The Principles of Telemedicine in Practice

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Abstract

Telemedicine (distance medicine) represents a field of medicine that has been in a tremendous expansion over the last couple of years thanks to the fast development of telecommunications and reduction of their costs. It enables a direct communication (visual) between the peripheral hospitals and referral facilities in the interior of the country as well as a connection of centres with referral centres abroad in the fields of diagnostics, consultations or education. The main objective is to encourage interest in telemedicine among physicians and other health care experts, initiate an exchange of opinions, and experience about the application of telecommunication technology in medicine, so to reach a common perception of its role in the context of future development of the health care system in Bosnia and Herzegovina. As a standard, current equipment consists of computers, which are equipped with frame grabbers and communication modem for communication through a public telecommunication system. Input data can all be visual data (X-Ray, CT, MRI, ultrasound, ECG, histological finding, cariogram, and of course photos of the patients, of operational/surgical field. The Institute of Pathology of the Sarajevo Medical Faculty has actively participated in the experimental project "SHARED" (1996-2000) together with the Radiology and Ophthalmology Clinic of the Sarajevo Clinical Centre. The past experience in using telemedicine has shown that the introduction of such a telemedicine system in B&H would be of great significance in the future in the context of providing better and more efficient health services to the patients. In practice, that means a more simple approach to some services and data for patients, a better and faster circulation of information and experience of medical experts and health care workers with cost control at the same time.

Keywords: telemedicine, telepathology, teleradiology, teleeducation, project "SHARED".

Introduction

The telemedicine is a new activity in medicine, which encompasses various approaches aimed at meeting the requirements, which can be expressed as simple as "displaced medicine or distance medicine". One of definitions of the telemedicine given by the EC for Telemedicine says: "Telemedicine is a fast access to distributed medical expert knowledge using telemedicine and information technologies regardless of actual location of a patient or relevant information". (1, 2)

The beginnings of telemedicine may be brought in connection with the appearance of television (around 1930) during which the efforts were made to establish communication between health care facilities through this new medium. Sixty years later, thanks to the development of the Internet, which radically changes medical education, and the expansion of medical information as well as the development of high-speed ISDN telephone communication system, the videoconferencing becomes a constituent part of numerous spheres of human activity including the medicine. (3)

Almost all developed countries have already established a telemedicine network, which covers even the most remote and least populated areas. That enables the patients to receive almost the same quality of medical care as the patients in urban areas. Examples can be found in the countries of Scandinavia, Germany, France, Austria, Canada, etc. Since having the telemedicine network established partly also results in significant savings of the overall national funds allocated for the health care system, the telemedicine grows to be more and more attractive for many developed countries.

The telemedicine allows physicians to be together while they are conducting clinical studies, regardless of geographic separation, sharing the patients' files and diagnostic images. Therefore, thanks to the telemedicine the geographic isolation does not represent an insurmountable obstacle any longer for the fundamental needs of having timely and good quality medical care (Scheme 1).

Scheme 1. Scheme of the telemedicine system

The telemedicine eliminates the effect of time as a potential risk factor because of the postponement and waiting, while the physicians in the inaccessible areas and in the remote medical centres get a chance to perform a consultation right away, quickly and efficiently with the most prominent experts in particular fields and so more easily and more reliably make decisions on the type and manner of intervention. The telemedicine has been used by health care workers in the growing number of specialization branches which include but are not limited to: radiology, pathology, dermatology, surgery, cardiology, psychiatry and family medicine. (4, 5)

Teleradiology is currently the best-specialized form of telemedicine in the world because the telemedicine is most easily applied in the branches of medicine such is radiology or surgery since they already use equipment which includes computers and very small improvement of the system is required for meeting telemedicine standards for networking and application. Considering the technical requirements of the system, teleradiology (especially the classical roentgenology) is the simplest one since it involves the transmission of black and white images of a relatively low resolution. On the contrary, telepathology, considering its input data, represents a great challenge for the IT system because of the great number of colours and also because the work requires zooming. It all results in the need for high-quality equipment and a developed telecommunication system. (6)

As a standard, current equipment consists of computers, which are equipped with frame grabbers and communication modem for communication through a public telecommunication system. Input data can all be visual data (X-Ray, CT, MRI, ultrasound, ECG, histological finding, cariogram, and of course photos of the patients, of operational/surgical field. The types of images which are being transmitted depend on the quality of the image processing program and the telecommunication system.

Basic goal

The main objective is to encourage interest in telemedicine among physicians and other health care experts and initiate an exchange of opinions and experience about the application of telecommunication technology in medicine, so consequently to reach a common perception of its role in the context of future development of the health care system in Bosnia and Herzegovina.

