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APPLICATION OF COMPUTER TECHNOLOGIES IN MEDICINE

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Abstract : At present, computers have become widespread in many branches of medicine. The work shows the chronological scale of the relationship between computer technologies and medicine from 1954 to 2006. The advantages and disadvantages of EMR and CDSS are shown.

Keywords: EMR, CDSS, NVMe drive, history, medicine, MUMPS database, drugs.

Starting with CPOE (computerized physician order entry) — a computerized system of doctor's orders (prescribing tests and/or medications), ending with robot interns assisting surgeons during operations. Computers also play a significant role in the work of clinics in general, helping to plan and perform various administrative tasks, track finances, conduct inventories, etc. The Internet also played a far from minor role, where a new direction in medical diagnostics emerged – teleradiology (in other words, the transmission of medical images and data via the World Wide Web).

This innovation made it possible to analyze patient data and make decisions regarding their treatment while being away from them, thereby saving valuable time. Doctors also had the opportunity to quickly consult with their colleagues from all over the world.

The vast medical knowledge base stored on the Internet is also available to patients, giving them the opportunity to learn about their illness, recognize symptoms, find out the necessary information about the doctor and/or clinic, about medications, etc. many controversies regarding the use of the Internet by patients .

The fact is that trusting the patient to diagnose and prescribe treatment is extremely dangerous for him. On the other hand, if the patient combines the use of information from the Internet with a visit to a real doctor, this can improve the quality of his treatment.

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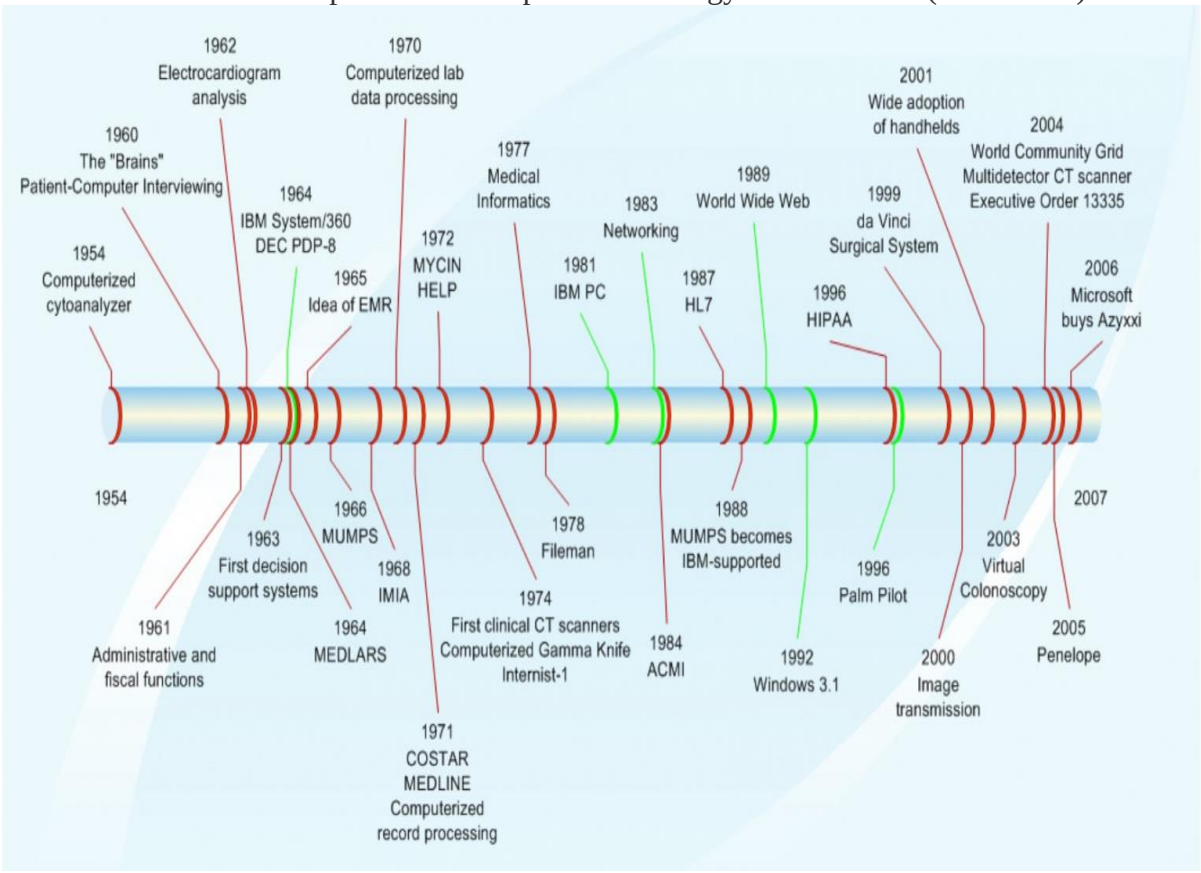
And perhaps the most unusual application of computer technology in medicine is video games. They are used to train surgeons who will later perform laparoscopic surgeries (where small incisions are made in the area to be operated on from the inside, rather than a large incision and "open" surgery). A 2004 study found that surgeons who played video games for about three hours a week made 37% fewer errors during such surgeries.

