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Telemedicine – prospects and difficulties before a new development

stage

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The article is devoted to telemedicine – an applied sphere of medical science linked with development and practical application of rendering distant medical care and specialized information, sharing methods on the basis of modern information and telecommunication technologies. This landmark sphere of medical care organization and rendering has already become an integral part of modern public health. The aim of telemedicine is to provide quality medical care to anyone regardless of their location and social status. Telemonitoring as a future technology is already finding wide use in spheres where constant domiciliary medical care is required. It is used in neonatology to observe infants with low and extremely low body weight during the antenatal period, in cardiology – to control the condition of a patient with an implantable device (pacemaker or cardioverter defibrillator); this method is also widely used in other spheres of medicine. It is possible to organize advisory assistance to medical care rendering through employing highly qualified specialists of large-scale medical centers in case of emergency. Extra possibilities of applying new medical approaches, which considerably expand the range of patients under outpatient observation and reduce the number of patients' visits to clinics, appeared owing to the application of information technologies in public health. The article gives a detailed account of various aspects of telemedicine.

Keywords: telemedicine, public health, public health organization, pediatrics, maternity and childhood protection, information technologies.

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In the conditions of public health reforming it is strategically important to organize an essentially new interaction of medical-preventive institutions with specialized medical institutions by rendering remote high quality care to population using modern information technologies and intellectual potential of the best specialists [1]. An essentially new area of organizing and rendering medical care to population has appeared in the conditions of progressing information and telecommunication technologies – telemedicine. Today it is not just a "new prospective technology", but an integral part of modern public health, which brings positive clinical, economic, moral and organization effect.

The first telephone transmission of electrocardiographic signals was made long ago, in 1906, by W. Einthoven. Medical consultations of seamen at sea using radio channels have been rendered by the Gothenburg University hospital since 1922; the similar service started operating in Italy in 1935 [2].

The first television consultation was rendered in 1959 in the United States of America (USA) to a psychiatric patient. Telemetric record of physiological parameters of the first cosmonauts may be considered the first steps of telemedicine as remote diagnostics: electrocardiographic data were telemetrically registered in 1 and 2 chest leads during flights of Y.A. Gagarin and G.S. Titov, respectively. In 1965, American cardiac surgeon M. DeBakey controlled an open heart surgery in Geneva being in the USA using satellite connection and interactive television systems [2]. An interactive television-and-radio system transmitting pictures, electrocardiograms, electronic stethoscope sounds, voice etc. was developed in a Massachusetts hospital in 1967. One of the first European countries to introduce telemedical principles in public health was Norway. There is hardly any Western European country where there are no telemedical projects. Telemedical technologies gained wide spread in the USA, Canada and Australia.

The term "telemedicine" coined by R. Mark in 1974 (according to other sources, Thomas Bird did it in 1970) combines many telecommunication and information methods employed in public health and their various clinical applications [2]. There are several definitions characterizing this area; they differ both in specification of its characteristics and in the content of technologies and areas involved. There is no doubt that it is an innovative approach combining medical knowledge and equipment with information and communication technologies, which allow examining, observing and treating a patient remotely. Telemedicine is an applied area of medical science connected with the development and practical application of remote medical care rendering and specialized information sharing methods on the basis of modern information and telecommunication technologies [3].

According to the Charter of the International Society for Telemedicine (ISFT), telemedicine is "the use of electronic information and telecommunication technologies to provide and support health care when distance separates the participants" [4]. The World Health Organization proposed a wider definition in 1997: "the delivery of health care services, where distance is a

critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities" [5].

Telemedicine aims at providing quality medical care to anybody regardless of their location and social status. Telemedicine allows taking treatment and diagnosis efficacy to a qualitatively new level. Efficacy of telemedical technologies has been proved by numerous studies and projects in a range of countries. Telemedicine is widely used to achieve the following goals:

- To provide continuity of education process, information support of measures in the area of healthcare organization, clinical audit and so forth [6, 7].

- To increase availability of specialized medical care and organize teleconsultations for people living in geographically remote regions or rural areas, for handicapped patients and for patients of exclusive or organized groups [7].