Since the work contains the results achieved in this area by the Institute of Pathology, the objective of the work is also to create by the development of the telepathology system in Bosnia and Herzegovina a foundation for an extensive introduction of telemedicine in practice and to brush up a local program for transmission and processing of images. It enables a direct communication (visual) between the peripheral hospitals and referral facilities in the interior of the country as well as a connection of centres with referral centres abroad in the fields of diagnostics, consultations or education.

Material and methods

The telemedicine requires high image quality, which matches that of the original (e.g. X-ray images) because the visual element is the key of a successful video conference. Owing to the latest computer-screen technology, a research team from the Johns Medical Institutions, in their research of the quality of the imaging of especially chosen and diagnostically very complex images, have concluded that there was no significant difference when it comes to the accuracy of the interpretation between the original and its image on the computer screen. The effects of the various types of compression on the quality of the image have also been studied and consequently the standards have been accepted which meet high requirements while allowing a significant image compression needed for a fast transfer between computers. (7, 8)

A video conferencing requires the following equipment:

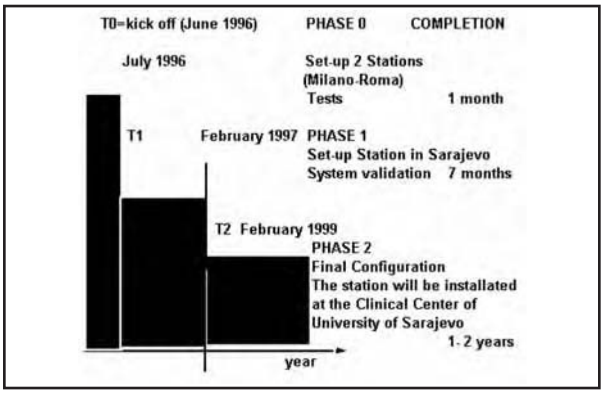
1. Video-camera is the most important peripheral piece of equipment in the video conferencing. A standard videoconferencing requires more than one camera. It is necessary to show the participants in the discussion, but what is also important is another video camera, so called document camera for showing the images about to be discussed. This one must be able to zoom in the images in order to show even the smallest details with quality. The telemedicine also requires a mobile video camera with which it is possible to take pictures of the patients from different angles.
2. Scanner is also one of the essential parts of the advanced system for visual communication with a purpose to present high-quality scanned images to the participants of the videoconference.
3. A useful peripheral piece of equipment is also a "35 mm slide-to-video converter" which enables the presentation of 35 mm slides, which are very frequent carriers of visual data in medicine.
4. What is also significant is audio equipment, which depends on the needs of the system user, i.e. on the field of activity in which the videoconferencing is being used.

It is necessary to have other video equipment, video recorders that record the conferences, additional monitors for presentation of visual data, printers and so on.

Since the videoconferencing system connects various centres, flexibility is one of the most important features of the system. That is why it is necessary that it be equipped with numerous inputs/outputs for audio, video equipment, additional monitors and cameras, various medical instruments as well as other computers. (9, 10)

The first telemedicine link of the Institute of Pathology was established with the Institute of Pathology of the Medical Faculty in Zagreb and a company VAMS which created a software system for telemedicine "PHAROS". Back in September of 1996, a month after the first telemedicine consultation and the presentation of this system at the Clinical Centre in Sarajevo, the Institute of Pathology of the Medical Faculty in Sarajevo together with the Clinic for Radiology and Ophthalmology of the Clinical Centre in Sarajevo became active members of the experimental project "SHARED".
The complete project was implemented in three phases. (Scheme 2)

Scheme 2. Scheme of the project development



1. The first phase, which began in July of 1996 lasted for one month and was based on the development and testing of the available equipment.
2. The second phase lasted for seven months and the project involved the above-mentioned Clinics of the Clinical Centre in Sarajevo. The objective of the second phase was to train the medical staff to use the equipment at hand.
3. The third phase lasted 1-2 years. During that period, the mentioned equipment was installed in the Clinical Centre in Sarajevo.

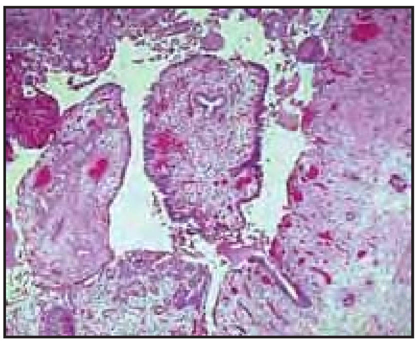
For the preparation of the video-conference the existing equipment at the Institute of Pathology in Sarajevo was used with the following characteristics (Picture 1):

- Microscope Polywar Reichart Jung with lateral macro zoom which can receive an X-ray image, record skin lesions, macroscopic preparation, e.g. biopsy etc.;
- CCD Panasonic TV camera (720 pixels, 600 lines) connected to the SVGA colour TV monitor (17 inches) and PCI.;
- Computer Pentium Compaq 133 MHz; 3,5 "floppy; 2 MD Video RAM; 17" SVGA monitor; CD ROM which can store 120 uncompressed images, 2 GB disk which can store 3000 digital colour images.