Timeline of the relationship between computer technology and medicine (1954-2006)



Year	Event	Description
1954	Computerized cytoanalyzer	An electron optical device for screening cells suspected of b malignant.
1960	“ Brains ”	IBM 650 called " Brains " - scanning medical records to de subtle anomalies.
1960	Computerized patient survey	Computerized patient history
1961	Administrative and fiscal functions	Implementation of computers for administrative and fisc functions

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1962	Electrocardiogram analysis	Electrical impulses from the heart were transmitted via telephone to a central computer, which created a curve a analyzed it.
1963	The first decision support system	A computer approach to rehabilitation has been introduced. example, a computer was used to determine the optimal tim wear a plaster cast during surgery.
1964	IBM System /360	S/360 computers are released
1964	DEC PDP-8	Presentation of the "mini " computer PDP-8
1964	MEDLARS	MEDLARS is a computerized database system for indexing retrieving medical citations from the National Library of Medicine (NLM).
1965	The idea of EMR	Development of the idea of electronic medical records
1966	MUMPS (Massachusetts General Hospital Utility Multi-Programming System)	Multi-Programming System (MUMPS)—also called "M"— a programming language for the healthcare industry.
1968	IMIA	The International Medical Informatics Association (IMIA) founded in France.
1970	Computerization of data processing from laboratories	Using computers to perform laboratory calculations, such a determining the chemical composition of amniotic fluid.
1971	Computerized records processing	IBM System /3 Model 6 was used to process patient test res
1971	COSTAR	Outpatient patient records database written in MUMPS language
1971	MEDLINE	MEDLINE goes online
1972	MYCIN	MYCIN is an interactive expert system for the diagnosis an treatment of infectious diseases. Developed at Stanford Sch of Medicine on the DEC PDP-10.
1972	HELP	Assessing health status through a logical process - Health Evaluation through Logical Process (HELP) was developed LDS Hospital
1974	Computer tomography	The CT scanner was invented by Hounsfield and Cormack 1972 (for the head only). In 1976 - for the whole body.

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1974	Computerized Gamma Knife	Implementation of the first computer program for dose plan of training for the gamma knife (a method of radiosurgical removal of brain tumors).
1974	Internist-1	A computer diagnostic system developed at the University Pittsburgh .
1977	Medical informatics	The term "medical informatics" is defined
1978	Fileman	A set of utilities written in the MUMPS language that implement metadata functions
1981	IBM PC	IBM's personal computer is out
1983	Networks	Introducing networking to the public
1984	ACMI (American College of Medical Informatics)	The American College of Medical Informatics (ACMI) was created.
1987	HL7	Health Level Seven , Inc. (HL7) was founded as a standard the exchange of clinical data.
1988	MUMPS and IBM	MUMPS becomes a language supported on IBM
1989	WWW (World Wide Web)	The Invention of the World Wide Web
1992	Windows 3.1	Windows 3.1 Release
1996	Palm Pilot	Palm Release Pilot (Pocket-mounted personal computer)
1996	HIPAA (Health Insurance Portability and Accountability Act)	Congress passed the Health Insurance Portability and Accountability Act.
1999	Surgical system da Vinci	This robotic surgical system was developed by Intuitive Surgical . The prototype was developed in the late 1980s at Stanford Research Institute under contract with the US Arm
2000	Transferring images	Clinics have begun to transmit electronic copies of diagnost images (X-rays, MRI scans)
2001	Widespread use of PDAs	In the early 2000s, healthcare workers widely used handhel devices to perform tasks such as accessing medical literatur and electronic pharmacopoeias.
2003	Virtual colonoscopy	Virtual Colonoscopy uses a combination of CT scanning technology and computer graphics.

