Application of progressive information technologies in medicine: computer diagnostics and 3D technologies

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Abstract. The article shows the features of the use of information technology in the medicine. In the modern world, computer technology is an integral part of a medicine. With the help of information technologies, the doctor is able to visualize information at various stages of work, create and maintain a data bank associated with various information medical systems, and have access to expert systems for making a diagnosis. With the support of 3D modeling, 3D scanning and 3D printing, it has become permissible to form medical products that are extremely adapted to the individual characteristics of the person. This article discusses the positive aspects of the introduction of information technologies in medicine and the problems that hinder their implementation, at the same time, some ideas are proposed that are necessary to improve the quality of healthcare.

1. Rationale
In a rapidly developing world, the need for information processing and subsequent access to this information has arisen. To achieve this effect, technical equipment as well as access to multimedia content and communication networks (both global and local) are needed. The main task of information technology is to unite and simplify all aspects of human life. In medicine and healthcare, this is about creating a medical information space that contains the data necessary for doctors in their work, this is primarily due to the inability of a person to remember and know everything about their activities. In healthcare, this problem manifests itself in the impossibility of memorizing all symptoms of the
disease and drugs for treatment, and sometimes a clinical study of the patient is required.

Today it is already impossible to imagine modern life without the use of computer technologies, they have penetrated into all aspects of our life. And medicine is not an exception. Computers are an essential tool of any area of medical practice. The use of computer technology in medicine has increased tremendously over the past 20 years [1]. Today, it is already impossible to imagine medical institutions without the latest technologies. In the Russian Federation there is a large-scale introduction of innovative computer and nanotechnology in the field of medicine. This process is accompanied by changes in medical theory and practice associated with the introduction of adjustments to the training of medical workers.

2. An overview of modern information technologies used in medicine

Communication means or any equipment related to monitoring the patient's condition are needed in order to help bed-bound patients. This type of equipment includes not only purely medical devices, but also some items of everyday life, for example, electronic watches that support pulse reading technologies, telephones or any other items with the ability to track a person's geolocation. The last option is primarily associated with the ability to track the location of the patient, in case of need to provide rescue emergency care, while it is difficult to provide permanent personal presence of a doctor for monitoring of patient state [2]. In this case, the doctor and the patient can conduct a video examination, which allows the doctor to conduct an external examination and interview of the patient on a disturbing issue and subsequently determine the danger and further course of work.

The above refers to the study of the patient's problem. It is necessary to enter the course of treatment and the diagnosis into the corresponding medical records, which can also be properly transferred to databases and electronic medical records with the help of information technology, to create a more convenient storage of the history of diseases, which will greatly simplify information processing.

After entering and processing the information, the doctor needs to determine how to work with the patient, in this case the global Internet provides doctors with access to the necessary information. But it shall be mentioned that in this case not all information is accurate or true. In some cases, non-professionals publish erroneous articles and studies, which can lead to problems with the patient's health and to professional problems of the doctor [3,4].

Another benefit of information technology in medicine is access to educational programs, at any point and time, which leads to an increase in the quality of education and the level of professionalism of the doctor. There is no doubt that there is also a risk of receiving a poor-quality education, but because of this, this method should not be excluded.

But in addition to improving the quality of medical services, information technology helps to reduce economic costs. It affects the benefits of use of new information technologies. In many countries use of the simplest options like creation of databases made it possible to get rid of the problems with constant confusion caused by the loss of papers or having trouble finding the information that doctors need.

Information technologies also provide an opportunity in telemedicine, this option provides an opportunity to examine and familiarize a person with solution of problems that have arisen at a certain moment, while the doctor does not have the opportunity to arrive at the place, due to the inaccessibility of this place.

But telemedicine does not provide an opportunity to solve problems associated with serious diseases, in this case telemedicine provides only information on how to act in certain conditions.

In the modern world, computer technology is an integral part of a medicine. And the oncological service is not an exception. Computer tomography (CT) plays an important role in the life of oncologists and cancer patients [5]. Multiphase scanning on multispiral tomographs allows detecting a tumor at an early stage. It is also used to perform minimally invasive surgical interventions (diagnostic puncture biopsies, drainages, ablations).

