Telemedicine applications in modern medicine, the possibilities and limitations

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Abstract

Telemedicine implies the use of electronic and telecommunications technologies to provide medical assistance, education of patient or physician and real-time (synchronous) or store-and forward (asynchronous) medical information transfer through bi-directional information exchange to improve patient care. This definition cannot be limited but will continue to expand because of rapid technological developments and new opportunities of using it in all areas of medicine between patient and physician, physicians, students and physicians and patients and the health care system. In this article the possibilities of its application and limitations are presented.

Key words:

telemedicine, Ehealth, mobile health

Introduction

The use of information and telecommunications technologies is an important supporting activity to health care, contributing to increased efficiency of the system. The basis for the development of telemedicine was the widespread use of electronic records of medical data giving the possibility of easy exchange of information and accessing them at any time and place. The literal translation of the term "telemedicine" means the delivery of medical services at a distance, especially carrying out diagnostic tests and performing a medical procedures without direct contact with the patient. It is a field that combines the characteristics of information technology, medicine and telecommunications. The terms frequently cited together with telemedicine are telehealth and eHealth, however, they have a broader meaning, as telemedicine is mainly based on the provision of clinical procedures, while telehealth and eHealth can also relate to research, education and administration (American Telemedicine/Telehealth Terminology) [1].

One of the first forms of telemedicine was using smoke signals by African tribes informing residents of neighboring villages about the spread of serious illness. In the early twentieth century, the citizens of Australia used CB radios powered by bikes in order to communicate with the doctors from Royal Flying Doctor Service of Australia. In 1906 Einthoven used the same technology to transmit ECG signals. The telemedicine solution utilizing standard telephone lines to diagnose and treat patients requiring immediate CPR was the system developed by S. Eric Wachtel, the founder of MedPhone Corporation in 1989. His mobile version of phone was introduced in 1990, and consultations and treatment were delivered by twelve hospitals in the United States [2].

An interesting example of the use of telemedicine is the case of a young girl named Zu Ling, who was treated at one of the Beijing hospitals in the 1990s. Doctors had problems with diagnosing and treatment of serious health condition of the patient, so her friends sent out messages about her health condition through the Internet to many specialists in various health centers. The feedback information obtained this way made it possible to make a proper diagnosis, which turned out to be thallium poisoning. Thanks to the telecommunications efforts it was possible to take up the treatment and the patient quickly recovered [3].

Initially, telemedicine was used in military and space programs, psychiatry, pediatrics, medical care at the airport. Later, radio broadcasts, videophones, web applications, desktop computers, portable devices like mobile phones, tablets, laptops, were used. In the 1960s, when the astronaut John Glen was flying around the Earth, his heart rate, blood pressure and ECG were analyzed, while the term telemedicine was formulated for the first time in 1970s of the twentieth century by Thomas Bird. Its origin is connected with the process of computerization of the health care, the growing popularity and availability of devices collecting digitalized data. The ubiquity of the Internet and the ever increasing rate of data transfer allows finding new solutions in all areas of science, including modern medicine. Thanks to the development of telemedicine, patient data, disease history, research results, audio and video recordings are transmitted via electronic transfer (radio, telephone, computer) to any place for informative, diagnostic, scientific, consultative or therapeutic purposes [4].

There are many definitions of telemedicine, but most often it implies the use of electronic and telecommunications technologies to provide medical assistance, education of patient or physician and real-time (synchronous) or store-and forward (asynchronous) medical information transfer through bi-directional information exchange to improve patient care. The American Telemedicine Association (ATA) states that the definition of telemedicine cannot be limited but will continue to expand because of rapid technological developments and new opportunities of using it in all areas of medicine between patient and physician, physicians, students and physicians and patients and the health care system. The devices used in telemedicine can be phones, mobile phones, satellite phones, cameras, TV, X-rays, CT scanners, computers with Internet or an intranet connection, fiber optics, satellites, remote operating systems. The most commonly transmitted data include patient records, ECG, USG, MRI, RTG, CBCT images. Currently, the systems for remote communication of

patients with physicians and the consultation of clinical cases between clinicians via videoconferencing, are being widely developed [5].

The practice of telemedicine largely breaks down into three types of solutions: 1. store and-forward, 2. remote patient monitoring, and 3. real-time encounters.

1. Store-and-forward involves cataloging of medical data, such as images or biosignals and presenting them to the physician in an analog or digital form, online or offline, anonymously or with patient data. With the stored information, there is no need of further presence of the patient for consultation by another specialist.

2. Remote patient monitoring allows medical personnel to track patient's vital signs and activities at a distance (patient staying at home or at another health care facility) using a variety of devices. This type of monitoring is often used for stable chronic conditions such as heart disease, diabetes, asthma.

3. Real-time encounters ensure the exchange of information on a regular basis between the patient and the supervising person via radio, the Internet or telephone. The information concerns medical history, psychological assessment, visual disturbances. In nursing, the ability of remote contact of auxiliary staff with a physician makes the access to a much larger group of patients in a larger area possible, as well as the provision of recommendations for the near future, and the involvement of a much larger number of ready-to-learn medical adherents to offer medical support [6].