- To provide senior population with quality outpatient observation [8-10]. As people near the retirement age, they enter the life period associated with high risk of expensive and life-threatening chronic diseases.

- To monitor a patient's physiological parameters [7-12], such as blood pressure, heart rate, blood glucose concentration etc. As a future technology, telemonitoring is already finding wide use in spheres where constant, stable and quality domiciliary medical care is required. It is used in neonatology to observe newborns with low and extremely low body weight in antenatal period [13], in cardiology – to control condition of a patient with an implantable device (pacemaker or cardioverter defibrillator) [14].

- To support measures in primary and secondary prevention and early diagnostics of diseases [8, 13, 15]. As the average life expectancy and the number of the lifestyle-associated diseases are continuously growing, the more people around the world require efficient medical care.

- To rehabilitate patients requiring psychiatric, psychophysiological and/or psychological care [6, 13]: not only psychological rehabilitation takes place in the process of remote audiovisual patient-doctor communication, but physical rehabilitation gathers pace as well. To conduct rehabilitation measures in the post-operative period and psychological adaptation of women in pre- and postnatal periods [6, 16]. A special kind of this type of care is the aspect of influence on psychological status of the parents of ill children – use of telemonitoring systems in pediatrics resulted in the reduction of anxiety level in parents [17].

- To organize consultative medical care rendering support by highly qualified specialists of large-scale medical centers in case of emergency. Facilities of telemedicine acquire special importance in case of emergency connected with natural and anthropogenic disasters and in combat areas. Prompt quality consultations that the doctors in danger area receive via telemedicine help them save many human lives. At the same time, information from the catastrophe area allows appraising the situation objectively and taking adequate, disaster-proportionate measures [18].

Thus, the use of information technologies in public health provided extra possibilities of using new medical approaches which considerably expand the range of patients under outpatient observation and reduce the number of patients' visits to clinics. Personal (domiciliary) telemonitoring of a patient's medical parameters is the new effective tool of modern medicine. Development of mobile telecommunication systems and information technologies considerably expanded performance capabilities of the implantable devices used in cardiac electrotherapy pacemakers and implantable cardioverter defibrillators [6, 12]. Patient's condition monitoring is no longer restricted to outpatient hospital examination procedures, but has covered intervals between them owing to the use of telemetric functions of implants, mobile transmitting devices and development of information networks. Receiving data on dangerous arrhythmia episodes and therapy alterations, electric cardiac therapy system's state, the doctor may correct the patients' treatment, if needed, by calling them for an extra outpatient examination. Analysis of message reliability showed that clinical decisions based on telemonitoring correlate with decisions made in the course of a standard outpatient examination in 97% of cases [12, 19-20]. Instantaneous diagnostics of the heart rate disorder allows preventing or seriously reducing rate of such a severe consequence for a patient's heath, as a stroke [21, 22]. Moreover, studies have showed the reduction in the number of patients' clinical visits. This is one of the advantages of telemonitoring, which gives major economic effect.

A randomized controlled study dedicated to the application of telemedicine in individual management of patients revealed improvement in blood glucose level control at pancreatic diabetes in the areas acknowledged to receive insufficient medical care in the New York State (USA) [10].

Realization of domiciliary monitoring provides a considerable reduction in the number of domiciliary patients' visits by doctors and nurses. Thus, 1.5mn domiciliary telecare sessions a day take place in the USA. Thus, a nurse, who normally manages 5-6 patients, may help 15-25 patients using telemedical technologies. The Finnish study of using domiciliary telecare showed 30% reduction in the number of patients referred to doctors; cost reduction also appeared to be 30% [23, 24].

A range of clinical studies conducted by specialists in medical organizations of Canada, Italy, Australia, England and Germany determined the following positive tendencies of telemedicine introduction into practical health care [6]:

- increase in adherence to the prescribed treatment: the share of patients using domiciliary self-control methods increases to 90%;

- reduction in the rate of hospitalizations and requests of emergency medical care [6, 13];

- life quality increase, patient's psychological state and social adaptation improvement [6, 10, 13];

- mortality reduction among patients with cardiovascular diseases by 20-25% in comparison with the routine technology of medical care organization [6, 12, 13];

- increase in patients' satisfaction with medical services;

- increase in patients' awareness about their diseases [6, 13];

- service quality improvement, timely drug therapy correction, high drug treatment efficiency;

increase in the economical effectiveness of medical care [6, 12, 13, 18].

