MODEL METHOD IN THE ORGANIZATION OF MEDICAL INFORMATION
BASED ON THE PHYSICIAN KNOWLEDGE

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Abstract

The overall purpose of this study is to develop a method for modeling physician knowledge. The obtained complication models of myocardial infarction according to its clinical expression were combinations the symptoms of four main symptom complexes. The clinical interpretation of prediction complication models of the myocardial infarction did not represent of particular difficulties for the physicians, as the models could be described by using common medical terms, that made their understanding easy. The prediction results served as a base for mathematical assessment of process gravity of myocardial infarction by computation of prediction gravity index (PGI) of the patient. By changing the value bounds of PGI, it is possible to form patient groups, which differ by the degree of risk of lethality – prediction gravity categories (PGC). In our forecasting model PGC is one of the final purposes of prediction, allowing the physician to select the tactics of treatment and physical patient rehabilitation with Q myocardial infarction.

Key Words

Model method, physician knowledge modeling, myocardial infarction.

1. Introduction

Development of decision support systems in ill-formalized domains such as medicine is a growing area of research. Selection and formalization of optimal tactics is an important challenge in medicine. Often available information is not sufficient. Different data integration may be needed for new methods of examination, treatment and experience exchange. Integration of data analysis and expert knowledge is a dominant current trend in medicine. Such models are understandable by every physician [1] and can be evaluated by experts on all the stages of model development.

2. Model method

To develop the model of possible complication [2] we used the information about 38 patients, divided by their cardiologist into seven complication groups according to the primary complication. Four groups consisted of the patients, who died during the period of their treatment in the hospital: "MR" – died of myocardial rupture (5 cases), "ACIR-1" – died of relapse of acute coronary insufficiency (4 cases), "TC-1" – died of thrombotic and thromboembolic complications (4 cases), "PHI" – died of progression of heart insufficiency (10 cases). The three remaining groups only included the patients, who have undergone the full course of treatment: "VTF" – had the periods of ventricular tachycardia or ventricular fibrillation with followed successful reanimation (4 cases), "TC-2" – had the slight thromboembolic complications or the exacerbation of chronic thrombophlebit (5 cases), "ACIR-2" – the acute coronary insufficiency recurrences in the form of rare attacks of angina (6 cases). These signs occurred in 70% of the cases. So the sign sets, characterizing patients of every seeded complication group and the representing complication models were obtained (see Table).

To predict the complications we selected the clinical features, typical for every groups, that is they took place with statistically significant frequency:

- A60 – the age up to 60 years;
- A65 – the age up to 65 years;
- HAH – very high arterial hypertension in anamnesis;
- AH – the existence of arterial hypertension in anamnesis;
- CI – circulation insufficiency in anamnesis;
- PC – pallor combined with cyanosis during the first day;
- MACI – marked acute cardiac insufficiency during the first day;
- EACI – expressed acute cardiac insufficiency during the first day;
- P80 – the maximal pulse frequency of during the first day up to 80;
- P90 – the maximal pulse frequency during the first day up to 90;
- B20 – the maximal breathing frequency during the first day up to 20;
- B24 – the maximal breathing frequency during the first day up to 24;
- GSG – general state of the patient during the first day is extremely grave;
- GSHG – general state of the patient during the first day heavy or is extremely grave.

The signs were coded by the binary code: 0 – sign absence, 1 – sign presence.
The prediction consisted in comparing of the coded image of the patient with the selected complication models. To do that we calculated the number of coinciding values of coded signs of the image of the particular patient with the signs of each complication models. Just because the models of different complications included the varying amount of signs (from 5 up to 13), we had to provide the comparability of patterns among themselves by means of the standardization of the coefficients. We calculated the weight of every sign in the model of every form of a complication. The standardization factor equal to 117-121 was chosen to maximize degree of similarity with every models. From the mathematical point of view the maximum degree of similarity was to be equal to 100, but in this case the coefficients there wouldn’t be whole numbers, and the calculations with fractions present well-known difficulties. The chosen value of maximum degree of similarity made possible to use integers and that made it easier the calculation of marks.

