Development of pathogenesis topological model node evaluation complex

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Introduction. Nowadays arterial hypertension (AH) is one of the main heart and vascular diseases. Higher blood pressure often is one of the human work disability reasons and in incurable phase can be lethal. Authors of the article work on intellectual computer method and system development for system recovery tasks and proposed AH modeling method. In further research multi therapy selection [1] and mathematical model processing approach [2] has been presented. In this article first paragraph therapy selection leading-motive is defined. Further paragraph is devoted for mathematical model information level increase approach definition. Results include further research objectives.

1. Definition of therapy complex selection method. AH therapy selection method is based on pathogenesis topological modeling, where basically mathematical model is represented as orientated graph. Mathematical topological graph model (further model) consists of three node types which represents organism subsystem functional levels, therapies and side effects of current therapy. Links between nodes describes functional interconnection. Efficiency of therapy is assumed by considering organism subsystem changes and therapy side effect manifestation. In the process of model creation, overall computer system knowledge of experts is used. Physicians knowledge about AH evolution and therapy selection is implemented. To create more ingenious and real system, therapy selection should be like physicians stream of thoughts, consequently it is necessary to discuss all possible therapy selection variants and select the most appropriate:

Use full therapy browsing

Method is based on all therapy modeling and ranging with goal to select the most efficient solution. It does not use any mathematical or graph assessment approach, but evaluate therapy by its efficiency. This type of selection method is implemented in current system and is useful for case of one or two therapy combinations. When graph size and therapy count (more than two therapies) expands this type of full research is ineffective and can take a long machine processing time. These are the main reasons why such selection method can not be used. Also the main objective is to use more graph theory and artificial intelligence processing tools to improve medical system performance;

Step therapy selection

Selection variant uses medic experimental therapy selection approach. This is iterative procedure with directed therapy enclosure. Such a type of selection can not be implemented because medical system has to work with human and it is not humane to experiment with people. In praxis exists therapy combination compatibility charts, who describe rational, possible or impossible medicine combination solutions. Such compatibilities can be used to evaluate final results and to form additional recommendations;

Use combinations from real patient diseases history

This method describes real physician way of thinking and decision making. Medical experts use their knowledge in medicine field to select the most appropriate therapy for definite patient. This competence is implemented in medical system and model contains all information about pathogenesis, however directly such a selection method is not realized, because all patients are individual and not in all situations the same medicine will affect equally. This method as well can be used to evaluate final results by forming informative references;

Optimal therapy mathematical formation approach

Last therapy selection approach is based on model mathematical processing and overall pointed therapy synthesis. Therapy is not just selected by its efficiency ratio but also evaluated by its information and impression level. Method includes model information level extension (which will be discussed further), iterative formation of therapy set and usage of optimization theory for selection task. This method is extensive, includes parts from previously described methods and it is the most rational therapy selection type.

2. Mathematical model preliminary treatment. Main goal is to enclose more information in existing model by adding additional evaluation results to graph nodes and to pathogenesis therapies.

2.1. Extension of topological model node information level. It is possible to point out three types of node attributes:

- Node weight α describes nodes functional level and it is in scale from 0 to 1. 1 indicates organism normal functional level, but 0 indicates worst level [1]. These parameters are individual for each patient and they describe organism overall condition. Medical expert can evaluate patient state of health and define model node parameters α;
- Node importance or dangerous factor a_1 describes how importance level of node is connected to patient group (age, health, habits and other conditions). For example, elder patients some organism subsystem dysfunction is more critical then young patients the same dysfunction. Also such variable describes how node is dependent from other nodes (relationship between organism elements). These importance levels are given by medical experts and by numerical values introduced in topological model. In medicine computer system values are set in table format and used in production law (If.. Then..) decision making mechanism [4] for further usage;

- Node embarrassment level a_2 describes how specific node is reachable from pathogenesis therapies. At the beginning all graph perambulations from all therapies are performed. Perambulation can be done by using path searching algorithm, for example Dijkstra, Floyd- Warshall or other algorithm [3]. Each node embarrassment level is inversely proportional to therapies count which can access given node. In AH pathogenesis graph model (see Fig. 1) organism subsystem functional level nodes with significance levels are pointed and it is visible that highest significance level (level 1) has node x_1 and next highest level 0.33 has nodes x_3, x_4, x_5, and x_6. Such an exponential correlation logically describes attainability importance. If node is accessible just from one therapy then it is necessary to examine it. If patient have specific organ dysfunctions and it is possible to heal it with just one medicament, then it is obligatory to select this medicament in relation to other therapies.