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2004	WCG	IBM launched this project to search for genetic markers of various diseases.
2004	Multi-point CT scanner	This new heart scanning technology could largely replace angiograms .
2004	Decree No. 13335	President Bush issued this order entitled "Incentives for the of Health Information Technology"
2005	Penelope	A robot intern was introduced to the world
2006	Microsoft buys Azyxxi	Microsoft has bought clinical medical software that can ext and display different types of patient data.

Electronic Medical Records (EMR)

Back in 1960, the New York The Times published an article in which a doctor from Tulane University made an interesting point about "medical records stored on tape or in other computer-friendly ways that could completely replace patients' written notes."

In 1967, an article mentioned the following vision of the future: “every man, woman and child could have all his or her medical data electronically recorded in a huge memory system in Washington.”

There was a discussion about the advantages of such a system. If, for example, a person had a heart attack, and he is in another city. The article gave the answer: "the assigned doctor will only need to call Washington, and in seconds he will have all the data of this patient." Now, more than half a century later, we see how such systems have become a reality and are widely spread in various medical institutions around the world.

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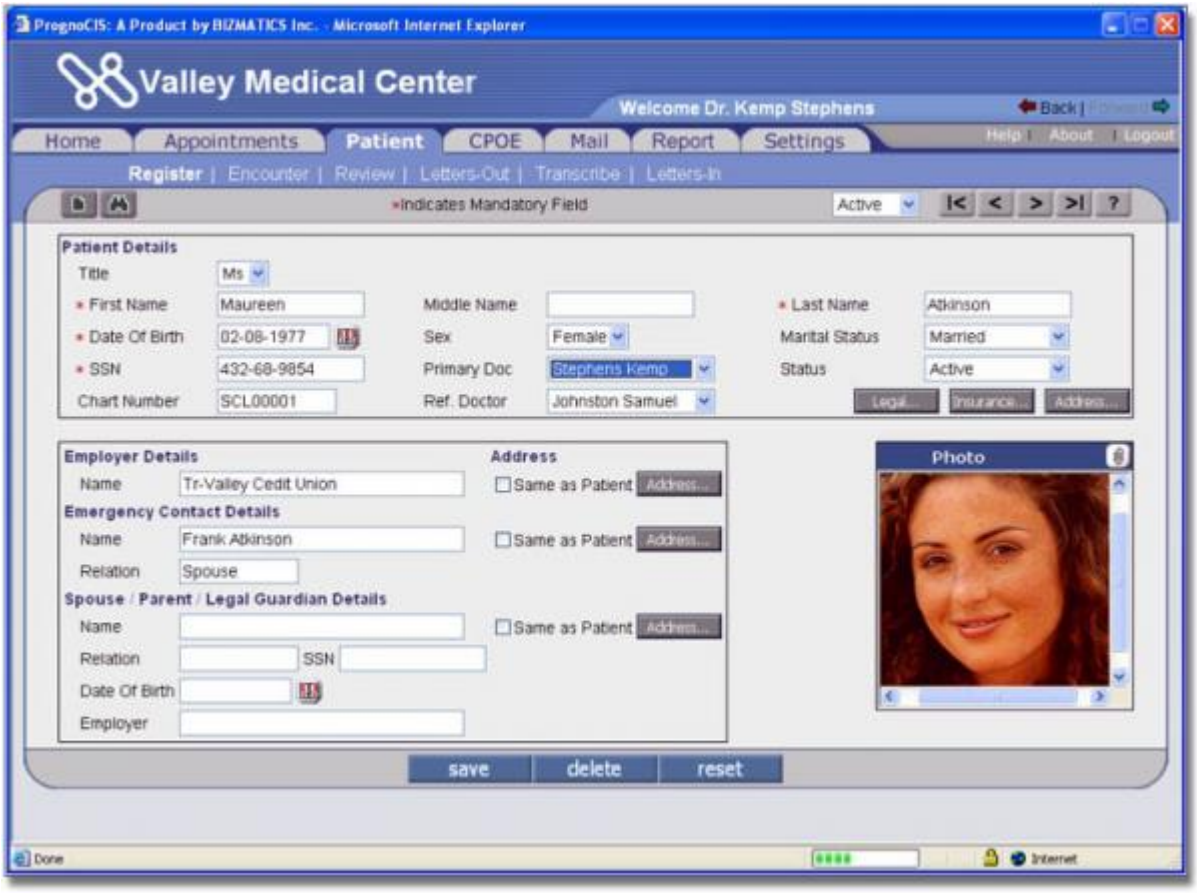

In addition to the benefit of remote access to data, EMRs have other advantages that we will discuss below. Based on these advantages and the fact that the idea of electronic records has been around for many decades, you might think that EMRs are used absolutely everywhere. However, this is not entirely true. For example, in the United States, EMRs are used in only 17% of hospitals.