The obtained complication models of myocardial infarction according to its clinical expression were combinations the symptoms of four main symptom complexes:

- the symptom complex of an elderly patient, that characterizes the salience of coronary atherosclerosis, the decrease of the compensation abilities of the patient, the slowing down of reparative processes;
- the symptom complex of the chronic increased postloading, reflecting the increase of the pressure in the cavity of left ventricle, that promotes the development of the heart aneurysms and rupture of myocard having disturbed reparative processes;
- the symptom complex of the acute cardiac insufficiency, including the circulation insufficiency in anamnesis and acute cardiac insufficiency during the first day;
- the symptom complex of the physician alarm, reflecting the gravity anamnesis of the patient, the depth and the area of them, overall estimate of the complication gravity.

The clinical interpretation of prediction complication models of the myocardial infarction did not represent of particular difficulties for the physicians, as the models could be described by using common medical terms, that made their understanding easy.

The prediction results served as a base for mathematical assessment of process gravity of myocardial infarction by computation of prediction gravity index (PGI) of the patient. By changing the value bounds of PGI, it is possible to form patient groups, which differ by the degree of risk of lethality – prediction gravity categories (PGC). In our forecasting model PGC is one of the final purposes of prediction, allowing the physician to select the tactics of treatment and physical patient rehabilitation with Q myocardial infarction.

The received PGI(I) has the form:

\[ I_k = \frac{\sum_i S_i^{k}_{\text{leth}}}{\sum_i S_i^{k}_{\text{nonleth}}} \]

where \( \sum S_i^{k}_{\text{leth}} \) is the sum of similarity estimates of every patient with lethal complication models ("MR" + "ACIR-1" + "TC-1" + "PHI");

\( \sum S_i^{k}_{\text{nonleth}} \) is the sum of similarity estimates with nonlethal complication models ("VTF" + "ACIR-2" + "TC-2").

Depending on the PGI value the patient lethality ranged from 0 up to 100%. We didn’t sufficiently founded the formation of patient groups with zero lethality, as well as the patient groups with 100% lethality. That kind of formation can give rise to the sense of exaggerated optimism or pessimism in physicians and patients. All that provokes inadequate patient behavior and the medical mistakes, caused by the decrease of the attention to not seriously ill and to seriously ill patients, while every patient needs increased attention of the medical personnel.

We formed four groups of patients, which differ by lethality level: I PGC = 2, 5%, II PGC = 8, 8%, III PGC = 24, 4%, IV PGC = 57, 4%. The lethality in I and II groups was lower then the average hospital lethality, but not so low as to neglect it. The lethality in III and IV groups was higher than the average hospital lethality, but not was so high as to count the patients hopeless. In this case the values intervals of PGI for every patient group were the following: I – 0-0,84; II – 0,85-1,24; III – 1,25-1,84; IV – ≥1,85.

3. Conclusion

We have developed the method of clinical and mathematical evaluation of patient’s state. The method was used for both the selection of the specific physical rehabilitation program for the patient, and for the developing of patient groups according to the gravity degree with the purpose of the scientific analysis of the efficiency of specific treatments the organization of the therapeutic process in general. In the case of the low characteristics of prediction (sensitivity is 67%, specificity is 61,5% and precision is 57, 5%) of concrete complications did not affect the authors, as the complications prediction was not the main purpose of our work, but presented only intermediate data for further use in order to predict the myocardial infarction complications and to choose the treatment tactics. The complication prediction served as the basis for choosing the treatment tactics and assessing the myocardial infarction gravity. The possibilities of complications prognosis we compared the frequency of the predicted concrete complications with actual frequency complications, which took place in a day after the beginning of the treatment.
<table>
<thead>
<tr>
<th>Names of complication models</th>
<th>Weight of one sign in models A 60</th>
<th>A 65</th>
<th>H A H</th>
<th>AH</th>
<th>Cl</th>
<th>PC</th>
<th>MACI</th>
<th>EACI</th>
<th>P 80</th>
<th>P 90</th>
<th>B 20</th>
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References