Modern information technologies and elements of telemedicine are rather frequent in daily medical practice. However, extensive integration of telemedicine to health care should be complex and systematic; this presupposes the following:

- use of specialized equipment to gather, transform and transfer medical information;

- telecommunication network providing connection between providers and consumers of medical information;

- use of software linking together all elements of the system;

- specialists providing professional and technical support and effective application of telemedicine in resolving medical issues.

Unfortunately, capabilities of Internet-technologies and remote communications are only partly integrated into health care, especially the pediatric service.

Socioeconomic changes that took place in the RF in the last 20 years, unfavorable demographic situation, i.e. reduction in the share of children population from 30 to 18%, set the following strategic tasks before the national pediatrics: reduction in morbidity, incapacitation, children's and infantile mortality. These tasks are to be resolved by the scientific platform "Pediatrics" adopted within the "Strategy of developing medical science in the Russian Federation (RF) until 2025" [25, 26]. This new multidisciplinary strategy aims at resolving the following tasks:

- breakthrough scientific studies and their rapid translation into practice;

personalization of pediatrics;

- use of information technologies in managing medical process, including creation of new cooperation modules for doctors, patients and their families;

- use of information technologies when preparing medical personnel simultaneously with scientific work and clinical practice in order to improve organization of medical care of children.

The platform includes scientific substantiation of the system of measures:

- improvement and development of new intensive therapy, nursing, rehabilitation, incapacitation prevention and social adaptation technologies for children with low and extremely low body weight; introduction of these technologies into wide clinical practice;

- fundamental studies involving development of molecular diagnostic methods for predictive and personalized pediatrics using cellular technologies, development of an effective dispensary system, optimization of organization of medical care rendering to children, including scientific substantiation and introduction of modern technologies of healthy lifestyle forming for children and families.

Given the set tasks, the development of a single national system of morbidity monitoring and control over the use of medical resources in children integrated with dispensary systems, incapacitation, infantile and children's mortality analyses together with the creation of regional networks will allow gathering, processing, accumulating and storing full-scale information on all children from antenatal period to the moment they are transferred under observation by the adult outpatient service doctors in short term. This approach will serve as a basis for the creation of an integrated medical information space pooling data on patients under observation at different institutions of all levels and will provide:

- quick access to all information on patients, including medical pictures;

- possibility of collaborative data analysis by doctors on the basis of any necessary information;

- formation of morbidity registers by nosologic forms, social strata etc.;

- quick reception of any statistical data in any profile necessary;

- remote contacts (including video conferences) of doctors with each other and patients for consultations;

- domiciliary health monitoring;

- online doctor's appointment system.

Regional computer networks and telemedical centers are being created in Astrakhan, Irkutsk, Nizhniy Novgorod, Chelyabinsk, Kurgan and Sverdlovsk Regions, Khanty-Mansiysk and Yamal-Nenets Autonomous Areas and in other RF regions; they provide capabilities for gathering data and their availability to the doctors observing children. These systems should provide medical-diagnostic and information-consultative functions, children's development and health condition monitoring. Basically, this means the creation of corporate problem-oriented systems forming a single information space in different areas of pediatrics on regional and federal levels. This space will unite all medical information accumulating on patients and it will be available for doctors observing these children.

Timely acquisition of necessary information on the patients' health condition, including primary examination and inspection data (detection of pre-nosologic deviations in children's health condition and early disease forms, including deconditioning dysfunctions; determination of patient groups with chronic pathology development risk), will provide for the full-scale situation analysis in terms of both individual and public health in real time. At the same time, rapid data sharing between different medical-preventative institutions will allow considerably increasing continuity of work of medical institutions.

Given high spread of socially dangerous diseases among children and continuous increase in chronic pathology, there is no doubt that it is important to create an information-technological product, which will allow conducting early diagnostics, monitoring condition of patients and evaluating adherence to therapy at a distance.

