Telemedicine: Perspectives and expectations

Svetozar Zdravković

SUMMARY

A rapid growth of Internet industry, total digitalization in almost all business fields including medicine and popularization of telemedicine and e-health impose dilemma about perspectives and expectations of telemedicine. The article has tried to point out some crucial facts about telemedicine perspectives and expectations to patients and health professionals, as well as wide social review. These facts could help readers to make their own general picture of telemedicine in the future.

Key words: *Telemedicine; Teleradiology; Telepathology; Remote Consultation; Education; Telemetry; Monitoring, Physiologic*

Oncology Institute of Vojvodina, Sremska Kamenica, Serbia

Correspondence to:
Svetozar Zdravković, Oncology Institute of Vojvodina, Institutski put 4, 21204 Sremska Kamenica, Serbia

svetozar@uns.ns.ac.yu

Telemedicine has numerous definitions, it is a phrase first coined in the 1970's by Thomas Bird, referring to health care delivery where physicians examine distant patients through the use of telecommunications technologies. The European Commission's health care telematics program defines telemedicine as „rapid access to shared and remote medical expertise by means of tele-communications and information technologies, no matter where the patient or relevant information is located."

On the Internet, we can find many more definitions of telemedicine:

– delivery of health services via remote telecommunications (http://plan2005.cancer.gov/glossary.html)

– the use of telecommunications and information technologies for the provision of healthcare at a distance, including real time videoconferencing as well as store and forward methodologies (http://www.cteconline.org/terms.html)

– use of telecommunication technologies to deliver medical information and services to locations at a distance from the care giver or educator (http://www.fao.org/docrep/W3733E/w3733e08.htm)

– delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation (http://www.isft.net/cms/index.php)

– the use of audio, video, and other telecommunications and electronic information processing technologies to provide health services or assist health care personnel at distant sites. (American College of Physicians online, http://www.acponline.org)

– the delivery and provision of healthcare and consultative services to individual patients and the transmission of information related to care, over distance, using telecommunications technologies (defined by the US Food and Drug Administration) the delivery of healthcare and the sharing of knowledge over a distance using telecommunications network (http://psmmis.com/support/glossary.html)

In its basis, telemedicine system is a technology system. One example of typical telemedicine system is shown in Figure 1.

Technology has implied standards in process of collect, archive, communicate, and search relevant medical images, video records and other medical information as well as standards of medical devices, telemedicine systems, computers and computer network devices and communication equipment.

Considering means of using telemedicine, the main telemedicine services are:

– teleconsultations (provide remote access to either medical professionals or information stored in electronic knowledge databases)

– telediagnostics (to make diagnosis to a patient with no direct contact with physician using medical data (medical report, image or video record)

– telemonitoring (remote monitoring of patients' physiological parameters, most often of patients with chronically diseases without hospital surveillance needs)

– telecare (treatment of patients outside of healthcare institutions)

– teleeducation (education and practicing of medical staff outside of healthcare institutions, remote access to medical knowledge databases using Internet) On the other side, the main fields where telemedicine is applied today include

– telepathology, teleradiology, telesurgery, and medical education at distance.

In the Internet age, let us see what telemedicine faces. These are undeniable facts:0

Figure 1. Typical remote telemedicine system

– information and communication technologies are present in almost all aspects of human business activities including medicine and healthcare
– uplift of telemedicine and e-health is evident in the last 2 decades
– number of articles containing keywords as "telemedicine," "remote consultation," "teleradiology," and "Internet" is increasing with geometric progression
– over 30% of physicians all over the world (70% in developed countries) use Internet 5 days in a week.

Despite all of these facts:

– great majority of physicians prefer traditional systems such as phone, pencil and paper, although over 90% of the same physicians consider medical information systems needed in their everyday practice
– over 95% of physicians are ready to accept telemedicine, but as everyday practice in future: many of them do not see telemedicine as everyday practice in their professional careers
– over 50% of articles and researches in the field of telemedicine are done in USA, Great Britain and Australia; other 50 countries contribute to telemedicine literature with 2% only
– major users of telemedicine are armies of USA and NATO countries as well as countries that implement space researches (USA, Russia, China and the most developed EU countries)

Telemedicine definitely has its limits. They can be grouped as infastructural-eductaional and ethical-professional. Let us face first with infrastructural-educational ones:

– poorly developed communication infrastructure in geographical means
– large number of hospitals does not dispose of communication and/ or computer infrastructure (local area network, computers, network devices)
– insufficient level of informatics education of average patient
– insufficient level of informatics education of average physician

Fig. 1. (A) Affixation point refers to the horizontal slice individuated by the vertex of the pit between the two gastrocnemius muscles. (B, C, D) Mechanical design of the wearable system for step counting. (B) Horizontal view. (C) Horizontal view and details of the Velcro strap. (D) Vertical view. The protective insulating gum and the force-sensing resistor (FSR) are not shown in true dimensions for the sake of clarity. RX-TX, receiver and transmitter. (E) The system affixed at the reference point. (F) The sensor with the case: details of the Gum on FSR, the RX-TX system, CPU µP PIC 16F877 and the batteries. (Continued on next page.)

