Knowledge bases for arterial hypertension strategy selection: development and estimation

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Introduction. The information technologies give the possibility to formalize and structurize knowledge in the knowledge base (KB). Thus, knowledge is available for computer processing [1]. The two KB developed comprise the same knowledge amount: „New European Hypertension Guidelines, 2003".

Goal. To build two KB and computer systems for decision making on strategy concerning arterial hypertension (AH) patients and to compare them.

Methods. Authors used rules and frames to formalize knowledge. Decision making are divided into three levels:

1. *The lowest level:* based on symptoms, the patients blood pressure (BP) class, risk factors (RF), number of target organ damage (TOD) and the AH-related clinical conditions (RCC) are detected.
2. *The medium level:* total risk is calculated.
3. *The highest level*: optimal AH strategy for the patient is determined.

Figure 1 illustrates the decision making tree on the medium level for patient with blood pressure class A.

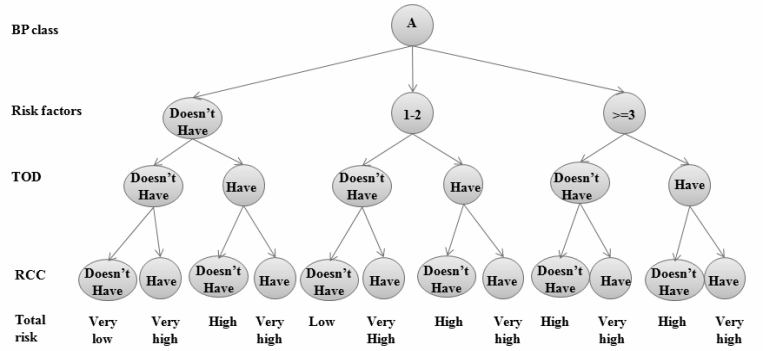

Fig. 1. Decision making tree for blood pressure class A patient on the medium level

On the highest level the AH strategy is determined considering the total risk calculated on medium level and blood pressure class (O, A, B, C). Figure 2 shows the decision making tree.

On the highest level final conclusion is made choosing one from 9 strategies:

1. The basic strategy for all patients.
2. Diabetic strategy for patients with diabetes mellitus.

3. Seven individual strategies, which depend on the number of patient risk factors, blood pressure class, RCC and the TOD: a) Strategy 1 - equal to the basic strategy b) Strategy 2 - before the start of drug therapy observe for 12 months, measure blood pressure 1-2 times a week c) Strategy 3 - before the start of drug therapy observe in 3 months, measure blood pressure every day d) Strategy 4 - before the start of drug therapy observe more than 12 months, measure blood pressure 1-2 times a month e) Strategy 5 - measure blood pressure every 2 months f) Strategy 6 - begin drug treatment g) Strategy 7 - Immediate Intensive Drug Treatment.

The recommended system strategies for an individual patient is composed of 3 components: a basic strategy + Individual Strategy (str. 1 to 7) + Diabetic Strategy if the patient has diabetes.

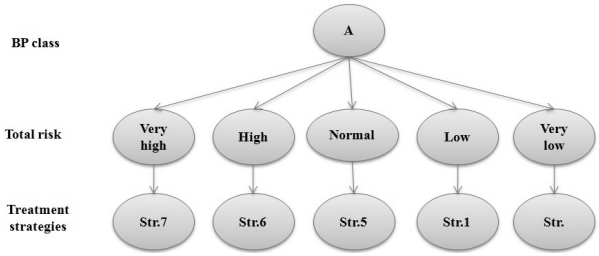

Fig. 2. Decision making tree for blood pressure class A patient on the highest level

Theoretical basis. Decision making in frame and production systems are different. In production system, forward inference is used. It (the facts – the conclusion) begins with the available facts about the problem. Applying the production rules, these facts are examined and new information is obtained. This is continued until the goal is reached [1] [2] [3]. Figure 3 shows how the management cycle recognize-act in the system works.

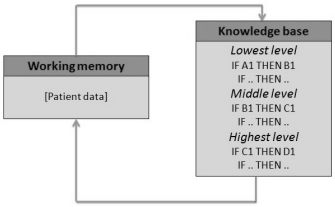

Fig. 3. Management cycle recognize-act

Having entered the patient data, they are placed in the working memory.

The system considers the KB of production rules, starting with the lowest levels, and compares rule premises provided in the working memory. If these conditions are the same, the performance or conclusion of found rule is placed in the working memory. In the same way the system operates on the middle and highest level. When the system reaches the highest level, and finds the rule,

corresponding the premises of the working memory condition, the conclusion of this rule determinates AH strategies and system completes the search [3].

