Cognitive IT-systems for big data analysis in medicine

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BACKGROUND: Rapid development of medicine requires regular update of clinical data evidence. This task accomplishment requires participation of numerous specialists in evidence-based medicine, who are proficient in various statistical methods and can work with big data analysis tools in biomedical sciences. This, in turn, requires significant time and other resources. Today, at the peak of IT development, cognitive systems in the field of medicine with special technologies of data collection and analysis, is the start of a new trend.

OBJECTIVE: The development of cognitive IT system for drug prescription with the potential to analyze automatically the information about drugs effectiveness and safety on the basis of clinical practice experience and scientific data according to evidence levels and patients' personal characteristics.

METHODS: The cognitive system was developed with the use of United Medical Knowledge Base (UMKB). UMKB is a semantic network of medical knowledge, which is structured according to the medical ontologies and the theory of fuzzy logic. UMKB is being filled simultaneously in all the areas of medicine. From one side it is filled by means of the linguistic module analyzing medical texts, from the second side - by academic institutions, from the third side – by the cognitive IT systems with the data from electronic health records (EHRs). Native language of UMKB is Russian. It is designed primarily for use in the Russian clinical practice. However the platform for filling knowledge is multilingual and supports any other languages. This means that the practice of world schools may also be integrated and used in UMKB. The peculiarity lies in the fact that UMKB is presented as a semantic network where biomedical knowledge are structured according to certain medical ontologies (special rules of information storage that "carries" data: phenomena, processes, simple and complex concepts in medicine, - in the form of interrelated objects). The keystone underlying UMKB is the model of medical knowledge representation, which is able to describe any area of medicine. With the help of this model one can accurately simulate risk factors, etiology, and pathogenesis of a disease (probability, time of development and the sequence of pathological signs at each stage of a disease). While describing pathological and compensatory mechanisms the database provides an opportunity to clarify a lot of conditions that affect this mechanism. It is also simple to simulate structural and functional features of the concept and its relationships (for example, compensatory mechanisms, reflexes, complex anatomical structures, all the features of variant anatomy and other characteristics), which form reactivity and resistance of the organism. All this is very important for cognitive IT systems concerning personalized and evidence-based medicine. When describing medical knowledge there are often situations of uncertainty, lack of sufficiently complete and accurate data on the subject area, poorly understood phenomena, conflicting

theories or imprecise concepts. Semantic network of UMKB presents complex relationships among medical concepts characterized by the following features: type and direction of relationship, its weight and value, accuracy and personalization of the weight or value of relationship, date of actualization. Multifactorial influence on the weight or value of relationship, a lot of elementary and intermediate traits that influence weight, the moment of actualization are supported to formalize. United Medical Knowledge Base is a large-scale project, its main goal is to increase the quality and duration of life through personalized care based on evidence that can only be achieved by combining medical big data from various fields of biomedical sciences.

RESULTS: On the basis of UMKB a prototype of the cognitive IT system PharmExpert with analytical potential was developed. PharmExpert is a clinical decision support system for drug prescribing, which is integrated into medical information system at health institutions and analyzes electronic health records (EHRs) in any format of the background mode, correcting drug therapy according to personal patient's profile and data about compatibility of the drugs. The system has a very important function – self-learning that will help it to absorb a huge mountain of medical data from routine clinical practice in the nearest future. Now it works on the basis of data from UMKB, handbooks in pharmacology, summaries of medical products characteristics (SmPCs), available reviews of scientific literature and clinical guidelines on drugs interactions and compatibility. In the short term, at the stage of clinical testing, PharmExpert memorizing all the cases of clinical experience and the reaction of the physicians (accepting or ignoring the recommendations of the system), will be able to realize self-learning function by rebuilding ties and remodeling knowledge of the semantic network according to clinical data and generating the best standards of drug therapy taking into account personal characteristics of the patient and levels of data evidence. Working in the background mode is one of the most important advantages of the system. The physician is not asked to enter any additional data beyond that the specialist enters into the EHR on an everyday basis. Now PharmExpert is installed in the medical information systems of the range of clinical centers in the Russian Federation.

CONCLUSION: We developed a prototype of cognitive IT system for drug prescription with the potential to analyze automatically the information about drugs effectiveness and safety on the basis of clinical practice experience and scientific data according to evidence levels and patients' personal characteristics. The system is based on the structured semantic network of medical knowledge from UMKB.

Keywords: Cognitive IT-systems, big data, medicine, medical knowledge, semantic, network

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