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ADAPTATION OF ELECTRONIC SYSTEM FOR ISCHEMIC HEART DISEASE PREDICTION AS A STEP TO COMMON INFORMATION SPACE IN CARDIOLOGIC HEALTHCARE

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SUMMARY

Electronic version of a patient's individual card protocol forming "Analytic system for monitoring and predicting various clinical variants of ischemic heart disease (CHD DM2)" database № BGU 00314 is combined with the computer system № DGU 01035 to assess yearly risk of adverse events by diagnostic coefficients; up-to-date prognostic signs, such as pre-test probability, Duke treadmill score and ventricular ejection fraction participating in the formation of prognostic conclusion were added. The database is a complex of program products intended for automation of dynamic management processes for both inpatients and outpatients with various clinical IHD forms and concurrent type 2 diabetes mellitus based on assessment of the disease course dynamics, completeness of prescriptions and patient's compliance. The proposed model is of high clinical practical significance since it can be transformed into electronic medical history or used as a database in chronic IHD registry to improve medical care quality.

Keywords: *analytic system for monitoring, complex of program products.*

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Especially urgent in view of limited funding for healthcare, disease prognosis is a key stage in choice of therapy tactics for patients with stable ischemic heart disease (IHD). Although expectation of life for patients with IHD was established to be associated with extent of coronary atherosclerosis, severity of coronary insufficiency and left ventricular dysfunction, international studies focus on stable angina prognosis with identification of additional factors affecting its outcome, and search for practical techniques for risk assessment [1,2,3].

Based upon retrospective analysis of the findings from 2-year follow-up of 90 signs in 141 patients with IHD the following markers for adverse course of the disease were identified:

1. systolic arterial pressure ≥160 Hg mm;
2. cholesterol of low density lipoproteins ≥115 mg/dl;
3. carotid intima-media thickness ≥0,8 mm;
4. myocardial infarction and diabetes mellitus in medical history;
5. ST segment ischemic depression in V4-6 leads in combination with T wave inversion in any lead.

These and some other markers were used for mathematical model in the form of diagnostic tables intended for predicting clinical effectiveness of standard therapy as a component of optimization of drug therapy for progressing angina pectoris in patients with type 2 diabetes mellitus.

According to the approach, the model in question is a set of selected signs with appropriate diagnostic coefficients (DC). To form a diagnostic table with appropriate DC some calculations were to be made. Thus, we (1) selected a number of the most frequent signs, (2) analyzed frequency of the signs in patients with IHD favorable and adverse course, (3) calculated relative frequency of the signs for patients with IHD favorable and adverse course (relative frequency is a ratio of absolute number of patients with the sign to number of all cases), (4) calculated ratios of relative frequencies, that is, arithmetical quotient from arithmetical division of relative frequencies in group of patients with IHD adverse course by relative frequency in group of patients with IHD favorable course, (5) found common logarithm of relative frequencies ratio (intermediate step in calculation of diagnostic coefficient), and finally (6) got diagnostic coefficient by multiplying relative frequencies ratio by 10.

DC is negative if the sign is typical of patients with therapy effect and positive if the sign is characteristic for those with no therapy effect.

Each sign identified in a patient should increase (if DC is negative) or decrease (if DC is positive) probability of prognosis for IHD favorable and adverse outcomes. In practice, signs are identified in each examined patient to sum up diagnostic coefficients of all signs. When DC ≥ +13, absence of either IHD favorable course or questionable effect of current drug therapy on course and outcome of the disease is predicted. When DC ≤-13, that is, in cases with minimum number of identified serious risk factors for IHD adverse course, drug therapy continues provided that hemodynamic parameters, such as target arterial pressure and heart rate, as well as metabolic parameters, such as lipid profile and carbohydrate metabolism, be effectively controlled. Intermediate data values are not identified requiring additional examination of a patient to reconfirm his/her condition. A cut-off value of total DC=13 is recommended for conclusions with correct prognosis probability at $P<0.05$.

The model underlies the program for identification of destabilized patients requiring aggressive control of coronary insufficiency, that is, surgery. The program uses mathematical method for development of diagnostic tables widely used in medicine and based on the Wald statistical procedure. In accordance with the approach, so called “trained group” was compared with the “group examined”. Prognostic conclusions assessed with the patients’ distribution algorithm, prognosis for IHD favorable course turned out correct in 53 (82.81%) patients, the one for IHD adverse course (including patients unidentified by algorithm) was correct in 11 (17.19%); there were 5 patients (7.81%) unidentified by the algorithm. Analysis of data demonstrated that prognostic conclusions on IHD favorable and adverse course made with the developed algorithm coincide with the reference ones in 53 (82.81%) patients. Sensitivity and specificity of the prognostic algorithm were 84.6% and 75.0%, respectively. Prognostic value of conclusions on IHD favorable and adverse course was 83.02% and 72.3%, respectively.

Thus, specific criteria of IHD adverse course signs and their quantitative contribution available, role of diagnostic tables in general analysis of condition of a patient with destabilized IHD course and concurrent type 2 diabetes mellitus can be easily understood.

“Method for unstable angina prediction by means of diagnostic tables” (IBS-15), a software application for IBM compatible personal computers was registered with Agency on intellectual property of the Republic of Uzbekistan (Patent №DGU 01035, 2008). Borland Delphi 4.0 is a software language and programming environment to serve as the interactive basis for detailing of criteria for the disease adverse course within a year and identification of persons requiring early surgery.