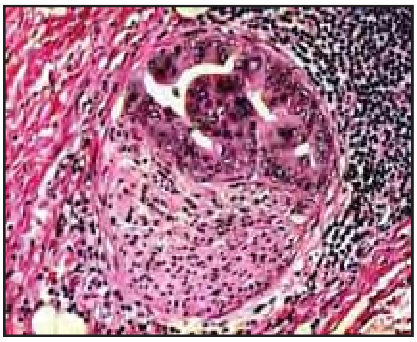
Picture 1. Usage of equipment at the Institute of Pathology

With the help of "Issa" Program, we have formed a structured database based on the data and images related to the patient's condition.
The images saved in the jpg. format as well as all clinical data on the patient are being sent via EUTELSAT II from the SFOR Italian military base two days prior to the "face to face" connection. Once the connection is established, the images are exchanged, all the important details that are characteristic for the biopsy in question are marked and that is how the conclusion and diagnosis is made. One should note that the counterparts in Milan are experts for particular disease not general pathologists.
During the conference, preparation a brief document is used which contains the history of the disease of the patient with additional information on macroscopic and microscopic images of the received biopsy. All additional data related to the biopsy that was performed during the conference are being registered in that document together with time spent and the number of images. All data are stored away in the archives of the Institutes in Sarajevo and San Raffaele Hospital in Milan. The look of this record is constantly modified by new information in case a consultant or we find it necessary to add some additional comments.

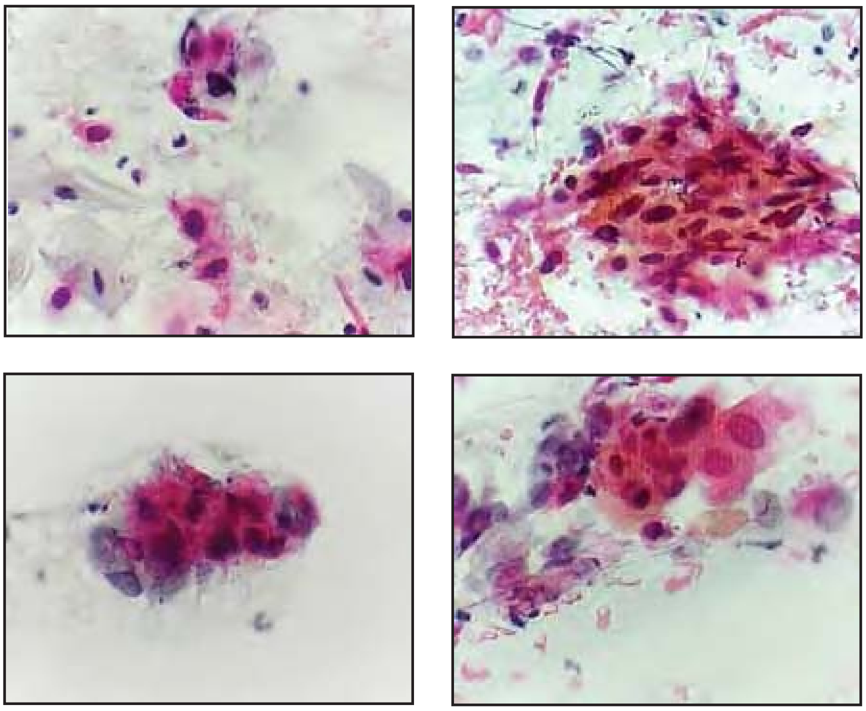
Picture 3. Microscopic: Papillary tumour fills the lumen of a gallbladder (enlarged 10x)



Picture 4 Microscopic: Invasion and perineural expansion of the tumour (adenocarcinoma) of the gall-bladder (enlarged 40x)



Pictures 5 An example of carcinoma planocellulare cervicis (CIS) Pap



The mentioned diagnoses were made after the telemedicine conference (Pictures 3, 4, 5).

Results

The timetable below shows data for 190 consulted cases (Table 1).

Discussion

Based on the results shown in this timetable one can say that from the moment this system was installed until the end of phase III the Institute of Pathology had 190 consultations. The opinions of our pathologists and those of the pathologists of the Institute of Pathology in Milan were similar in 83% of cases. The biggest number of consultations was concerning the Pap test (59) and the lymph node biopsies (31), and here the opinions were similar in 75% of cases. The total connection time for the first 40 cases was 372 minutes. The biggest number of recorded images for one case was 44, and the smallest 4 images.

