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MATHEMATICAL SUPPORT OF THE INTELLIGENT INFORMATION SYSTEM OF ASSESSING THE OBJECT STATE

At present, information technologies (IT) are intensively used all over the world in various sectors, and today medical institutions cannot do without them when organizing the process of medical diagnostic. The IT efficiency is determined by the degree of their intellectualization that is by including knowledge bases as their component and by the transition from data processing to the processing of knowledge. The efficiency of making decisions in various areas of activity is determined by the quality and quick delivery of information. Medicine constitutes no exception in this sense. The advanced level of computer technology, applied tools, diagnostics on the basis of automated systems of decision support made it possible to solve the tasks of assessing the state of the object at a qualitatively new level. The **subject** matter of this study is to ensure the mathematical support of the intelligent information system (IS) of assessing the state of the object. The **object** is understood as a patient who came through a myocardial infarction (MI). The **goal** of the study is to develop mathematical support of the intelligent IS of assessing and predicting a patient's condition. To achieve the stated goal, the following **tasks** were solved: statistically valid and uncorrelated signs were specified; these signs enable distinguishing the group of patients who survived from those who died, "decisive rules" were formulated for predicting the MI clinical outcome. In the process of the study, the mathematical IT of assessing the state of the object was developed. The following **result** was obtained: the suggested mathematical models for predicting the outcome of myocardial infarction that were developed with the use of the method of discriminant function and took into account human blood values can prevent sudden coronary death and improve the diagnostic efficiency. **Conclusions.** Mathematical models were developed to predict the state of the object in the event of uncertainty. The use of the developed mathematical models enables improving the accuracy of predicting the state of the object in a real-time environment and in the early stages of the disease development by 4.2% and 10%, and applying adequate preventive and therapeutic and rehabilitation measures in time as well as preventing sudden coronary death. The developed mathematical models were tested.

Keywords: mathematical support, information system, myocardial infarction, prediction model.

Introduction

At present, IT is intensively used around the world in various sectors, and today medical institutions cannot do without them when organizing the process of diagnostic and treatment. The IT efficiency is determined by the degree of their intellectualization, that is by including knowledge bases as their component and by the transition from data processing to the processing of knowledge.

The effectiveness of decision-making in various areas of activity is determined by the quality and speed of the information received. Medicine in this sense is no exception. The increased level of computer technology, the tools used, the construction of diagnostic systems on the basis of automated decision support systems made it possible to solve problems of determining the state of the object at a qualitatively new level.

The efficiency of making decisions in various areas of activity is determined by the quality and quick delivery of information. Medicine constitutes no exception in this sense. The advanced level of computer technology, applied tools, diagnostics on the basis of automated systems of decision support made it possible to solve the tasks of assessing the state of the object at a qualitatively new level.

Since the decisions making process is weakly formalized, the development of intelligent information systems is of vital importance and the experience of specialists on the basis of expert assessment should be used which will enable building a distributed information system (IS) that allow a great number of people who often do not have enough experience to perform diagnosis.

The need to solve the problem in real time and the limitations associated with a rapid change in a patient's condition, insufficient medical qualification and lack of reliable information regarding the values of the monitored state parameters characterize the process under investigation.

Thus, the task of developing an information intellectual system for diagnosing a patient's condition with myocardial infarction (MI) functioning in real time is very important.

Analysis of literary sources and problem setting

At present, in connection with the society information support, the problem of developing object-oriented IS becomes particularly urgent [1–4]. Modern IS have such properties as adaptability, complexity, divisibility, integrability, and the degree of structure. Any IT is designed to collecting, storing, and processing information, and the use of data bases, knowledge bases, data base management systems (DBMS) and knowledge base management systems, mathematical models and the methods of prediction and so on should be used for its operation [5–7].

Medicine and medical diagnostics are the subject areas of IT application [8–14].

Among the developments in this field, the IS of dynamic monitoring for diagnosing cardiovascular diseases called "CardioVita" is known [15], this system allows a physician to choose different types of analysis (statistical, correlation, dispersion, regression) independently, depending on their purposes and tasks. Also, the system for diagnosing the cardiovascular system of a patient was developed using the MI as the example, this system is based on the mathematical apparatus of fuzzy logic [16]. The diagnosis is made with the help of the production model of knowledge representation, which enables reducing the time to find a disease. The disadvantage of these systems is the inability to determine the development of post-infarction syndrome in patients with MI.