Figure 2. Telemonitoring system for patients with Parkinson disease

– absence of system solution for physicians' informatics support (ICT team as a part of hospital, or outsourcing, or local/regional/state agency)

What are ethical-professional limits?

– physical clinical remote patient examination is not available, but virtual is not clinically accepted (so far is applicable in US Army and cosmonauts)
– evaluation of telemedicine clinical efficiency is not present
– traditional relationship physician/patient is still dominant both with physicians and patients
– absence of clinical guides for telemedicine practice defined by professional medical associations (medical chambers, professional associations of specific medical specialty: radiology association,) and even such guides are present they are not well known to the majority of physicians.

All these limits slow down the development of telemedicine, but cannot influence on its raising trend. Never the less, let us see telemedicine in the mirror of statistics. These statistical data are based on study in one EU country which can be regarded as typical country among 52 countries that make contribute to telemedicine (author finds these statistical data only as descriptive in order to give an actual view, and cannot be consider as a true statistical sample):

– more than 50% of physicians do not have opinion on their informatics education,
– over 80% are ready to participate in telemedicine projects, but only if they are research projects,
– over 80% never meet telemedicine in their everyday practice,
– over 65% of physicians consider telemedicine in positive mean, especially during control exams with patients
– about 25% of physicians consider medical imaging diagnostics teleconsultations and surgery teleconsultations fully acceptable

Now let us see what physicians have expected of telemedicine:

– generally, about 30% of physicians believe that use of telemedicine will affect on:

        reducing errors in medical practice
        improvement of treatment and diagnostics
        improvement of medical care
        improvement of expert communication among physicians
        better control of patients with chronically diseases
        reducing treatment costs
        easier exchange of medical images
        wide use in everyday practice, but in future

– less than 15% of physicians have negative or exclusive negative attitude on telemedicine
– hence, at least 50% of physicians do not have attitude on telemedicine mostly because their insufficient education and undefined position of telemedicine in everyday practice and healthcare policy.

On the other side, what patients have expected of telemedicine:

– contact with their physicians in any time
– monitoring their health condition upon formula 24/7/365, e.g. 24 hours in day, 7 days in week and 365 days in year
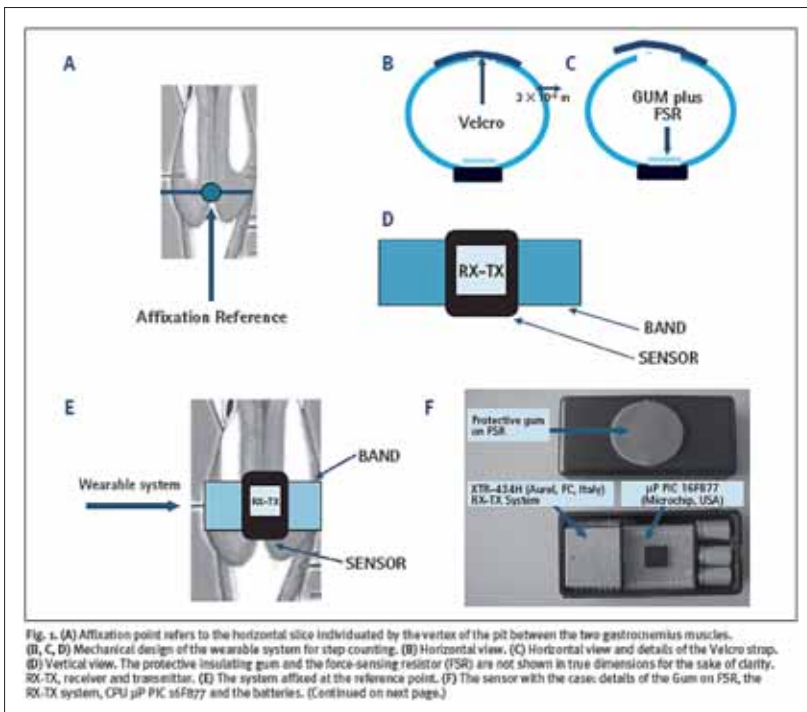– healthcare education to establish competent attitude on their health

– education for participating in projects of early detection of diseases

– education for proper attitude on chronically diseases

– key argument that patient is in the center of healthcare

According to said above, now is the time to see telemedicine perspectives. Today it seems that the most acceptable telemedicine services are:

– Telemonitoring

– **Teleconsultations/video-conferencing**

– Teleeducation

– Teleradiology

– Telepathology

These telemedicine services have deserved some detailed explanation in a form of crucial facts and one story.

