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## METHODOLOGICAL APPROACH TO RISK PREDICTION NON-COMPLIANCE IN PATIENTS WITH MYOCARDIAL INFARCTION

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### Highlights

- The adherence to treatment of patients with myocardial infarction was comprehensively assessed and the risk of non-compliance in such patients was predicted on the basis of the original author's questionnaire. The minimum and maximum values of prognostic indices for 29 factors were determined. A personalized algorithm for a comprehensive assessment of non-compliance in myocardial infarction is presented which is based on the principle of normalized intensive parameters. It allows subsequent substantiating of the preventive programs expediency and the need to eliminate factors associated with low patient compliance in the treatment of the disease.

<b>Aim</b>	To develop a methodological approach in order to predict the risk of non-compliance in patients with myocardial infarction.
<b>Methods</b>	416 patients were questioned in the single-centered, prospective, non-randomized study using the original author's method. The patients were treated in specialized cardiological departments of the city of Kemerovo with the diagnosed myocardial infarction. The methodological approach to predicting the risk of non-compliance in patients with myocardial infarction covered 29 factors in 6 main blocks: socio-demographic and socio-economic characteristics, health status, medical and pharmaceutical culture of the patient, awareness of medical and pharmaceutical services, patient adherence to medical recommendations.
<b>Results</b>	Patients with myocardial infarction were characterized by insufficient adherence to the therapy, low awareness of the disease, which can negatively affect the long-term disease prognosis. The identification of a large number of subjective factors limiting adherence to the therapy is the reason for the widespread use of non-compliance risk measurement among patients with myocardial infarction, which will allow determining the range of the risk group for each individual patient.
<b>Conclusion</b>	The adherence to the treatment of patients with myocardial infarction is revealed as 80% which is indicated as low and requires the prophylactic use of educational and psychological programs that increase medical and social awareness and readiness to comply with the doctor's recommendations, and also justifies the need for complex risk measurement of non-compliance patients for personalized identification and addressing risk factors for poor adherence to therapy.
<b>Keywords</b>	Myocardial infarction • Factors of adherence to therapy • Noncompliance • Prediction of risk

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### Список сокращений

MI – myocardial infarction NIP – normalized intensive parameter

### Introduction

In recent years pathologies of the circulatory system have occupied a leading place among chronic non-epidemic diseases [1]. The studies in this sphere show

that atherosclerotic diseases, in particular coronary heart disease, myocardial infarction (MI), strokes, are an unhappy lot of highly developed countries where socio-economic burden is growing in accordance with

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the progress of civilization [2, 3]. In our opinion this is explained by a number of reasons and the leading ones are the rare visits of people to medical organizations, insufficient availability of high-tech medical care, the lack of a unified methodology for the study and control of morbidity, and others. According to the registered cases of cardiovascular pathology in medical organizations and according to large population epidemiological studies, the basic trend today is the "rejuvenation" of cardiovascular morbidity and mortality including deaths from MI [1, 4]. In this respect the study of the main factors influencing the development of patient noncompliance in MI is of particular importance [3].

Adherence to treatment in MI is specified by a set of factors determined by the disease, the system of medical care, the medical worker and the patient. [5]. Nevertheless the most significant factors are related to the patient, as well as the psychological characteristics of the patient's personality [6–8]. The lack of deep understanding of noncompliance mechanisms formation, risk stratification and methods of its prediction in patients with MI makes this issue relevant for the study, especially in real clinical practice in which insufficient adherence to pharmacotherapy is traced both at the inpatient and outpatient stages, even among patients with adverse cardiovascular events in the anamnesis despite all intensive medical supervision [9–11].

**The aim of the study** is to develop a methodological approach to predicting the risk of noncompliance in patients with myocardial infarction

## Methods

The present study is a single-centered prospective non-randomized study. The work protocol complies with the standards of Good Clinical Practice which means that all the participants signed an informed voluntary consent to take part in the questionnaire. The main object of the study is patients with the "myocardial infarction" diagnosed according to the current criteria of the Russian Society of Cardiology, hospitalized in the specialized cardiology departments of the CPSSZ Research Institute (2017). The survey of the patients with MI was carried out on the 3rd–7th day of their stay in hospital.

The study used the data from a questionnaire

survey of patients with MI which was conducted for a comprehensive study of this problem. The volume of the respondents' representative sample was based on the formula of a random non-repeated sample and included 416 people. 16 questionnaires were excluded from the analysis due to incorrect way of filling in the blanks. The collected material was processed in the Statistica 10.0 program (StatSoft Inc., USA).