According to the main classification of methods for forecasting systems and processes, suggested by T.A. Dubrovaya, three main classes are distinguished: expert, deterministic and stochastic methods [17]. The expert methods involve the multistage survey of experts according to special questionnaires and the processing of the results obtained. The disadvantages of these methods are the complexity of the organization of the expert evaluation, the impact of official relationships; besides, there may be the ambiguity and insufficient validity of individual decisions. Deterministic methods presuppose the existence of functional or rigidly deterministic connections when a completely certain non-random value of the effective attribute corresponds to each value of the factor attribute. These methods involve establishing a strictly defined functional relationship among the indices.

Since medical problems are usually related to semistructured or unstructured tasks, labour-intensive probabilistic-statistical methods or heuristic procedures, that is fuzzy sets, neural networks, expert methods, and so on prevail among the methods used in solving medical problems.

At present, probabilistic methods based on the Bayesian approach are widely used for solving diagnostic and prognostic problems in medicine. These methods are also successfully used to identify a number of cardiac diseases. However, this group of methods is sensitive to the form of the presentation of diagnostic information, and the use of the strategy of diagnosing on the basis of this approach does not enable preventing a sudden coronary death and determining the critical period after the old myocardial infarction, which reduces the quality of further therapeutic and preventive activities. The sequential Wald analysis is hyposensitive to the form of representation of signs. It is close to probabilistic methods on a mathematical basis and represents a consistent procedure of examination, where the chosen level of probability of a diagnosis or a prediction is achieved according to the results of the evaluation of qualitative and quantitative indicators. The disadvantage of this type of analysis is the inability to determine the further development of the disease.

The logical-and-probabilistic algorithm is also widely used in MI prediction systems which uses the value of the conditional probability of the manifestation of signs (clinical instrumental or clinical laboratory) that are typical for a disease and its a priori probability, which ensures the recognition of diseases according to matrix tables that contain a set of diagnoses or clinical outcomes. The disadvantage of this algorithm lies in the fact that only stochastic information is taken into consideration and that there is no possibility to determine the outcome of the disease by the available actual quantitative and qualitative indicators, which reduces the accuracy of predicting the outcome of the myocardial infarction.

There are the methods for predicting MI that take into account the process position and the degree of the lesion on the basis of the operation of multilayer fully connected neural network with the forward signal propagation and nonlinear activation functions. The instability during the operation with data obtained from different regions and the sensibility to the form of their representation can be considered as their disadvantages.

A number of ideas show the practicability of using probabilistic statistical methods in medical research: in most cases medical data are not accurate, therefore they can be considered as random variables that are subject to certain distribution laws; the patient’s condition is affected by a large number of factors that have a random character; the prognosis of the patient’s condition can only be probabilistic.

The human body is an open system affected by various external factors and the processes that occur in the body are partly probabilistic in nature and the change in the body’s homeostasis is also of a probabilistic nature. The adequate description of such processes is achieved through the use of statistical methods that are based on accumulated information on the investigated indicators and give a probabilistic estimate of the prediction of their change.

There are many situations in which it would be highly desirable to determine the probability of a result depending on the set of variables being measured, in particular, in predicting the fatal outcome of the myocardial infarction.

Two common features are typical for similar cases: first, for many subjects, there is information about their belonging to a particular group; secondly, each subject may have additional information to create a model for predicting the subject’s belonging to a particular group.

The indicators obtained as a result of expensive and long-term immunological studies are used as the factors determining the possibility of predicting the outcome, as well as functional studies such as coronary angiography. However, these methods do not enable predicting the outcome in the shortest possible time and making a timely decision on the course of treatment [19]. Therefore, one of the statistical methods for determining the belonging of the investigated object to two or more disjoint groups has recently become the discriminant analysis, on the basis of which the clinical outcome of a process can be predicted.

The discriminant analysis is similar to the cluster analysis. However, in the cluster analysis objects are classified on the basis of their differences without any preliminary estimation of the number and composition of classes, which further reduces the accuracy of predicting the belonging of an object to a particular group [18].

Like most statistical methods, the discriminant analysis is based on the formulation of a regression equation that is derived on the basis of the objects whose group membership is known, which enables selecting the coefficients of regressors in the most accurate way. After the regression equation has been derived, it can be used to predict the behaviour of objects.