In the frame system, the decision is made calculating the rate of compliance for each frame:

$$F = \frac{F_1^{'} + F_1^{''}}{2}, \quad (1)$$

$F_k^{'}$ – *k* is a frame score for patient *P1*;

$$F_k^{'} = \frac{N_{P_1}}{N_{F_k}}, \quad (2)$$

where N_{p_1} is the patient P_1 symptoms, which coincides with the frame F_k symptoms; N_{F_k} is the number of symptoms, which consists of *k*-frame; $F_k^{''}$ is *k*-frame rate liabilities over the total situation.

$$F_k^{''} = \frac{N_{F_k}}{N_{F_\Sigma}}, \quad (3)$$

where N_{F_k} – *k* is the frame comprising the number of symptoms, N_{F_Σ} is total number of symptoms of all participating frames. In this case, it is quite small, so it will not be taken into account, and compliance will be estimated only after $F_k^{'}$ [4].

Results. Two ES are designed to determinate the AH patients risk and to recommend appropriate control strategy. Systems make decision according to entered parameters. Rule based system data input and conclusion is depicted in figure 4, 5 and 6, but for the frames based system in figures 7 and 8.

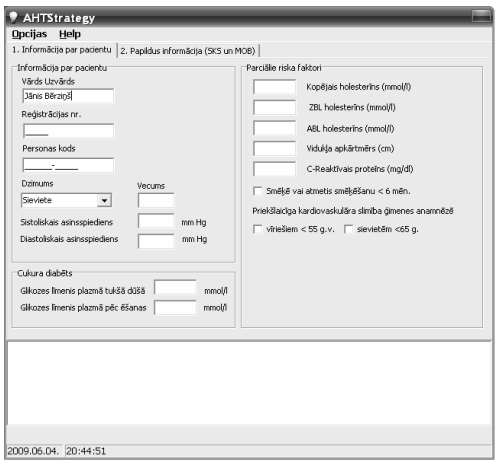

Fig. 4. Data input window of rules based system

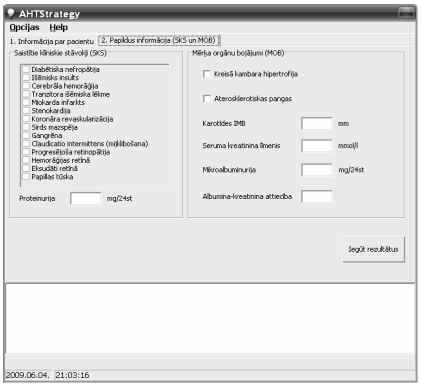

Fig. 5. Data input window of rules based system

Fig. 6. Data result window of rules based system

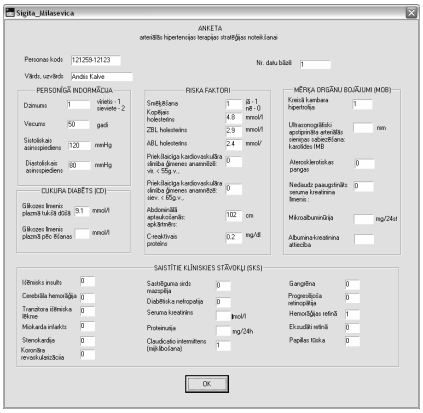

Fig. 7. Frame based expert system (data input windows)

Fig. 8. Frame based expert system (data result windows)

The comparison of the developed ES is demonstrated in **Table 1.**

Table 1. Comparison of the developed computer systems

Criteria	Rule system	Frame system
Possibility of the knowledge representation	Satisfactory	Satisfactory
Amount of knowledge	88 production rules Logical sets	127 frames
Level of difficulty to design KB	easy	difficult
KB structures visibility for expert	Depends on amount of knowledge	Clear
KB realization in expert system	KB representation is similar in all systems	Depends on chosen programming language
Resources of computer	Delphi 88 production rules Independent file	Flex, Prolog 125 frames Can not create independent file
The necessary human resources	The same in theoretical and practical part	Additional activities
Systems convenience for user	Easy to use	Less convenient for use Require the Flex instalation
System decision making	If…. Then… Forward inference	The formula for calculating the frame rate of compliance
Eligiblity for particular task (AH strategy detection)	More appropiate for dinamic decision making	More appropiate for statistical aspect

Conclusion. Knowledge presented in „New European Hypertension Guidelines, 2003" can be formalized using both the production rules and frames. The comparision of the 2 types KB finds the production rule KB base to be easier to make and to use. The KB created allow to develop ES serving a definite aim, i.a., strategy selection for AH patients control.

References

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The paper deals with the building of knowledge basis on the existing knowledge amount in a given domain. In our case we operate with new European Hypertension Guidelines, 2003.
There are developed two knowledge basis containing one and the same knowledge amount applying different representation techniques, i.e., rules and frames. Those knowledge bases are the central element of the two datorized systems for carrying out decision making on health care strategy of arterial hypertension patients. It makes possible the comparison and estimation of two knowledge basis and datorized systems on the whole.