The need in global introduction of information technologies in medicine is confirmed by numerous studies and does not cause doubts at the first sight. We may distinguish several baseline aspects of telemedicine:

- administrative: remote medical technologies will help to resolve administrative tasks comprising the public health development and reforming policy;

- health care structure reinforcement: telemedicine may help to improve connection between district hospitals and the leading national clinical centers by means of telecommunications, thus eliminating isolation of rural and community hospital doctors; it may help to secure medical personnel in country towns and rural areas;

- education: telemedicine may provide continuous education of doctors and paramedical personnel from remote regions of the country;

- provision of quality and efficacy of medical services: telemedicine may help to reduce morbidity and mortality by improving diagnostics, treatment, prevention and public health system's management;

- external audit – evaluation and analysis of all medical institution's parameters will help to optimize work of medical-preventative institutions.

Science development and technology enhancement are rapid in the modern society. Prospects of telemedicine are associated with miniaturization of monitors, introduction of smart-technologies, robotics and the latest achievements of the information science. However, a real breakthrough is

expected on the verge of biological sciences with physics, mechanics and computer science and is connected with the development of applied aspects of nanotechnologies.

The need in developing telemedicine is recognized in the leading countries of the world, including the USA and Japan, Germany and France, Great Britain and Norway. Projects linked with forming telemedical network are among the first-priority medical programs financed by the European community. Telemedical methods are being actively developed in Brazil, Hungary and several other countries.

Introduction of telemedical achievements into Russian health care as well is on the agenda. There is no doubt that the need in remote medical technologies in the RF with its vast territory, low population density and almost no medical institutions in the hard-to-reach areas is much higher than in the congested Europe or the highly developed USA. The first steps towards the introduction of telemedicine into Russian health care have been made.

A roundtable "Creation of the National Telemedical System (NTS)" in the framework of the national program "Health care development in the RF" was organized in Moscow on 14 December 2012 [27]. The participants agreed that modern innovative development of national health care is impossible without a complex integration of traditional clinical methods and modern information-communication technologies aimed at improving the system of management in health care.

Issues of creation and introduction of telemedical systems are under the federal control. In the framework of work of the Presidential Commission on modernization and technological development of the RF economy, work group #5 "Medical equipment and pharmaceutics" recommended to start the step-by-step introduction of telemedical systems in the RF by means of creating pilot regional complex telemedical systems. Instruction of the RF Government ISH-P2-7852 of 09.11.2011 charges the federal executive authority organs and organizations with the fulfillment of paragraph 2.5.1.2. of the calendar of activities for the realization of the second stage (2012-2015) of the "Strategy of economic development of the Commonwealth of Independent States until 2020 for creating a joint complex national telemedical system in the RF". Without developing and introducing the most advanced integrated solutions, technologies and equipment, it is impossible to overcome systemic crisis in health care; this completely correlates with the latest tendencies in the world health care.

The roundtable's concluding post-release defines telemedicine as a socially important and economically sound tool serving to achieve the following goals [27]:

- provision of equal availability of medical and social service for the whole population of the RF;

- provision of the single high quality standard of medical and social service to the RF citizens regardless of their place of residence and social status;

- creation of additional permanent work places for the highly qualified medical and technical personnel;

- enhancement of a system of preventive measures in health care, including mass health examination and maternity and childhood protection;

- quick and qualified medical care in case of emergency;

- provision of a remote process of continuous education and retraining of medical and managerial personnel of the public health system;

- introduction of modern medical methods of medical care rendering;

- optimization of health care expenses by means of quick information acquisition and reduction in a number of wrong diagnoses;

- shift to personal telemedicine;

- provision of medical care to senior and handicapped people;

- healthy lifestyle propaganda.

Telemedical systems and technologies are based on new remote forms of interaction of an attending doctor and a consulting physician, medical worker and patient. Telemedicine will be economically sound only if it becomes the mass servicing system not only on the regional, but also on the federal level.

The main factors inhibiting large-scale development and introduction of telemedicine are:

- lack of detailed complex project of the step-by-step creation of the national telemedical system;

- insufficient elaboration of issues of using the core information systems;

- need in forming new standards and developing legislative and normative frameworks.

Preparation of such a national-scale project is possible only in the framework of interdepartmental and interdisciplinary activity.

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