The goal and objectives of the research

The goal of the study is to develop the mathematical support of the IS of the assessment of the object’s state, which enables predicting the threat of fatal outcome by blood tests as soon as possible, which is especially

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important in the acute and the acutest periods of the disease.

To achieve this goal, the following tasks should be solved:

- to identify statistically significant and uncorrelated characteristics that distinguish the patients who survived from those who died;
- to formulate "decisive rules" for predicting the MI outcome.

The development of mathematical support of predicting a patient's status

To develop the mathematical support of the IS of predicting the object' state, the following task was considered.

Let the attribute space $X = x_{ij}$ is set, its elements are the vectors of the states of individual patients with the anterior or posterior MI, where i is the patient's serial number $i=\overline{1...n}$. The vector $x_i = x_{ij}$ that describes the state of each patient consist of n elements that contain the values of clinical anamnestic and laboratory signs of this patient, where j is the serial number of the sign, $j=\overline{1...m}$.

Each patient belongs to one of two subsets of the set $Y = y_1, y_2$. The subset y_1 comprises the patients who came through the MI. The subset y_2 comprises the patients who died of the MI. Then, to determine the probability of the affiliation of the ith patient to one subset of the set к Y the pattern of the function should be determined: $y_i = f(x_{ij})$; $x_i \in y_1$ if $F_{1i} > F_{2i}$, $x_i \in y_2$ if $F_{3i} > F_{4i}$.

To develop the mathematical support of the IS, a set of formal decisive rules should be determined, which enables predicting the clinical outcome for a patient with the anterior or posterior MI who has random values x from *X*.

The data of 649 patients were analyzed to build mathematical models for predicting the clinical outcome of the patients with the anterior or posterior MI.

Determining the indicators predicted as significant. As a result of calculations using the discriminant function method, 23 informative signs characterizing the patient's condition were identified from 34 investigated indicators. The objects can be divided into the selected groups according to the values of the discriminant function with the appropriate accuracy. For this, the canonical coefficients b_{ik} and b_{ok} of discriminant functions are determined according to the formulas

$$b_{ik} = \nu_{ik}\sqrt{n-g} \quad (2)$$

$$b_{ok} = -\sum_{i=1}^{p} b_{ik}\overline{x_i} \quad (3)$$

where *n* is the general number of observations in all groups (the patients with the fatal outcome and the patients who came through the anterior or posterior MI);

g is a number of groups (2 groups of patients with the posterior MI /2 groups of patients with the anterior MI);

$\overline{x_i}$ is the mean variable value i in all classes (general mean);

ν_{ik} is the latent vector of the discriminant function.

Usually, in similar cases, the linear regression models are used as computationally simplest ones. To assess the model coefficients, the least square method (LSM) was used, and the computational procedure is as follows:

$$\hat{A} = (X^T X)^{-1} X^T Y \quad (4)$$

However, according to the specificity of the controlled process, LSM prerequisites are often violated, which leads to the multicollinearity. In this case, the task has the degenerate solution. To cope with this factor, the regularized procedure was used:

$$\hat{A} = (X^T X - \alpha I)^{-1} X^T Y, \quad (5)$$

where *I* is the unit matrix,

α is the parameter of regularization (predetermined number).

Using the above model enabled obtaining the following relationships that determine the outcome of the disease in patients with the posterior myocardial infarction:

$$\begin{aligned} F1 = &-158.421 - 3.399*X1 + 10.549*X2 + 2.17*X3 + 4.145*X4 - 0.991*X5 + 1.383*X6 + \\ &+1.742*X7 + 1.261*X8 + 1.474*X9 + 0.688*X10 + 1.053*X11 + 0.264*X12 + 0352*X13 + \\ &+0.967*X14 + 0.04126*X15 + 0.02703*X16 \end{aligned} \quad (6)$$

$$\begin{aligned} F2 = &-151.647 - 3.143*X1 + 13.656*X2 + 5.822*X3 + 5.372*X4 - 0.387*X5 + 1.163*X6 + \\ &+2.015*X7 + 0.97*X8 + 1.47*X9 + 0.726*X10 + 0.802*X11 + 0.183*X12 + 0.666*X13 + \\ &+0.852*X14 - 0.0839*X15 + 0.01247*X16 \end{aligned} \quad (7)$$

where $X_1 - X_{16}$ are informative coefficients that affect the prediction.

