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OVERVIEW OF AUTOMATED SYSTEMS FOR DIAGNOSING DISEASES OF INTERNAL ORGANS

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Abstract: *This review paper presents a comprehensive study of medical expert systems for diagnosis of diseases of internal organs. It provides a brief overview of medical diagnostic expert systems and presents an analysis of already existing studies. Automated systems today play a very important role in the development of medicine, and provide assistance to medical personnel in the event of controversial and problematic situations in the treatment of patients. Moreover, medical diagnostic systems can solve not only the problems of diagnosis, but also help in predicting the course of diseases. Modern automated diagnostic systems are computer programs that can analyze on the basis of symptoms and clinical data and can help professionals in problem situations. To date, there are very few computer programs are based on clinical examination data for the diagnosis of diseases of internal organs. Thus, it seems relevant to develop an automated system for diagnosing diseases of internal organs. The purpose of the study as a whole is the development of a computer advisory diagnostic automated system for the diagnosis of diseases of internal organs. Finally, this article provides an overview and analysis of existing medical systems for diagnosis and methods for diagnosing diseases of internal organs basically in Kazakhstan.*

Keywords: *information technologies in medicine, automated diagnostic system, diagnosis of diseases of internal organs*

ІШКІ ОРГАНДАР АУРУЛАРЫН ДИАГНОСТИКАЛАУ ӘДІСТЕМЕЛЕРІ ЖӘНЕ АВТОМАТТАНДЫРЫЛҒАН ЖҮЙЕЛЕРІНЕ ШОЛУ

Аңдатпа: *Бүгінгі күні автоматтандырылған жүйелер медицина дамуында өте маңызды рөл атқарады және пациенттерге ем жасау барысындағы даулы және проблемалық жағдайларда медицина қызметкерлеріне көмек көрсетеді. Медициналық диагностикалық жүйе диагностиканың проблемаларын ғана шешіп қоймай, сонымен қатар аурулардың алдын алуға көмектеседі. Заманауи автоматтандырылған диагностикалық жүйелер – симптомдар мен клиникалық деректер негізінде талдай алатын және проблемалық жағдайларда мамандарға жәрдемдесетін компьютерлік бағдарламалар. Бүгінгі күні ішкі аурулардың диагностикасы үшін клиникалық зерттеулерге негізделген компьютерлік бағдарламалар жоқтың қасы. Осылайша, ішкі органдардың ауруларын диагностикалаудың автоматтандырылған жүйесін жасау маңызды. Зерттеудің мақсаты ішкі органдардың ауруларын диагностикалауға арналған компьютерлік кеңестік диагностикалық автоматтандырылған жүйені құру болып табылады. Бұл мақалада ішкі аурулардың диагностикасы үшін қолданыстағы медициналық жүйелерге шолу және талдау жүргізілді.*

Түйінді сөздер: *медицинадағы ақпараттық технологиялар, автоматтандырылған диагностикалау жүйесі, ішкі органдардың ауруларын диагностикалау*

ОБЗОР АВТОМАТИЗИРОВАННЫХ СИСТЕМ И МЕТОДОВ ДИАГНОСТИКИ ЗАБОЛЕВАНИЙ ВНУТРЕННИХ ОРГАНОВ

Аннотация: *Автоматизированные системы на сегодняшний день играют очень важную роль в развитии медицины, и обеспечивают помощь медицинскому персоналу в случае возникновения спорных и проблемных ситуаций в вопросах лечения пациентов. Медицинские системы диагностирования способны решать не только задачи постановки диагноза, но и помогать в прогнозировании течения болезней. Современные автоматизированные системы диагностики представляют собой компьютерные программы, которые могут проводить анализ на основе симптомов и клинических данных, а также способны помогать специалистам в проблемных ситуациях. На сегодняшний день существует очень мало компьютерных программ, основанных на данных клинического осмотра для диагностики заболеваний внутренних органов. Таким образом, представляется актуальной разработка автоматизированной системы для диагностики заболеваний внутренних органов. Цель исследования в целом – разработка компьютерной консультативной диагностической автоматизированной системы для диагностики заболеваний внутренних органов. В данной статье приведен обзор и анализ существующих медицинских систем диагностирования и методов диагностики заболеваний внутренних органов.*