To predict the risk of patients with MI noncompliance, a special questionnaire was developed. It included the main factors affecting this problem. When using the NIP method (normalized intensive parameters), the values of the studied phenomena must be calculated in intensive terms as a whole according to the data of the entire study (M). When the immediate risk factors are identified, it is necessary to determine the significance or "weight" of each. To do this a simple weighting factor is used which is called the relative risk indicator (R). This index is the ratio of the maximum intensity level of the indicator (c) to the minimum (d) within each individual factor ( $R = c/d$ ).

Normalized intensive parameters were used in this study instead of the standard ones [14] which are calculated according to the formula (1):

$$N = r/m, (1)$$

where N is the NIP; r is the intensive patient compliance parameter; M is the normalizing parameter.

## Results

The compliance parameter of patients with MI is assumed to be 80%. For example:

$$NIP_1 = 14.5/80 = 0.18 \text{ (group up to 49 years old),}$$

$$NIP_2 = 23.6/80 = 0.29 \text{ (group 50–59 years old).}$$

All factors NIP included in the study were calculated in the similar way (Table 1). Taking into consideration the equality of the importance weights of the selected factors, the calculation is made according to the formula (2):

$$\chi = N \times R, (2)$$

where  $\chi$  is an integrated risk measure on the strength of influence of a particular factor (predictive coefficient); N – NIP specific factor; R is the relative risk (weight ratio).

**Table 1.** Integrated assessment of factors that form the risk of non-compliance in patients with myocardial infarction

Factor	Zone of influence	Parameter, %	NIP, N	Relative risk indicator (weight coefficient), R	Integrated risk assessment, $\chi = N \times R$
Socio-demographic characteristics					
Sex	male	56.4	0.70	1.24	0.86
	female	43.6	0.54		0.67
Age	up to 49	14.5	0.18	1.24	0.22
	50–59	23.6	0.29		0.36
	60 years and older	61.8	0.77		0.95

Education	incomplete general	14.5	0.17	1.27	0.21
	complete secondary	5.5	0.06		0.76
	initial professional	1.8	0.02		0.25
	secondary vocational	50.9	0.63		0.80
	unfinished higher	5.5	0.06		0.07
	higher	21.8	0.27		0.34
Occupation	unemployed	5.5	0.06	1.23	0.07
	employed	32.7	0.41		0.50
	retiree	56.4	0.70		0.86
	housewife	3.6	0.04		0.04
	disabled	1.8	0.02		0.02
Family status	single/not married	9.1	0.11	1.24	0.13
	married	60.0	0.75		0.93
	divorced	9.1	0.11		0.13
	widow/widower	18.2	0.22		0.27
	in a civil marriage	3.6	0.05		0.06
Socio-economic characteristics					
Income	below the cost of living	14.5	0.18	1.24	0.02
	within and above the subsistence level	85.5	1.06		1.31
Health status					
Health assessment	bad	7.8	0.10	1.24	0.01
	satisfactory	62.7	0.78		0.96
	good	29.4	0.36		0.44
The presence of chronic diseases	yes	49.0	0.61	1.22	0.74
	no	51.0	0.61		0.75
Frequency of visiting a doctor	sldom	68.6	0.85	1.25	1.06
	semiannually	15.7	0.20		0.19
	once or more a month	15.7	0.20		0.19
Seeing a doctor in case of poor health	yes	27.5	0.33	1.24	0.41
	no	72.6	0.91		1.13
Smoking	yes	29.1	0.36	1.24	0.44
	no	70.9	0.88		1.09
Drinking alcohol	yes	41.8	0.52	1.24	0.64
	no	58.2	0.72		0.89
Disability group	II	13.7	0.15	1.20	0.18
	III	7.8	0.08		0.09
	no	78.4	0.97		1.16
Patient's medical and pharmaceutical culture					
Attitude towards a healthy lifestyle	positive, I try to always stick to it	51.0	0.63	1.24	0.78
	positive, but I don't always follow it	49.0	0.61		0.75
Compliance with the daily routine	constantly comply	43.1	0.53	1.22	0.64
	do not comply	25.5	0.31		0.37
	observed in case of illness	31.4	0.38		0.46
Attitude towards self-medication	positively	66.7	0.82	1.23	1.01
	negatively	33.3	0.41		0.50