History of EMR

In the late 1960s, a programming language called the Massachusetts General Hospital Multi-Programming System was developed. General Hospital Utility Multi-Programming System (MUMPS) for use in healthcare systems.

It did not gain widespread use until the 1970s, when it began to be used to create many clinical programs. To this day, many older systems run on MUMPS-based software.

Despite its original medical focus, MUMPS is also widely used in other industries that require a large number of simultaneous connections to the database (banks, stock exchanges, travel agencies).

In 1978, Joseph (Ted) O'Neill, Marty Johnson and their team developed Fileman using the MUMPS language. Fileman was a set of generic procedures, specifically simplified for users who were not familiar with MUMPS or programming in general.

Fileman during the late 1970s and early 1980s . Later, the U.S. Department of Veterans Affairs began using Fileman as its official medical program.

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In 1981, Mickey Singer founded a software company called Personalized in Florida. Programming Inc. , which became one of many that would later form Medical Manager Inc .

It provided clinics and private practitioners with software that was so popular that by 1997, more than 24,000 clinics and 110,000 practitioners were using it. But it only went downhill from there.

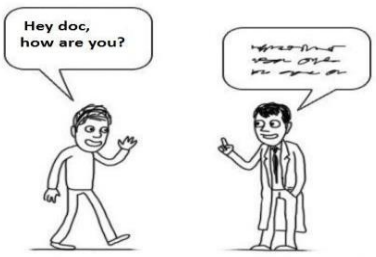
In exchange for Medical Manager Inc. came Open Public Public License (GPL), which provides its users with the source code of the software, giving them the opportunity to carry out the necessary customization .

There are currently between 250 and 500 companies providing EMR solutions. Some focus on small systems like prescriptions or patient records. Others offer packaged solutions.

Benefits of EMR

The primary users of EMRs are physicians and other medical personnel . A standard EMR gives them access to an electronic version of a patient's medical record that has been stored on paper for years . So why change what has worked for so long?

- The answer is simple - doctors' mistakes. One of the main problems of medicine in all eras was iatrogenic complications of the patient's condition, that is, those that were unintentionally caused by the actions of the medical staff . personnel . For example, prescribing the wrong drug, or prescribing too much or too little of it. Electronic medical records, when coupled with clinical decision support systems, can provide automated checks to prevent such errors.
- Another advantage is access to the database from anywhere in the world. This allows for better coordination of the work of various specialists, reducing the time for reviewing the anamnesis and making a decision. And time, as we know, is very often a critical factor in the fight for the life and health of the patient.
- To facilitate the work of doctors and reduce the time spent by the patient on their visit, it is also necessary to coordinate EMR with other systems, such as laboratory systems. Previously, a patient would come to the doctor, the latter would prescribe certain tests/analyses, the patient would go to the lab, give the prescription, do the tests , and the results would again be written down on paper and had to be given to the doctor. This is a lengthy process, during which errors and confusion are not uncommon. Let's start with the classics - the doctor's handwriting may be illegible, the wrong tests may be performed, the results may be lost or mixed up. If you use the interconnection of two electronic systems, the referral and results will be placed in the patient's electronic folder, to which the doctor has access.



This unfortunate doctor's handwriting brings many problems to the process of prescribing medications. The pharmacist may misread either the name or the dosage of the medicine, and this, as you understand, can have terrible consequences. The electronic prescription system eliminates the possibility of such "misunderstandings".

