73, which means that the probability of developing generalized periodontitis in a given patient with hypertension is 73.00%. This patient with hypertension has a high risk of developing generalized periodontitis. After examining the condition of the periodontium, the patient was found to have moderate to severe periodontitis. A clinical evaluation of the constructed model for predicting the development of periodontitis was carried out on 162 patients with hypertension; 122 of whom (75.31% of patients with hypertension) were diagnosed with periodontitis. After a comprehensive examination, a high probability of periodontitis was predicted in 118 (72.84%) patients with hypertension. The sensitivity of the model for the probability of developing periodontitis in patients with hypertension was 96.72%. Of the 40 patients who did not have periodontal diseases at the time of examination, 2 (5.00%) were classified as low and medium risk of periodontitis. Thus, the specificity of the periodontitis development model was 29.50%. The overall diagnostic accuracy of the method was 95.57%. The research results allow us to conclude that the developed model is highly predictive and that it is necessary to use it in the practice of general practitioners and periodontists to predict the development of periodontitis in patients with arterial hypertension and the formation of groups for dispensary observation. The planned software tool is designed to provide an individual approach to the treatment of periodontal diseases in patients with hypertension, which will allow to personalize the therapy of periodontal diseases, carry out targeted interdisciplinary interaction and significantly reduce the negative impact of inflammatory-destructive periodontal lesions on the mechanisms of development of hypertension.

Conclusions. Based on the developed prognostic model, the features of the individual medical characteristics of patients with combined pathology hypertension and generalized periodontitis were established. The leading risk factors have been identified, including age, hereditary history of hypertension, bad smoking habit, stage of hypertension, the presence and number of chronic diseases, total blood cholesterol levels, triglyceride levels and atherogenicity index. Prediction of the possibility of developing periodontal diseases in patients with hypertension is possible on the basis of a developed equation that takes into account a minimum set of the most significant medical and laboratory indicators. The computer program “Predictive modeling of the probability of developing periodontal diseases in patients with hypertension” after clinical testing can be recommended for use in practical healthcare.

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