Computer tomography has been visualising organs and tissues for over 30 years. For the first time,
the method of radiation diagnostics became known on April 19, 1972. Due to computed tomography, an impetus to the development of digital radiography, magnetic resonance imaging, and single-photon emission tomography has been given. In X-ray practice, two types of computed tomographs are most often used: spiral or screw and multispiral or multislice.

Computer tomography is a diagnostic method based on the use of X-rays. During CT scan the patient is x-rayed around its longitudinal axis, which provides a cross-sectional image. For examining the brain or lungs, a 4- or 16-spiral CT scanner is sufficient. But at least 64 spiral CT scanner is needed for the diagnosis of the heart. The radiation dose from computer tomography is much less than from radiography [6]. CT is effective for diagnosing the following diseases: brain cancer, lung cancer, tumors of the stomach and intestines, kidney cancer, liver cancer, pancreas cancer, spleen cancer, etc. Contrast-enhanced CT scan helps distinguish malignant tumors from benign tumors. It also makes it possible to assess the condition of the tumor and determine the presence of the metastases. In addition to diagnosing cancer, CT is used to monitor the correctness of certain procedures. During the procedure, the patient lies without motions, while the tomograph rotates around the examined area of the body. To obtain clearer images a contrast agent is used in oncology. It is drunk or injected into a vein and pictures are taken before and after use of a contrast agent.

Diagnostic puncture biopsies, drainage of cavities, local drug and radiation therapy, percutaneous tumor ablation, neurolysis, and various pain therapy options are performed with the help of CT control. Puncture biopsy machines are equipped with a CT scan mode. The manipulations are greatly simplified by the use of automatic puncture needles [7].

Computed tomography plays an important role in the detection of cancer, because it produces a layer-by-layer scan that allows physician to detect the tumor in the early stages and start treatment in a timely manner. CT scan for cancer is performed not only for diagnosis, but also to assess the effectiveness of treatment, search for metastases. Also, biopsy of neoplasms is performed under CT control.

Modern society is used to saving time. So, this need has reflected in medicine naturally. Computer diagnostics of the body perfectly replaces the long waiting in queues. Previously, people had to spend for up to several days within the walls of hospitals in order to conduct a full examination and get an established diagnosis. Today, all this confusion and long wait can be replaced by signing up for computer examination. Medical diagnostics has made great strides in recent years [8,9]. The latest technologies make it possible to identify the disease at an early stage and to help the patient in timely manner. These methods include bioresonance testing.

Benefits of computer diagnostics:

- Computer examination allows physician to conduct accurate identification of pathological signs of the disease at the stage of the asymptomatic period.
- Computer examination reveals the links between various pathological processes. After analysis of these links the full picture of the state of health can be seen.
- Identification of parasitic, microbial, viral and fungal infections.
- This method allows person to obtain complete information about his health. It is not fully available during use of ultrasound diagnostic, X-ray diagnostic, etc. These diagnostic methods only detect an already formed process.

Due to the high precision, productivity and versatility, computer technologies have found their place in modern dentistry. There are programs where there may be a function of modeling of a specific clinical situation and a proposed treatment plan for dental patients reflected on the screen in addition to automated work with documents. At present, a variety of intraoral digital photo and video cameras have been developed for visualization. These devices are easily connected to a personal computer and are easy to use. Computed radiovisographs are increasingly being used for X-rays. They do less harm than X-rays and receive more accurate information [10]. Also, with the help of computers, physician can control the conducting of anaesthesia.
Due to the high development of technologies, devices appear capable of conducting high-precision diagnostics in modern ophthalmology. For example, corneal topography. The method is based on computer analysis of concentric luminous rings reflected from the cornea. The refractive power and curvature of the cornea is calculated not only in the optical zone, but also over the entire surface, which is necessary during examination for refractive surgery, during diagnosis of the irregular astigmatism, during scars and corneal deformities. Also, it is necessary for accurate selection of contact lenses.