Compliance with doctor's orders	doing	82.4	1.02	1.24	1.26
	does not follow	17.6	0.22		0.27
Disease prevention	engage	31.4	0.38	1.23	0.46
	do not engage	68.6	0.85		1.04
Treatment preference	medication	88.2	1.10	1.25	1.37
	non medication	11.8	0.15		0.18
Assessment of the quality of medical care	satisfied	94.1	1.17	1.92	2.24
	dissatisfied	5.9	0.75		0.14
Awareness about health and pharmaceutical services					
Sources of information about medical services	printed (booklets, leaflets)	32.2	0.41	1.24	0.51
	oral (at the doctor's office) and advice from pharmacy workers	52.5	0.65		0.81
	tips from relatives and friends	5.1	0.06		0.07
	other sources (advertising, internet, television)	10.2	0.12		0.15
From whom more information about the disease	from a doctor	74.5	0.92	1.19	1.09
	from relatives with MI	7.8	0.08		0.09
	from friends and acquaintances	5.9	0.07		0.08
	from special literature	2.0	0.02		0.02
	from magazines, newspapers, television	7.8	0.08		0.09
	other	2.0	0.02		0.02
Assessing your own awareness of medical and pharmaceutical products	good	33.3	0.41	1.23	0.50
	sufficient	35.3	0.44		0.54
	insufficient	29.4	0.36		0.44
	no	2.0	0.02		0.03
Patient adherence to medical recommendations					
Reason for not taking drugs	forgetfulness	19.6	0.23	1.18	0.27
	other cases	5.9	0.07		0.08
	it gets worse from drugs	7.8	0.08		0.09
	other	3.9	0.05		0.06
	never missed	62.7	0.75		0.88
Attitude towards the doctor's prescriptions	strictly complies	80.4	1.01	1.24	1.26
	at first, I observe, as my health improves, I reduce my medication intake	17.6	0.22		0.27
	I do not comply, I take medications as needed	2.0	0.02		0.02
Trust in the attending physician when prescribing a treatment regimen	yes	98.0	1.22	1.32	1.16
	no	2.0	0.10		0.13
Fear of unwanted side effects	yes	25.5	0.31	1.23	0.38
	no	74.5	0.92		1.13
Cases of early termination of treatment	yes	27.5	0.34	1.24	0.42
	no	72.5	0.91		1.13

Reasons for early termination of treatment	unreasonable expectations of recovery	9.4	0.11	1.21	0.13
	forgetfulness	46.9	0.58		0.70
	knowledge of the disease	3.1	0.03		0.04
	due to the complexity of the regime	6.3	0.07		0.08
	duration of treatment	18.8	0.24		0.29
	adverse drug reaction	9.4	0.11		0.13
	ineffectiveness of prescribed therapy	6.3	0.07		0.08
Normalizing factor (M) – 80%		The sum of the relative risk indicators – 36.5			
<i><b>Note:</b> MI – myocardial infarction; NIP – normalized intensive parameters.</i>					

Further on it is necessary to determine the range of risk values for the complex of factors taken. We find the minimum and maximum values of the prognostic coefficient ( $\chi$ ) for each of the 29 factors in the prognostic table. These values are summed up and divided by the sum of relative risk indicators ( $\Sigma R_n$ ) given in the table  $\Sigma \chi_n / \Sigma R_n$ . In this case the minimum initial risk value is 0.20, the maximum is 0.81. The risk range is in the range of 0.20–0.81 (Table 2).

As an example we have a patient with MI: a 56-year-old man with a secondary professional education, income within the subsistence minimum, satisfactory health condition, married, has a chronic disease (coronary heart disease), does not always consult a doctor in case of deterioration of health, smokes, does not drink alcohol, treats a healthy lifestyle negatively, does not always follow the treatment regimen and doctor's prescriptions, prefers medication, is satisfied with the quality of medical care, the main sources of information are oral (doctor and pharmacist), trusts the attending physician, there is no fear of side effects of taking medications, forgets to take medications from time to time.

To determine the risk of developing noncompliance in this patient, it is necessary to use the prognostic table and find the corresponding coefficients ( $\chi$ ) for each factor, sum them up ( $\Sigma \chi_n$ ) and divide by the sum of the relative risk indicators ( $\Sigma R_n$ ).

$$P = \chi_1 + \chi_2 + \chi_3 \dots + \chi_n, (3)$$

$$P = 0.86 + 0.36 + 0.80 + 0.50 + 0.93 + 1.31 + 0.96 + 0.74 + 1.06 + 0.44 + 0.89 + 1.16 + 0.5 + 0.46 + 0.27 + 1.37 + 2.24 + 0.81 + 1.16 + 1.13 + 0.7 = 18.65$$

$$P_1 = (\Sigma \chi_n / \Sigma R_n), (4)$$

where  $P_1$  is the NIP of noncompliance risk under the influence of a complex of factors taken for the study;  $\Sigma R_n$  is the sum of relative risk indicators given in the prognostic table.