Ключевые слова: *информационные технологии в медицине, автоматизированная система диагностирования, диагностика заболеваний внутренних органов*

Introduction

The use of information technology is becoming a critical in the development of all areas of knowledge.Diagnosis plays an important role, and diagnosis requires a great deal of skill, knowledge and intuition from a doctor. Timely accurate diagnosis greatly facilitates the choice of treatment and increases the likelihood of recovery of the patient. The accuracy of the diagnosis and the speed of diagnosis, depend on many various clinical data and, finally, the qualifications of the doctor himself. Based on this, it is quite natural to try to determine the conditions under which a diagnosis can be made as quickly and accurately as possible. Recently, with using of modern methods of treatment and diagnostics, the possibilities of diagnostics have greatly expanded. Therefore, it is important to find accurate methods for describing, researching, evaluating and monitoring the process of diagnosis.The purpose of this work is to review and analyze automated systems and methods for diagnosing diseases of internal organs, as well as to identify their advantages and disadvantages.

Diagnosing diseases of internal organs is a rather laborious process and requires processing the information in a logical sequence. Modern medical equipment allows you to see through the body. Moreover, in the diagnosis of diseases of internal organs there is no need to introduce sensors inside - everything that happens in the body will be shown on a computer monitor or in pictures. Such studies are called non-invasive[2]. The main methods of diagnosing diseases of internal organs that are used in the Republic of Kazakhstan are:

- X-ray - a method of diagnostic X-ray research, in which the image is displayed on a luminous fluorescent screen.
- Ultrasound diagnostics of internal organs - ultrasound examination technology is based on the action of a special sensor emitting and receiving ultrasonic waves and transmitting them through the patient's organs. However, they are either absorbed or reflected from them like an echo. The procedure is completely harmless, because the waves are produced literally for 2–3 seconds, and then the sensor only receives information. This method has established itself as one of the most affordable and effective for the diagnosis of many diseases.
- Computed diagnosis of internal organs - Computed tomography is more often used in the diagnosis of diseases of the chest, abdomen, retroperitoneal space, and pelvic organs. The newest CT scan makes it possible to examine in detail the inflammations, abnormal changes,

identify circulatory disorders, tumors, and accurately diagnose diseases.

• MRI diagnostics of internal organs - The newest, most accurate and popular type of hardware diagnostics. The technology does not provide for irradiation, therefore it is absolutely safe. The principle of operation is quite complicated. Inside it, a magnetic field is produced, the waves of which act on the human organs at the molecular level. The molecules start moving, and the computer transmits these movements to the monitor. In the course of a single MRI procedure, it is possible to visualize in detail all the organs of the gastrointestinal tract, chest, brain and make a diagnosis at the earliest preclinical stages. [1]

Let's analyze the existing automated systems used to diagnose diseases. For the processing, storage and reuse of medical data in diagnostic and treatment technologies require the use of artificial intelligence [4]. Artificial intelligence is the field of informatics, the technology of creating hardware and software tools that allow the user to set and solve intellectual problems, communicating with a computer in dialogue mode [3].

Automated systems for diagnosing diseases allows automate the decision-making process when examining patients, making a diagnosis, prescribing a treatment, raising the level of qualification [3]. In practice, the use of automated systems has shown that the quality of diagnosis and treatment of the patient has improved significantly. Medical automated systems allow the doctor to check their own assumptions, and also help make a decision in difficult diagnostic cases. At the same time, such an information system does not replace a doctor, but acts as a "competent partner" - an expert consultant in a particular subject area. The use of such systems has a number of indisputable advantages, such as objectivity of conclusions, since there are no emotional human factors (fatigue, unwillingness to work, problems in the family, incompetence). They also accumulate experience and knowledge of highly qualified specialists.Therefore, it is necessary that automated systems have the ability to flexibly formulate tasks, apply to all areas of medicine, have large information capacity and noise immunity, and do not need a long time to process medical data.