3. 3D technologies in medicine

3D technologies have brought about a real revolution in medicine. With the support of 3D modeling, 3D scanning and 3D printing, it has become permissible to form medical products that are extremely adapted to the individual characteristics of the person. Today 3D scanners and 3D printers are a common practice in surgery and dentistry.

The latest technological processes make it possible to produce mock-ups of organs and bones, generate 3D models and carry out high-precision 3D printing of prostheses, implants, orthopedic insoles and other products. Due to these innovations, it is possible to increase product safety, save time, reduce production costs and the price of end products, but most importantly, due to them it is possible to improve the life of patients [11,12].

Medicine was one of the first industries that decided to use the potential of 3D printers for practical purposes. Moving from simple to complex, leading physicians have been looking for ways to introduce additive printing into medical practice.

Developers of 3D printers also did not stand still, developing materials that were ideally optimal for printing dental implants, prostheses, prototypes of human organs, and also discovered a method of printing using biological material. Interesting fact: The first implant has been printed in 2012 by LayerWise Corporation. At the same time, doctors performed the main procedure on the implantation of a titanium lower jaw, which has been printed on a 3D printer. Nowadays, three-dimensional printing is used in almost all branches of medicine: dentistry, prosthetics, eye surgery and microsurgery and many others. 3D modeling in medicine makes it possible to form volumetric models [13]. The technology has found application in aesthetic dentistry, oncology, otolaryngology and other areas. 3D models printed on the basis of additive technologies, coupled with computed tomography, have become one of the indispensable achievements in the field of medicine. Three-dimensional images of patient organs are transformed into a picture with significant quality, and then converted into 3D models. Modeling provides an opportunity to conduct an extremely high quality of the preparation for the procedure and study the characteristics of the disease. For example, during preparation for an operation to remove a tumor, doctors carefully examine the size, shape, outline of the neoplasm in three dimensions, in order to understand what tactics to choose during the procedure.

The organization of operations with support for 3D modeling is carried out according to the following method:

- scanning of the desired organ / tumor;
- creation of a three-dimensional image by the program;
- printing a prototype;
- study of the model;
- choice of treatment or surgery technique.

Examples of equipment that use information technology are mainly associated with the ability to examine the results of scanning equipment in more details. For example, using information technology in dentistry, different fragments of a dental image can be examined and then these changes can be entered into the database.

Thus, modern, 3D printers can help workers to prepare for surgery in an appropriate way.
4. Findings
All of the above examples of the use of computer technology in medicine are only a small part.
Digging deeper, it can be concluded that the use of computers plays an important role in the modern
life of the doctor and his patient. After all, with their help, now person can easily check his or her
health, doctor can establish the correct diagnosis and prescribe an effective course of treatment
without long-term waiting.
But whatever the benefits of information technology, the main problem is the availability of
equipment and software. Their development and creation is rather difficult and the problem is in its'
spreading to remote parts of the world, countries or regions. These problems lead to a slowdown in the
spread of information technologies [14,15].
The basic necessary equipment (not only for highly specialized, but for a wide spectrum
physicians) is required in most hospitals, but their delivery and installation is quite problematic. In this
case information technology allows creating a base of necessary equipment for institutions in need in
accordance with the need. Thus, a shortage of equipment can be responded (the need for medication
has the same principle of work).
Information technology is also used in laboratory research, thereby they help to accelerate drug
development and improve the quality of experiments.
With the help of information technology, it becomes possible to conduct an examination and find
out future possible problems on the basis of the body size and its characteristics [16].
The study of the inner part of a person is associated with risk and in this case it is not about
physical harm. The problem is related to the receipt and storage of the collected data. In this case
information technologies make it possible to process and issue all data with high efficiency at any
access point.
The appearance of such a quantity of equipment has led to the need to create unified software
standards that can automatically analyze and predict the development of the disease and treatment with
the subsequent transmission and processing of information.
The development of information technologies and the subsequent application of these technologies
in medicine contribute to the improvement of human health and, consequently, to an increase in the
quality of life of people with a subsequent decrease in the risk of disease in the population.

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