Consequently, determining the clinical outcome in the patients with the anterior MI is described with the following discriminant functions:

$$\begin{aligned} F_3 = &4,973*X_1 + 0,4*X_2 + 0,184*X_3 + \\ &+3,532*X_4 + 0.04*X_5 + 4,998*X_6 + \\ &+0,554*X_7 - 23,144 \end{aligned} \quad (8)$$

$$F_4 = 4,891 * X_1 + 1,36 * X_2 + 0,013 * X_3 + +3,843 * X_4 - 0,0327 * X_5 + 0,747 * X_6 + +1,282 * X_7 - 27,860 \quad (9)$$

where $X_1 - X_7$ are informative variables that affect the prediction.

To confirm the statistical value of the obtained discriminant functions of assessing the state of a patient with the anterior or posterior MI, Wilkes λ- statistic is used, which is calculated according to the following formula:

$$\lambda_i^* = \prod_{i=k+1}^{g} \frac{1}{1+\lambda_i}; \quad (10)$$

where k is a number of calculated functions.

Wilkes λ-statistic is the measure of differences among the classes according to several variables (discriminant variables). The nearer λ is to 0, the better is the difference among the classes, and the nearer λ is to 1, the worse is the difference (the classes coincide). For the patients with the posterior myocardial infarction λ=0,021, for the patients with the anterior myocardial infarction λ=0,406.

To determine the separative power and significance of the discriminant function, the coefficients of canonical correlation are determined according to the formula:

$$r_i = \sqrt{\frac{\lambda_i}{1+\lambda_i}}; \quad (11)$$

where i is the number of the corresponding discriminant function; λ_i is the latent root.

The procedure for assessing the state of the object involves predicting: the obtained values of the variables F1 and F2 are compared and if F1> F2 with the accuracy of 91.5% it can be interpreted that the patient with the posterior IM will come through the disease, and if F2> F1 – the patient will die. If F3> F4 with the accuracy of 92.3%, it can be interpreted that a patient with the anterior IM will come through the disease, and is F4> F3 – the patient will die.

Discussing the results of the mathematical support of the information system of assessing the object's state

The estimation of the quality of the developed regression models (6–9) for the information system of assessing the object's state is presented in table 1.

Table 1. *Assessing the results of modelling (the adequacy and the quality of the models for predicting the clinical outcome of the patients with posterior and anterior MI)*

MI localization	The coefficient of the canonical correlation, r_i	Wilkes λ	χ^2	Significance, p
Anterior myocardial infraction (N = 229)	0,871	0,406	105,405	0,0013
Posterior myocardial infraction (N = 193)	0,990	0,021	13,762	0,0001

The more the value r_i, the better separating power of the discriminant function. For the patients with the posterior MI $r_i = 0,990$; for the patients with the anterior MI $r_i = 0,871$.

The results of checking the models for predicting the clinical outcome of anterior and posterior myocardial infractions are given in Tables 2, 3 (n1 is a number of patients in groups пациентов в группах "prototype model", "training set" и "test set" that are classified as true; n2 – is a number of patients that are classified as false (according to the group).

Table 2. *Assessing the accuracy of determining the clinical outcome of patients with the anterior MI*

Study group	A number of patients with the anterior MI (N=382)					
	The prototype model (N=382)		The developed model (N=382)			
			Training set (N=229)		Test set (N=153)	
Group 1 (fatal case)	n1	n2	n1	n2	n1	n2
	179	25	115	9	81	6
Group 2 (non-fatal case)	24	153	13	92	7	59
The model accuracy	0,872		0,903		0,915	

Table 3. *Assessing the accuracy of determining the clinical outcome of patients with the posterior MI*

Study group	A number of patients with the posterior MI (N=258)					
	The prototype model (N=258)		The developed model (N=258)			
			Training set (N=193)		Test set (N=65)	
Group 1 (fatal case)	n1	n2	n1	n2	n1	n2
	160	29	107	10	39	3
Group 2 (non-fatal case)	17	52	7	69	2	21
The model accuracy	0,822		0,912		0,923	

To check the validity of the developed mathematical models 382 patients with the anterior MI were examined and 258 people who came through the posterior MI.