Currently, medical diagnostic systems are based on several methods of information processing [3]:

- building a decision tree;
- statistical data processing;
- using the method of artificial intelligence.

*Building a decision treemethod.*When using this approach, the program records the sequence of questions asked by the doctor when solving a diagnostic problem. Such a protocol is structured as a tree (see fig. 1). Each vertex of such a tree is a specific question asked to the patient, and the branches emanating from the vertex correspond to alternative answers to the question and lead, in turn, to new questions. The program proceeds from question to question until a solution is found or possible transitions are exhausted [3].

Statistical data processing method. This approach is to apply the methods of mathematical statistics. It is based on the processing of large amounts of information collected on diseases subject to machine diagnostics.

Data processing, based on the use of elements of artificial intelligence. In such systems, an attempt is made to simulate a person's ability to examine the subject area and make inferences with the rejection of the least promising areas of search (see fig. 2). For this purpose, sets of rules are used that are set a priori and are, in essence, the knowledge of experts in a particular problem area. It is the quality of knowledge that determines the "competence" of a problem-oriented expert system [3].

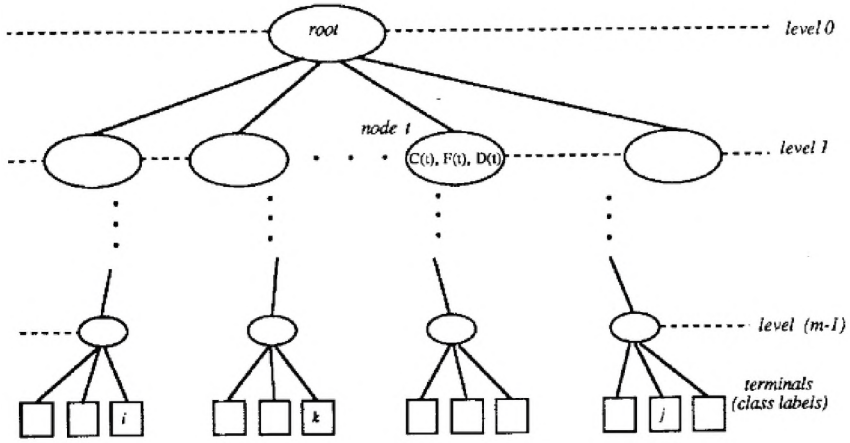

Figure 1: Decision tree method

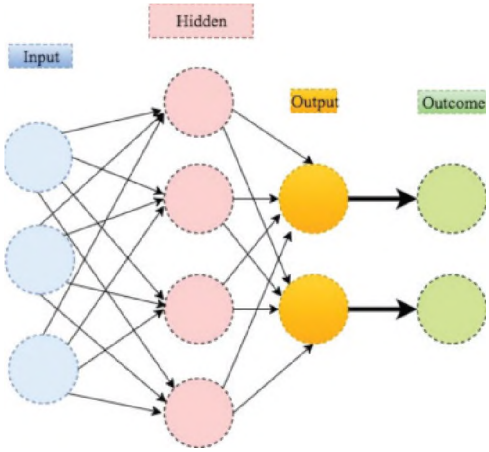

Figure 2: An illustration on neural network

Medical diagnostics is not an exact science. If the patient specifies a specific set of symptoms of a disease, then this relationship is not always absolute.