Telemonitoring crucial facts:

– wide specter of chronically diseases of nowadays suggests underground monitoring of all vital and clinical parameters in order to improve patient quality of life

– telemonitoring is the most rational solution both for patients and physicians

– telemonitoring is consisted of system of sensors needed for parameters reading, sending towards specific device in hospital (monitoring spot), storing and analysis, experts system as making decision support – in shortly: telemonitoring information system

– system must be portable, simple for use and cheap

– telemonitoring systems are not product of nowadays, several telemonitoring systems for cardiac and lung functions are in use over 10 years, and they are very efficient

Telemonitoring story is telemonitoring of patients with Parkinson disease (Figure 2):

– system is based on sensor for monitoring pace force resistance (e.g. footstep counting) on specific muscle (gastrocnemius); a process is consisted of 10 counting of 500 footsteps with 3 different speed

– exchange signals between sensors and receiver system is done by telemetric system XTR-434H (Aurel, FC, Italy)

Teleconsultations/video-conferencing crucial facts:

– business need for consultations and data exchange using videoconferencing is more and more immanent both in multinational companies and regional small companies – this process did not bypass healthcare

Teleconsultations/video-conferencing story is about TelePresence by US company Cisco (Figure 3):

– one of systems that will dominate in the field of videoconferencing is TelePresence by US company Cisco.

– TelePresense is a term defined by technology industry to describe new way of communication; TelePresence enables communication between remote participants but with sensation that all of them are located in the same office using high definition video and audio equipment: big plasma TV that show speakers in life size, the most quality audio devices, high resolution cameras, in one word eye-to-eye contact; sensation is so real that the sound of speaker from left really comes from left side, even body language is visible

– TelePresence is available in Serbia by Telekom Srbije

– more about this product can be found on this URL http://www.cisco.com/en/US/netsol/ns669/networking_solutions_solution_segment_home.html

Figure 3. TelePresence by CISCO

Teleeducation crucial facts:

– present life do demand continued education and professional development

– on the other side, modern way of life force us to live healthfully which is not possible without adequate education

– hence, continued education is modern significant need and with Internet in everyday life, our possibilities for teleeducation are practically inexhaustible.

Teleeducation story is an example from Oncology institute of Vojvodina (Figures 4a, b and 5 a,b):

– accordant with needs for continued education, Oncology institute of Vojvodina has enabled patients and public to educate about oncology on his official web site

Figure 4a,b. Teleeducation on Oncology Institute of Vojvodina

– early detection of breast and testicle cancer has wide social significance so Oncology institute of Vojvodina has presented to patients and public his telemedicine services: self-breast examination and self-testicle examination

Teleradiology crucial facts:

– teleradiology represents use of new computer technology for transfer radiology images and texts from one location to the other in order to interpret and/or consult, compare with old images or educate

– it is one of the most popular telemedicine services

– teleradiology postulates are: PACS (Picture Archiving and Communication System), based on DICOM 3.0 standard (Digital Imaging and Communications in Medicine), LAN/WAN (Local Area network/Wide Area Network) and medical and engineer professionals training to work with high sophisticated computer oriented equipment integrated in RIS (Radiology Information System)

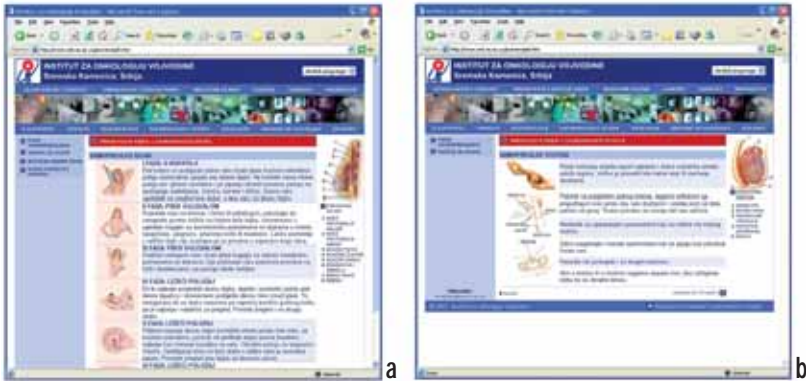– typical teleradiology system is presented on this scheme.

Figure 5. a) Self-breast examination, b) self-testicle examination

Teleradiology story is an example from Oncology institute of Vojvodina:

– Oncology institute of Vojvodina inaugurated RIS (Radiology Information System) based on Kodak PACS a month ago

– Oncology institute of Vojvodina is making preparation for teleradiology project to make cooperation with several hospitals in Slovenia.