A patient’s individual electronic registration card registered with Agency on intellectual property of the Republic of Uzbekistan (№ BGU 00314, 2014) as an electronic database “Analytic system for monitoring and predicting various clinical variants of ischemic heart disease (CHD DM2)” was produced in the frames of innovative project implemented as a task of Uzbekistan Public Health Ministry in 2014-15. As a part of database, the electronic version of a patient’s individual card protocol is combined with the computer system IBS-15 to assess yearly risk of adverse events by diagnostic coefficients; up-to-date prognostic signs, such as pre-test probability, Duke treadmill score and ventricular ejection fraction participating in the formation of prognostic conclusion were added.

IHD is associated with high risk of complications and adverse outcomes. Thus, according to some authors’ reports, annual death rate ranges from 1.2 to 2.4%, cardiovascular death rate is 0.6-1.4% and the one of non-fatal myocardial infarction is 0.6-2.7% [4, 5]. Risk degree is quite different in various patients; individual prognosis is extremely significant for management of each patient with stable ischemic heart disease.

Prognostic conclusion starts from clinical IHD pre-teat probability [6]. IHD pre-test probability is automatically calculated in electronic version of a patient’s registration card with his/her sex and age, and character of symptoms taken into account. Assessment of adverse events risk determines management tactics for the patient, with stable IHD, in particular. Diagnostic coefficients for EGC findings and results of laboratory tests (glycemia and lipid profile) further modifying assessment of adverse events risk are included into risk stratification of these events.

Physical load tolerance expressed as arterial pressure response and ischemia induced by physical load is stable prognostic marker in the form of well-validated Duke treadmill score taken into account upon conclusion formation [7, 8].

Left ventricular function is a strong predictor of long-term survival; the function reduces the mortality increases [9]. As a patient with left ventricular ejection <50% is at high risk of cardiovascular events, it is important not to miss vessels with obstruction causing ischemia in this category of patients.

Thus, in accordance with the standards for assessment of prognosis for patients with IHD the procedure in the proposed analytical system comprises (1) risk stratification as per results of clinical estimation of patients (medical history data, physical examination, ECG and laboratory investigations), (2) risk stratification as per left ventricular function (echocardiography in the rest) and (3) risk stratification as per stress test results (stress ECG, Duke treadmill score).

The data base is a complex of program products intended for automation of dynamic management processes for both inpatients and outpatients with various clinical IHD forms and concurrent type 2 diabetes mellitus based on assessment of the disease course dynamics, completeness of prescriptions and patient's compliance. Eventually, the system summarizes basic parameters to form prognostic conclusions.

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Examples.

1. Patient: Abidjan Rapikov, Tashkent

Conclusion: risk of adverse events is questionable. Recommendations: strict control of hemodynamics and lipid profile. Correction of other risk factors.

DC: -14.5

Pre-test probability: 84%

Ventricular ejection fraction: 65.5%

Duke treadmill score: 6

2. Patient: Khamidulla Ibragimov, Syrdarya

Conclusion: risk of adverse events is possible. Recommendations: strict control of hemodynamic and lipid profile.

DC: 7.8

Pre-test probability: 69%

Ventricular ejection fraction: 69.4%

Duke treadmill score: 3

3. Patient: Mustafa Sharipov, Khorezm

Conclusion: risk of adverse events is high. Recommendations: strict control of hemodynamics and lipid profile. Consider coronarography (consultation with a cardiac surgeon)

DC: 18.8

Pre-test probability: 69%

Ventricular ejection fraction: 52.4%

Duke treadmill score: - 3

The system makes possible long-term store of patients' dynamic parameters Its data base is the centralized one with secure remote database access for subordinate institutions of education system. The system is arranged with three tier architecture including Web-browser, application server and database server, and facilitates operation as a Web-interface functioning in various operation environments, such as Microsoft Windows and Unix (Linux). The system operates on DBMS MySQL with possible setting in Microsoft Windows and Unix (Linux). Access to the system is performed by Web-interface with SSL certificate and S-HTTP. The program is combined with Microsoft Excel for statistical data processing.

Functionally the system is divided into following groups.

1. Basic data form
2. Inclusion criteria
3. Exclusion criteria
4. Informed consent
5. Demographic data
6. Style of life
7. Medical history
8. Unbiased examination and vital signs assessment
9. Results of laboratory and tool investigations performed within previous 12 months
10. Drug therapy
11. Diagnosis at discharge
12. Recommended drugs
13. Repeated visits
14. Degree of adherence to vital therapy recommendations
15. Morisky-Green adherence scale
16. Prognosis
17. Management

The proposed model is of high clinical practical significance since it can be transformed into electronic medical history or used as a database in chronic IHD registry to improve medical care quality.

CONCLUSION

Development of economically feasible algorithm for ischemic heart disease diagnosis is an essential stage in reduction of cardio-vascular mortality in our country. The algorithm based on clinical data and findings of available instrumental investigations, making possible stratification of patients with various disease prognoses, allows choosing proper therapeutic strategy, and setting out the patients who need more active therapy, myocardium revascularization in the first place. Economic efficacy of the program is in reduction of expenditures for some invasive and expensive studies in groups of patients with low and moderate risk after simple tests, appearing the object of our innovative solution. The proposed prediction scheme can be used in clinical practice, in cardiologic dispensaries, cardiologic and therapeutic departments in hospitals to choose conservative or surgical tactics of management for the patients. The computer system makes possible automation and computerization of medical technologies in cardiologic and cardio-surgical clinics; reduced to medical practice, the model can be transformed into electronic medical history or used as a database in chronic IHD registry to improve medical care quality.

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