$$P_1 = 18.65/36.5 = 0.51$$

The significance of the indicator is determined by the table 2. The obtained result indicates that the patient requires increased attention and intensive medical supervision in order to avoid an unfavorable outcome of the disease associated with noncompliance. Next we directly evaluate the noncompliance index according to the formula (5):

$$P_n = (\Sigma \chi_n / \Sigma R_n) \times M, (5)$$

where  $P_n$  is the predicted patient compliance indicator (in intensive terms);  $M$  is the normalizing value of the average patient compliance indicator according to the data of the entire study.

$$P_n = (18.65/36.5) \times 80 = 40.87$$

This value will be a predictive indicator of the patient's noncompliance in intensive terms. Under the influence of various factors it is possible to change the compliance of patients after discharge from the hospital.

## Discussion

The present research assesses the patients' adherence to treatment by means of the questionnaire using A.G. Petrov's method which was previously successfully tested on miners with occupational diseases and showed

**Table 2.** Distribution of non-compliance risk groups in patients with myocardial infarction

Non-compliance risk range	Range size	The specific gravity of the range, %	Risk group
Low	0.20–0.39	$\leq 23.6$	Potentially favorable outcome of MI
Middle	0.40–0.61	23.7–33.6	“Attention!”
Maximum	0.62–0.81	33.6–100.0	Potentially poor outcome of MI

**Note:** MI – myocardial infarction.



greater effectiveness in comparison with the Morisky–Green test [10]. The analysis of the applicability of this technique in patients with MI in Kuzbass was carried out for the first time.

The assessment of risk factors for noncompliance in patients with MI can be theoretically and practically useful for a differentiated understanding of the adherence aspects of certain categories of patients, for example, in primary and repeated MI. The authors of the article have already performed a comparative analysis of the adherence of 145 patients. 74 of them were hospitalized with MI for the first time, 71 – with repeated MI. However, the prediction of the risk of noncompliance, taking into account the complex of the most significant factors (29), was not carried out in these groups of patients [3].

It was found that most of the patients had chronic diseases for a long time, clearly realizing that they were the result of cardiovascular risk factors and only few of them consulted cardiologists. The data collected during the research indicates that despite the doctor's prescriptions, some additional information about the right use of the therapy and some pharmaceutical support are needed. The works of N.B. Lebedeva, E.V. Gorbunova with co-authors have already provided the information about similar socio-demographic and anamnestic features of patients with primary and repeated MI who need information and psychological adaptation and the effectiveness of these measures in correcting target markers of cardiovascular health and motivation for compliance was revealed [15, 16].

It is worth saying that the use of predictive tables for conducting periodic and targeted preventive examinations will be effective. Unless the nature and degree of individual factors influence is known, it is impossible to determine the probability of pathological risk for an individual who has certain working conditions. This would make it possible to identify groups of people who are at pathological risk, although they do not have any pronounced signs.

Considering all mentioned above, the solution of such issues can be presented in the following way:

- identification of factors affecting the level of quantitative health indicators (morbidity, disability, injury, etc.);
- determination of the degree of risk factors influence on risk indicators;
- determination of the pathological risk probability for individuals and for groups of individuals, taking into account the coefficients of various factors.

It seems appropriate to conduct further studies that will allow evaluating the effectiveness of the prognostic methodology offered in the work, depending on the course of MI for a certain dynamic period.

## Conclusion

The adherence of patients with MI to the treatment is only 80% and it indicates a special need for preventive measures, as well as it points out the need for comprehensive risk assessment in patients' noncompliance for personalized identification and elimination of risk factors for insufficient adherence to doctor's recommendations.

The methodological approach to a comprehensive assessment of the noncompliance risk introduced in this study makes it possible to determine the probability of non-adherence to prescribed therapy and substantiate the preventive measures. Thus, in order to achieve accessibility and improve the quality of medical and pharmaceutical care for patients with MI, along with social factors, behavioral determinants of noncompliance should be taken into account.

## Conflict of Interest

A.G. Petrov declares no conflict of interest. N.V. Abramov declares no conflict of interest. D.Y. Sedykh no conflict of interest. V.V. Kashtalap is a member of the editorial board of "Complex Issues of Cardiovascular Diseases" journal.

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### Author Contribution Statement

*PAG* – contribution to the concept and design of the study, data collection and interpretation, manuscript writing, approval of the final version, fully responsible for the content

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