Practical realization of the development results

Example 1.

$$\begin{aligned}F1 &= -158.421 - 3.399*0.5 + 10.549*5.08 + 2.17*0.38 + 4.145*2 - 0.991*11.2 + 1.383*18 + 1.742*4.5 + \\ &+1.261*2 + 1.474*78 + 0.688*5 + 1.053*6.84 + 0.264*135 + 0.352*6 + 0.967*73 + 0.04126*150 + \\ &+0.02703*11.11 = 132\end{aligned}$$

$$\begin{aligned}F2 &= -151.647 - 3.143*0.5 + 13.656*5.08 + 5.822*0.38 + 5.372*2 - 0.387*11.2 + 1.163*18 + 2.015*4.5 + \\ &+0.97*2 + 1.47*78 + 0.726*5 + 0.802*6.84 + 0.183*1.35 + 0.666*6 + 0.852*73 - 0.0839*150 + \\ &+0.01247*11.11 = 134\end{aligned}$$

The analysis of the results showed the increase F2 over F1, which enabled predicting the given patient's fatal outcome. The obtained result is verified practically.

Example 2.

$$\begin{aligned}F1 &= -158.421 - 3.399*0.13 + 10.549*4.06 + 2.17*0.38 + 4.145*3 - 0.991*8.4 + 1.383*16 + \\ &+1.742*6.8 + 1.261*2 + 1.474*82 + 0.688*5 + 1.053*3.42 + 0.264*1.15 + 0.352*4 + \\ &+0.967*78 + 0.04126*123 + 0.02703*6.84 = 136;\end{aligned}$$

$$\begin{aligned}F2 &= -151.647 - 3.143*0.13 + 13.656*4.06 + 5.822*0.38 + 5.372*3 - 0.387*8.4 + \\ &+1.163*16 + 2.015*6.8 + 0.97*2 + 1.47*82 + 0.726*5 + 0.802*3.42 + 0.183*1.15 + \\ &+0.666*4 + 0.852*78 - 0.0839*123 + 0.01247*6.84 = 138.\end{aligned}$$

The analysis of the results showed the increase F2 over F1, which enabled predicting the given patient's fatal outcome.

Example 3.

$$\begin{aligned}F3 &= -158.421 - 3.399*0.25 + 10.549*4.84 + 2.17*0.38 + 4.145*1 - 0.991*6 + \\ &+1.383*18 + 1.742*3.9 + 1.261*4 + 1.474*85 + 0.688*20 + 1.053*6.84 + \\ &+0.264*1.35 + 0.352*4 + 0.967*73 + 0.04126*148 + 0.02703*8.55 = 152\end{aligned} \;;$$

$$\begin{aligned}F4 &= -151.647 - 3.143*0.25 + 13.656*4.84 + 5.822*0.38 + 5.372*1 - 0.387*6 + \\ &+1.163*18 + 2.015*3.9 + 0.97*4 + 1.47*85 + 0.726*20 + 0.802*6.84 + \\ &+0.183*1.35 + 0.666*4 + 0.852*73 - 0.0839*148 + 0.01247*8.55 = 149\end{aligned} \;.$$

The analysis of the results showed the increase F1 over F2, which enabled predicting the given patient's favourable outcome.

During the research, the authors proposed The mathematical support for the information system of making decisions regarding the patient's state was suggested in the context of the research. Mathematical models are developed taking into account the prediction of the object's state under the conditions of uncertainty.

The use of the developed mathematical models enables increasing the accuracy of predicting the patient's state in real time and at the early stages of the disease development by 4.2% for patients with anterior MI and by 10% for patients with posterior MI and applying adequate preventive and therapeutic-rehabilitation measures timely.