Presently, a large number of automated expert systems for the diagnosis of diseases in medicine have been created. With the help of them a wide range of tasks is solved, but only in highly specialized subject areas. Diagnostic systems are used for diagnosis. The most well-known automated system is MYCIN, which is designed to diagnose infectious diseases. Currently, this system makes a diagnosis at the level of a specialist doctor. It has an extensive knowledge base, so it can be applied in other areas of medicine [5]. The MYCIN expert system, developed at Stanford in the mid-1970s. The program is one of the first systems that addressed the problem of making decisions based on unreliable or insufficient information. All the reasoning of the MYCIN expert system was based on the principles of control logic. MYCIN was written in LISP list processing language. MYCIN was designed to diagnose bacteria that cause severe infections, such as bacteremia and meningitis. MYCIN was also used to diagnose blood clotting diseases. After launch, the program asked the user (doctor) a long series of simple and textual questions. As a result, the system provided a list of suspected bacteria, sorted by probability, indicated a confidence interval for the probabilities of diagnoses and their rationale, and also recommended a course of treatment [5].

Consider a simple system of diagnosing "Home Doctor" - the expert system recognizes about 100 of the most well-known and common diseases. The program with the aim of establishing the diagnosis asks questions with the answers "yes", "probably, yes", "I do not know", "not quite", "no". After asking dozens of questions, the system tries to determine the disease. In case she succeeds in doing this, the program will provide a description of the disease, its symptoms and treatment methods. The system is intended only for the initial determination of the nature of the disease. The program relies on a rather limited number of symptoms, which affects the quality of forecasting [6].

The automated system "Cardiologist" is used to diagnose cardiovascular diseases, determines the patient's diagnosis by the symptoms entered, prescribes a course of treatment and prevention. For the development of the expert system

"Cardiologist", the Pascal language and the Delphi 7 development environment were chosen [7].

MatheMEDic's EasyDiagnosis system is an online version of the medical expert system, where any user can make a diagnosis with a varying probability. This system is a free English-language service, where it is possible to establish the diagnosis of the disease or the causes of illness with the help of a test. After accepting the terms of service by the user, a window opens with a test where you need to specify your gender and age and then begin to answer questions. After all the questions have been answered (their number varies depending on the disease), a diagram appears where the probability of having a particular disease is given as a percentage [8].

The DXplain system is an example of an intelligent system for supporting clinical decisions; it contains in its knowledge base symptoms, laboratory data and procedures linking them with a list of diagnoses. It provides support and justification for differential diagnoses and subsequent research. Its database contains 4500 clinical manifestations that are associated by associative links with more than 2000 different nosology [4].

The Germwatcher system was developed to help the hospital epidemiologist. System contains a large amount of data on various microbiological cultures. Includes a rule-based knowledge base that is used to generate hypotheses about possible infections GERMWATCHER has been deployed at Barnes Hospital, and infection control environment, the expert system design, and redeployment then compare our system to other efforts in computer-based infection control [9].

The Aibolit software package is intended for the diagnosis, classification and correction of the treatment of acute circulatory disorders in children. It was actively used in surgical interventions and the choice of postoperative treatment in the intensive care unit. The system includes a mathematical model of blood circulation that "reacts" to the current information coming from the sensors. It allows not only to diagnose and evaluate the patient's condition, but also to help in the selection and subsequent correction of therapeutic measures [10].

The HELP system is a complete information system based on artificial intelligence technologies [4]. It supports not only standard hospital information system functions, but decision support functions. These functions are incorporated into the routine applications of the hospital system. They support the clinical process with alarms and reminders, interpreting data, developing proposals for managing the treatment process and clinical protocols. These functions can be activated from normal applications or activated independently after entering clinical data into a computerized medical history. We also note the SETH system, the scope of which is the analysis of the toxicity of drugs. The system is based on the modeling of expert reasoning, for each toxicological class taking into account the clinical symptoms and doses used. The system monitors the treatment process, aimed at controlling the interaction of mutual exclusion of drugs. So, today, artificial intelligence technologies are used in various fields of clinical medicine. Briefly describe these areas.It is about real-time patient monitoring through bedside monitors. Expert systems are embedded in such monitors and assess the patient's condition and their changes. They can also remind you of the need or order for taking medication and send reminders, for example, by e-mail [4].