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- Equally important is the convenience for patients, since they do not need to call all the clinics they have visited to collect the necessary medical history. It is all stored in the patient's single folder.
- Electronic patient records can (and should) be backed up , etc. This is difficult with paper records, and frankly, no one has done it. For example, after Hurricane Katrina, thousands of patient records were lost, and it took many months to restore them.
- The more widespread EMR is in the world, the easier it will be for researchers. A huge database of patients, their symptoms and diseases, treatment methods and recovery process - all this will help to study certain diseases, improving methods of combating them.
- In the long term, using EMR is cost-effective. There is no need to spend money on office supplies (it's a small thing, but on a global scale the amounts will be large), a reduction in the number of personnel, a reduction in time costs, and, accordingly, an increase in labor efficiency.

Disadvantages of EMR –

Despite the very impressive benefits of EMR, their rate of adoption is not impressive.

- Many modern EMRs are incompatible. The fact is that each clinic has its own database, which does not work with the database of other clinics. Since facilitating the process of patient transition to competitors is not profitable, you understand.
- The big question always remains the confidentiality of information. How to make sure that only the necessary information gets into the hands of only the necessary people? How to protect EMR from hacking? Many do not want to answer these questions, simply refusing to implement an electronic system.
- In order for the EMR to be complete, it must contain the patient history, not just the latest data. Accordingly, this history must be entered into the database, and this is a lot of manual work, which requires not only time, but also financial costs. Many clinics are not ready for this.
- Now the format in which the data is stored is one, but what if it changes in the future? Will it be possible to access the data? Very strange questions, I agree . But they scare clinics from implementing EMR.

Clinical Decision Support System (CDSS)

In this section, we discuss the history of clinical decision support systems (CDSS), current research, commercial focus, and potentially interesting areas for future research.

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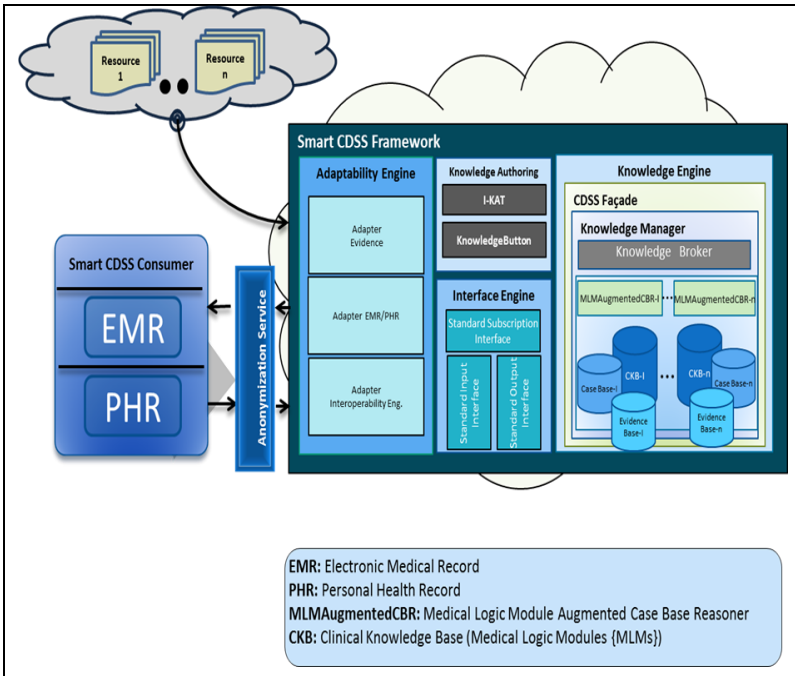

History of CDSS 1960 - Patient-Computer - Perhaps one of the earliest uses of computers to support physicians was a computerized patient interview system. The idea for this system was inspired by the fact that physicians often ask the wrong questions or forget to ask the right ones when interviewing patients.

Thus, the anamnesis will be incomplete, and the treatment will be less effective. Accordingly, it will be much more effective to conduct a formalized questionnaire. In 1960, this process was automated using a computer.

1970 — Expert System which is a classic example of decision support system. In the early 70s, research in the field of computer technology in medicine was mainly aimed at the diagnostic process. It was believed that a computer with great computing power could greatly simplify the diagnostic process. The first such expert was MYCIN — a system developed at Stanford University, aimed at diagnosing and treating blood-borne diseases. MYCIN proved to be a very accurate diagnostician, making far fewer mistakes than non-specialized doctors. However , no one was in a hurry to use MYCIN. Many different questions and disputes arose. Doctors did not want to be replaced. Lawyers did not understand who would be responsible for the diagnosis made by the computer. In addition, setting up the operation of this system was a very complex, long and laborious process. Therefore, MYCIN remained in history simply as a very successful experiment.