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МАТЕМАТИЧНЕ ЗАБЕЗПЕЧЕННЯ ІНТЕЛЕКТУАЛЬНОЇ ІНФОРМАЦІЙНОЇ СИСТЕМИ ОЦІНЮВАННЯ СТАНУ ОБ'ЄКТА

В даний час інформаційні технології (ІТ) інтенсивно застосовують у всьому світі в різних галузях, і вже сьогодні в медичних установах практично неможливо обійтися без їх використання при організації лікувально-діагностичного процесу. Ефективність ІТ визначається ступенем їх інтелектуалізації, тобто включенням до їх складу баз знань, переходом від обробки даних до обробки знань. Ефективність прийняття рішень в різних областях діяльності визначається якістю і оперативністю одержуваної інформації. Медицина в цьому сенсі не є винятком. Збільшений рівень обчислювальної техніки, що застосовується інструментарію, діагностики на базі автоматизованих систем підтримки прийняття рішень дозволив вирішувати завдання визначення стану об'єкта на якісно новому рівні. **Предметом** даного дослідження є математичне забезпечення інтелектуальної інформаційної системи (ІС) оцінювання стану об'єкта. Під **об'єктом** будемо розуміти пацієнта, який переніс інфаркт міокарда (ІМ). **Метою** дослідження є розробка математичного забезпечення інтелектуальної ІС оцінювання та прогнозування стану пацієнта.Для досягнення поставленої мети були вирішені наступні **завдання:** виявлено статистично достовірні ознаки, що не корелюють між собою, які дозволяють відрізнити групу тих, що вижили пацієнтів від померлих, побудовані "вирішальні правила" для прогнозування результату ІМ.У процесі дослідження розроблено математичне ІС оцінювання стану об'єкта. **Результат.** Пропоновані математичні моделі прогнозування результату ІМ, розроблені з використанням методу дискримінантних функцій та обліком показників крові людини, дозволяють попередити раптову коронарну смерть і підвищити ефективність діагностики. **Висновки.** Розроблено математичні моделі для прогнозування стану об'єкта при наявності невизначеності. Використання розроблених математичних моделей дозволило в реальному часі підвищити точність прогнозування стану об'єкта на ранніх стадіях розвитку захворювання на 4,2% і 10%, а також, своєчасно застосувати адекватні профілактичні та лікувально-реабілітаційні заходи, попередити раптову коронарну смерть. Була проведена апробація розроблених математичних моделей.

Ключові слова: математичне забезпечення, інформаційна система, інфаркт міокарда, модель прогнозування.

МАТЕМАТИЧЕСКОЕ ОБЕСПЕЧЕНИЕ ИНТЕЛЛЕКТУАЛЬНОЙ ИНФОРМАЦИОННОЙ СИСТЕМЫ ОЦЕНКИ СОСТОЯНИЯ ОБЪЕКТА

В настоящее время информационные технологии (ИТ) интенсивно применяют во всем мире в различных отраслях, и уже сегодня в медицинских учреждениях практически невозможно обойтись без их использования при организации лечебно-диагностического процесса. Эффективность ИТ определяется степенью их интеллектуализации, т.е. включением в их состав баз знаний, переходом от обработки данных к обработке знаний. Эффективность принятия решений в различных областях деятельности определяется качеством и оперативностью получаемой информации. Медицина в этом смысле не является исключением. Возросший уровень вычислительной техники, применяемого инструментария, диагностики на базе автоматизированных систем поддержки принятия решений позволил решать задачи определения состояния объекта на качественно новом уровне. **Предметом** данного исследования является математическое обеспечение интеллектуальной информационной системы (ИС) оценивания состояния объекта. Под **объектом** будем понимать пациента, перенесшего инфаркт миокарда (ИМ). **Целью** исследования является разработка математического обеспечения интеллектуальной ИС оценивания и прогнозирования состояния пациента. Для достижения поставленной цели были решены следующие **задачи:** выявлены статистически достоверные и некоррелирующие между собой признаки, позволяющие отличить группу выживших пациентов от умерших, построены "решающие правила" для прогнозирования исхода ИМ. В процессе исследования разработано математическое ИС оценивания состояния объекта. **Результат.** Предлагаемые математические модели прогнозирования исхода ИМ, разработанные с использованием метода дискриминантных функций и учетом показателей крови человека, позволяют предупредить внезапную коронарную смерть и повысить эффективность диагностики. **Выводы.** Разработаны математические модели для прогнозирования состояния объекта при наличии неопределенности. Использование разработанных математических моделей позволило в реальном времени повысить точность прогнозирования состояния объекта на ранних стадиях развития заболевания на 4,2% и 10%, а также, своевременно применить адекватные профилактические и лечебно-реабилитационные мероприятия, предупредить внезапную коронарную смерть. Была проведена апробация разработанных математических моделей.

Ключевые слова: математическое обеспечение, информационная система, инфаркт миокарда, модель прогнозирования.