Table 1 displays the comparison analysis on existing medical automated systems; each column corresponds to system's characteristics and rows represent the various systems' names, with which a specific result is described. References to every work are presented in a table.

Table 1: Comparison of Existing Studies on Medical Expert System

System name	Diseases diagnosed	Inputs used in the system	Additional	Drawbacks	Refe-rences
MYCIN	infectious diseases	decisions based on unreliable or insufficient information, and real patients data are collected by doctor	This system is developed by using rule-based inference method of evidential reasoning different types of uncertainties. Practical case studies shows that the system results are effective.	The system need to be updated manually. So, the system all itself doesn't learn.	[5]
Home Doctor	100 well-known common diseases	Asks questions step by step	System use decision tree method and the program relies on a rather limited number of symptoms, which affects the quality of forecasting	This system is developed for a specific domain, which is not required.	[6]
Cardiologist	cardiovascular diseases	Disease symptoms, real patients data	This medical automated system will be practical for doctors for providing decision of disease. Patient's information can be used to valuation of the automated medical system	The system saves only temporary information, no memory for long-term patient's information.	[7]
EasyDiagnosis	Various diseases	Online test, questionnaire	After all the questions have been answered, a diagram appears where the probability of having a particular disease is given as a probability.	No evidence that questionnaire is accurate	[8]
Dxplain	Diseases of internal organs	Disease Symptoms, Lab test results	It contains in its knowledge base symptoms, laboratory data and procedures linking them with a list of diagnoses. It provides support and justification for differential diagnoses	Too expensive	[4]
Germwatcher	Diseases of internal organs	Disease Symptoms	This rule based medical system detects diseases under uncertainty using evidential reasoning approach. Results show that proposed system is reliable and accurate.	System is not reliable to install everywhere	[9]
Aibolit	Various diseases	Disease symptoms, real patients data	The system includes a mathematical model of blood circulation that "reacts" to the current information coming from the sensors. It allows not only to diagnose and evaluate the patient's condition	Can be used only among hospitals, not able to learn from the mistakes	[10]
Help	Diseases of internal organs	Disease Symptoms	The system is based on the modeling of expert reasoning, for each toxicological class taking into account the clinical symptoms and doses used. The system monitors the treatment process.	No experimental results of current system,	[4]

Conclusion

This article is devoted to the review and analysis of existing automated systems for the diagnosis of diseases. In medicine, it is important to find accurate methods for describing, researching, evaluating and monitoring the process of diagnosis. If we are dealing with a large number of interdependent factors that reveal significant natural variability, then for a fairly effective description of a complex pattern of their influence, there is only one way - using the appropriate statistical method. If the number of factors or the number of data categories is very large, then it is desirable or even necessary,

to use a computer so that the desired results can be obtained in a relatively short time. This approach in no way detracts from the diagnostic abilities of the doctor. On the contrary, it opens up even more room for the manifestation of these qualities, freeing the physician from the need to deal with such problems that can be formulated in numerical and logical form and, therefore, solved by mathematical methods and using computer technology. However, it is assumed that each disease has its own non-overlapping sets of symptoms, while in practice it often happens that the same symptoms occur in different diseases. Currently available evidence suggests that computers can undoubtedly play an important role in the diagnosis; assess the accuracy of diagnoses that doctors put in order to increase the overall level of diagnosis; the creation of textbooks for students, as well as for the collection, synthesis and processing of clinical data for the qualified use of their doctors in the diagnosis.

In general, we can conclude that the introduction of IT in the field of medicine and more precisely, the diagnosis of diseases will help improve diagnosis, which in turn will improve the quality of service, significantly speed up the work of medical personnel and reduce subjectivity.

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