Opportunities

The advantage of remote diagnostics is shortening of time since the patient reported at the doctor for performing the necessary tests until making the final diagnosis. Currently, consultations between doctors often require the need of referring or transporting the patient to distant specialized clinical centers, which entails additional costs and exposes patients to unnecessary stress and slows down the diagnostic process. Teleconsultations can eliminate these disadvantages provided there is a remote access to test results and medical records. Doubts about the effectiveness of remote diagnostics result from the approach of some patients for whom electronic devices cannot replace the direct contact with the physician [7].

Introduction of telemedicine in penitentiaries resulted in a significant reduction in the number of transports to the hospital, reducing the risk of prisoners' escapes and the provision of medical care by local staff without the need of bringing a specialist, which significantly reduced the cost of treatment. A similar increase in the effectiveness in reaching patients with medical support can be achieved in African countries, where there are very big distances between the medical centers. Establishing telemedicine networks in these countries between smaller centers and management centers would be a significant step forward. However, limiting the use of telemedicine to the Third World or very sparsely populated countries would not fully exploit the potential of modern technology. Recently, United States Army has been conducting works on the use of telemedicine, because the possibility of consulting soldiers by specialists in combat areas in various parts of the world is extremely important [8].

Teleconsultations/teleconferences conducted synchronously create shared remote workstations similar to those traditional medical consultation services. In a medical environment, this will include sharing the medical documentation, mostly imaging documents, and providing all participants with a audio channel they can communicate by. Such an interactive session when supported by additional media such as video, text messaging, or remote indicator, etc. makes synchronous teleconferences even more similar to their traditional counterparts [9].

Remote access to test results is increasingly facilitated by the use of their digital representation. Most modern medical diagnostic devices process signals from the patient's body into digital data, which can be stored, retrieved and analyzed without losing quality. This is particularly evident in radiology as well as in many other diagnostic techniques. The common standard developed in the field of digital medical data representation is now the DICOM standard, the spread of

which is an essential factor in accelerating the development of teleconsultancy support systems [10]. Today, virtually all commercially available medical imaging devices are DICOM compliant. These include, among others angiographs, computer tomography, magnetic resonance tomography, scintigraphy, ultrasound, electrocardiography, cameras, scanners and other transducers for digital recording of data from older media. The DICOM standard can be used in diagnostic methods in almost every field of medicine - currently there are known applications used in cardiology, radiology, dentistry, endoscopy, ophthalmology, orthopedics, anatomopathology, pediatrics, radiotherapy, surgery, veterinary and many others [11].

The present telemedicine systems are used, for example, for: 1) information purposes: online registration, online examinations, access to medical information portals, or telephone consultants, information provided by lower level personnel; 2) preventive purposes: remote health monitoring (measurement of pulse, weight, glucose and hemoglobin), education of healthy patients, 3) treatment: electronic documentation, remote operations, transmission of X-ray, CBCT, ECG, MRI, ultrasound imaging; 4) educational and research: video conferencing for professionals from various fields of medicine and doctors and patients, virtual teams consisting of health professionals, cooperating and exchanging information about their patients in order to improve skills and improve the quality of services, clinical supervision of specialists during the procedure similarly to the Venetian mirror, examining and controlling young doctors [12].

Limitations

The development of modern technologies significantly affects the organization and operation of health care around the world. The change concerns particularly the method of obtaining, storing, processing and transmitting patient information. However, due to the intense pace of telemedicine development, there is a justified fear that progress will not be accompanied by an increase in the quality of services

provided due to the lack of adequate system testing the equipment or used applications and the assessment of their effectiveness and safety [13].

Although remote medical services (telemedicine) have already been implemented and successfully applied in many medical centers around the world, there are doubts about the responsibility for the treatment in case of lawsuits. Statutory regulations are needed in answering the question whether the consulting physician should have the appropriate license in his /her country, the country in which he/she consults, or both countries. To which judicature is he/she subordinated? Can treatment that uses telemedicine and is not successful be considered negligent? Other limitations that delay the development and widespread use of telemedicine concern the lack of adequate infrastructure that links data from different sources within a given medical unit or multiple health care units. Doubts also relate to legal limitations on the confidentiality, disclosure and security of medical records. The introduction and deployment of telemedicine may also be countered by the medical environment because of its significant impact on its structure and mode of operation, requiring a change in the way of operation and behavior or starting work in the new system [14].

Conclusions

Despite such a large and wide access to databases and the possibilities of telemedicine, no physician has complete knowledge and is not able to follow all the results of the latest research, treatment options, modifications or new procedures and medicinal preparations, either. However, further dynamic development of telemedicine is inevitable due to the numerous benefits of its applications, reducing costs and the possibility of accessing more patients. Hence, it becomes a necessity to consult individual patients by many specialists, using the latest technology and diagnostic equipment. The usefulness of telemedicine applications can also be found in more specialized fields such as dentistry [15].

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