Telepathology crucial facts:

– telepathology represents use of new computer technology for transfer pathology preparation images and texts from one location to the other in order to interpret and/or consult, compare with old images or educate

– on-line and off-line telepathology are existing

– quality of pathology preparation image has essential importance either in technical mean (resolution, color,...) or in medical mean (quality of preparation, method, ...).

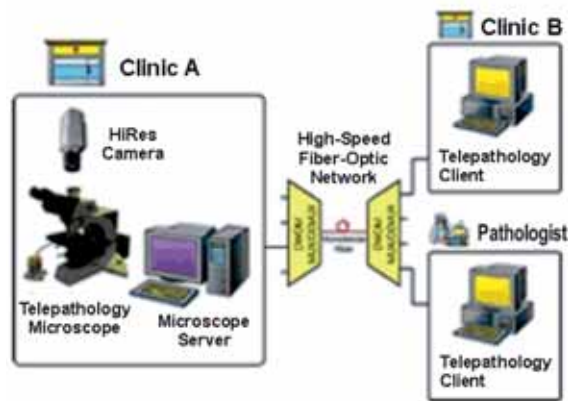Telepathology story is simplified to telepathology scheme (Figure 6):

Figure 6. Typical telepathology system

Resume to the perspectives of telemedicine and analyze factors that affect on them. The factors are overlapping but the main groups are:

– medical (medical services, development of medicine based on new technologies, nano technology...)

– social (patient-physician relationship, telemedicine acceptance by society…)

– technical-technological (communication and informatics technology, EPR (Electronic Patient Record)...)

– personal (patient home healthcare, patient contentment…)

– economical (healthcare costs, quality of life, life standard...)

According to all said above, telemedicine perspectives in general are:

– reliance on the Internet

– repose on interdisciplinarity (physician-ICT expert, physician-physician)

– all telemedicine participants (patients, physicians) are well informatics educated

– engagement all relevant telemedicine subjects: ICT giants (Google, Microsoft, Cisco, Vodafone, Nokia...), state institutions, healthcare institutions, social security funds and institutions, universities...

– main use: diagnostics, patient follow-up, education, robotized medical devices and instruments

– main effect: improved treatment and better treatment results.

Is a robot-physician installed in some American hospitals perspective of telemedicine? It is very hard to answer simply with yes or no. Interesting fact is that is very well accepted by patients, believe or not.

But technology and main development trends could be emphasized in the following table (Table 1).

Table 1. Technology and main development trends

Module	Examples
Data transfer	Telephony, GPRS/EDGE, 2G, 3G, DSL, ISDN, ATM, leased lines, optical network
Content	Voice, videoconferencing, 2D and 3D gray and color images, video, physiologic signals, physiologic values, random signals
Devices	TV sets, PC, PDA, cell phones, medical devices (for example Endoscope), diagnostic devices (MR, CT, PET, US), scanners, cameras, digital cameras
Data processing	Data exchange, creation and maintenance of databases, safety and security, interactivity, diagnostic signal and image processing, virtual reality

At the end, let us make attention on telemedicine in oncology or better said where the place of telemedicine in oncology is.

To determine the place of telemedicine in oncology, oncology premises must be regarded:

– early detection of cancer has essential importance for its treatment and cure

– cancer begin to repute chronically disease

– quality of life depends on healthcare level, patient responsibility and level of patient oncology education.

According to these premises, following telemedicine services in oncology are recognized:

– teleeducation: efficient way for healthcare education for early detection of cancer

– teleeducation: efficient way for education how to live with cancer

– teleconsultations as diagnostic assistance

– teleconsultations as a part of oncology healthcare

– teleconsultations as permanent contact physician-patient.

And finally, let us try to identify main assumptions for further development of telemedicine:

- legislation
- medical regulative: telemedicine services standardization, protocols.
- definition of telemedicine services price list
- positioning of telemedicine services in social security system
- making responsible relationship physician-patient
- systematically definition of physician education process for use of telemedicine
- systematically definition of patient education process for use of telemedicine
- making OER society (OER = organized, educated, responsible)

CONCLUSION

It is very pretentious to make conclusion about telemedicine perspectives and expectations. Five years ago, rarely anyone could determine significance of cell telephony as it has today. Development of cell telephony technologies are going with giant steps and it is very hard to assume where their limits are. Maybe tomorrow, this story will be repeated with telemedicine. Instead of conclusion, a following expression will better give us the final picture: to comprehend way of further development of telemedicine it is necessary to change an angle of observation; and to find a place for telemedicine in our everyday healthcare practice of nowadays and in the future by putting together all technical-technological and medical pieces.

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Conflict of interest

We declare no conflicts of interest.

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