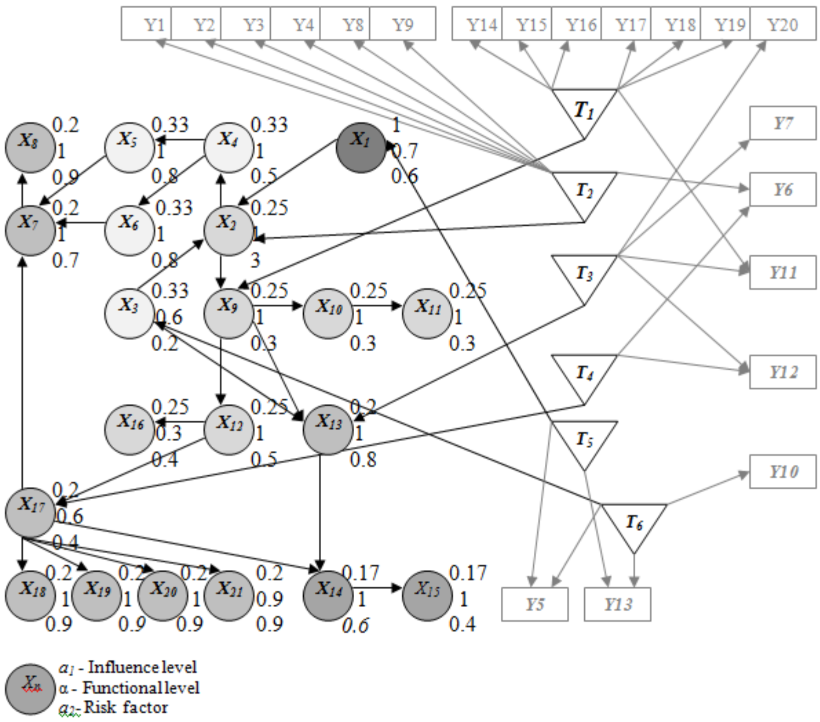

Fig. 1. AH topological model with node attributes

2.2. Usage of attributes and further therapy complex assessment. In previous paragraph examined node attributes should be formed for further usage. Attributes are used to examine therapy information and efficiency level. They are like input variables for therapy selection process and it is not necessary to aggregate them in one common variable. Therapy complex assessment keynotes:

- Complex efficiency $Z(T_i)$ of therapy T_i is the main parameter who describes influence and therapy impact results. It is discussed in [1];
- Complex influence rate to process essential parts. It is described by spectrum which is created by therapy and by surrounding node importance. It is necessary to use node attribute a_1 to evaluate each therapy influence on most urgent organism subsystems;
- Parameter which describes if therapy includes nodes' which are accessible just from one therapy (which are difficult to reach). In this parameter node risk factor a_2 is integrated;
- Previously defined elements are positive, but other valuations are negative and include therapy cost, raised side effect amount and negatively changed organism subsystem node amount.

Results and further research. Article includes foundation of arterial hypertension mathematical model node assessment approach. Three attributes are discussed, which will be used to evaluate therapies and to compare them mutually. Further research covers united valuation scale foundations, therapy complex estimation expansion and implementation in medical computer system.

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Research area of authors includes development of intellectual computer systems for random medicine tasks. In case of arterial hypertension, topological structure model is used as mathematical model. This model is possible to process by using graph theory applications and methods. In this article authors consider node assessment complex, which is necessary for optimal therapy selection process. Node assessment increase model information level and encapsulates knowledge for further processing.