- 1980s - Real-Time Clinical Decision Support Technology time . One of the most notable implementations of the computer world in the world of medicine is the system of monitoring the patient's heart and brain. In the 80s, these systems received automatic functions, such as detecting arrhythmia in an electrocardiogram. And in the 90s, these systems began to be replaced by PCs with special software.
- 1995 - PCs and Networking in Healthcare Many clinics began using networked PCs to store and transmit data related to administrative tasks. This was an important step in the formation of a modern CDSS.

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- 2000 - Present - Reference Databases and Portable Access Computer technology has made reference information accessible to any doctor or patient. Today, almost everyone has a PC or handheld device (tablet, smartphone, PDA), which gives them access to the necessary medical information.

Unexpected consequences of healthcare computerization - As we have already understood, computerization of the medical sphere is extremely important and should be developed. This process faces many difficulties. Not everyone wants to spend money on the implementation of new systems, personnel training. Someone is afraid of legal consequences in the case of data exchange between clinics. There is also the question of confidentiality of information. All these are factors that hinder progress. But there are opinions that claim that this should not be forced, since unforeseen consequences may arise.

Depersonalization - Dr. Gail Thompson, who has been practicing since the 60s, said that computerization leads to the fact that we forget that there is care for the patient. Doctors have forgotten how to determine the patient's condition by the pupils, relying more and more on diagrams and graphs on computer monitors. Stephen Angelo, a doctor from Connecticut, completely agrees with this opinion. He told how one day in his hospital the patient monitoring system "broke down." The doctors were confused and did not know what to do.

Of course, relying more and more on modern technologies, we forget about the good old methods.

Drug related errors

Some doctors claim that electronic systems, although they help reduce the number of errors, do not eliminate them completely. This is because a person, as a source of error, controls this electronic system.

This is undeniable, but the problem still remains in the human factor, and not in the system as such. To solve this difficulty, it is necessary to pay more attention to the training of medical personnel . personnel . If the personnel does not know how to use the system, then, of course, all its advantages lose their meaning. As long as there is at least one person in the industry, there will be mistakes.

Misinformation on the Internet

There are many articles on the Internet about various diseases, medications, etc. Many of us have used such content for self-diagnosis and even self-treatment. Of course, information is power, but only when it is correct.

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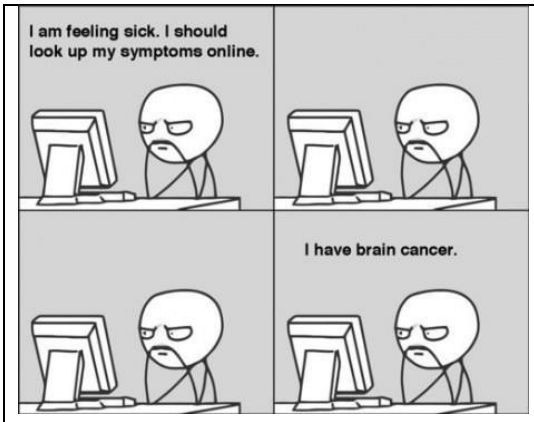

A lot of medical information on the World Wide Web contains errors. This can lead to the patient starting the wrong treatment or simply ignoring a potentially dangerous disease. This problem can only be solved by introducing standards for the reliability of information and methods for checking and monitoring publications.

Finding the right information - Storing the entire patient history in one electronic folder allows the doctor to quickly access it. But will he be able to find what he needs in this particular case so quickly?

A huge flow of information that must not only be viewed but also analyzed can delay the formation of anamnesis and diagnosis.

Conclusion - The world does not stand still. Computer technologies are cutting deeper into other areas of our lives, bringing a lot of new things, good or bad, sometimes it is difficult to say. But progress cannot be stopped, relying only on the fear of something new. This also applies to medicine. Many diseases would remain incurable if some daredevils had not decided to treat them differently , not as before.

The main thing to remember is that man creates technology, man improves it , and only he can be responsible for it.

Today, many clinics are switching to remote storage and processing of information. We offer solutions for this type of clients, including solutions using the latest NVMe drives, which allow for “instant” processing of requests in large databases. The data centers where the equipment is located meet the required levels of certification in the field of data security. And the geographical distribution and isolation of modules even within one location allows us to organize the most fault- tolerant systems for clients of this type.

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