The analyses of French pathologists have shown that in the 80% of cases the pathologist makes a diagnosis on his/her own after the first analysis of routine biopsies, in 15% of cases he makes the diagnosis after the consultation with another pathologist and another analysis while in 5% of cases he/she consults with an expert pathologist. (11)

This work is primarily about sending and receiving digital images through a direct teletransmission (the image

Table 1. Review of realised consultations

No.	Tissue	No.of case	No.images	Length of consultation	Similar opinion
1.	Cytological smear	59	6-19 +7-20	2-5 min	50
2.	autopsy	1	14	15 min	1
3.	Lymph node biopsy	31	4-25+13-19	5-10 min	25
4.	Soft tissues biopsy	14	15-44+11	15-18+2	9
5.	Skin	13	15-20	10-12	13
6.	Stomach	3	15-20	5-15	3
7.	Gynaecological biopsy	15	5-6+10-17	5-15	14
8.	Punctate of the bone marrow	5	10	10 min	2
9.	Spleen biopsy	1	10	15	1
10.	Retroperitoneal tumour mass biopsy	10	5	5 min	7
11.	Oesophagus biopsy	1	20	15	1
12.	Bone biopsy	8	19+16	2 min	6
13.	Thrombi	1	11	3 min	1
14.	Breast biopsy	11	10	10 min	10
15.	Larynges biopsy	2	11+13	12 min +2 min	1
16.	Thyroid glands biopsy	4	17+13-17	2 -5 min	3
17.	Testis biopsy	2	12-11	2 min	2
18.	brain	3	14-16+9	10-15 min + 5 min	1
19.	Kidney biopsy	1	18	10 min	1
20.	Eyelid biopsy	1	17	5 min	1
21.	Lung biopsy	2	7-14	5-10 min	2
22.	Pleura biopsy	1	5	10 min	1
23.	Pancreas biopsy	1	20	10 min	1

must be of high resolution). With an aim to meet the requirement for a fast and interactive data exchange, the telemedicine system must provide:

-transmission of high-resolution image, live or frozen, black and white or colour;
-transmission of time signals in real time or memorized sequences of time signals;
-voice transmission;
-data transfer and access to hospital and specialized databases.

Such a system, applied in a health care environment provides for an exchange of a complete set of information related to the patient in question, a possibility of revision of referrals and similar cases as well as a possibility for a fast and accurate insight into personal and administrative data of the patient, and it requires no special staff nor education for daily use. Using the experience of working in telemedicine it has been proposed to have an hierarchical organization of this system in Bosnia and Herzegovina connecting small hospitals with regional centres in Bosnia and Herzegovina and connecting these centres with the national centre in Sarajevo. The national centre in Sarajevo would be connected to all other specialized international centres in Europe. Another proposal is the introduction of an internal telecommunication system at the level of the Clinical Centre, where the pathologist would be connected to all other departments which are being serviced, i.e. the institutions which have digital equipment (radiology, oncology, surgery, OB/GYN, internal medicine,..). On the way out of the hospital the patient would get a recorded finding in the form of an image with the digital findings of an ultrasound, MRI, CT, together with a biopsy image. All successive findings would be linked to the previous one.

In health care facilities, the videoconferencing is used more and more for distance learning. In the not so developed countries in which bad road communications and occasional extreme climate conditions cause a partial traffic isolation of less urban or rural areas, the application of the videoconferencing system may overcome these problems, eliminate the distance between a teacher and a student, a local out-patient clinic and a bigger hospital. The applicability of such systems is obvious in our surroundings. Apart from the studies and distance medical interventions, the application of the videoconferencing system opens up numerous possibilities for a better quality simultaneous exchange of information between the students from different universities, joint research work, documents, as well as a possibility for better co-operation with the leading educational institutions in Europe and world-wide. (12-14)

Conclusions

It has already been proven that realization and use of telemedicine systems brings benefits in all segments of health care community. Here we shall only list these benefits without deeper analysis.

- -uniform level of health cares regardless of regional economics and population characteristics,
- -availability of regular and efficient health care in remote areas decreases drain of population and makes return more attractive,
- -attracts trained and educated workers in non-developed regions producing a positive impact to local economy,
- -gives rise to national health care parameters,
- -improves general image of a country,
- -decrease of expenses for travelling of patients,
- -decrease of expenses for travelling of specialists,
- -decrease of hospital accommodation expenses,
- -decrease of expenses for hospital medical services,
- -savings which come out from health care delivery in small local centres in big cities and regional centres,
- -decentralization of health care and distribution of competencies,
- -fast, easy and efficient availability of second opinion,
- -avoidance of late reactions and expansive mistakes,
- -shortening of patient time spent for waiting on medical service,
- -increased efficiency of specialists and
- -uniform distribution of expert knowledge and decrease of expenses needed for permanent education of medical staff.

The project of telemedicine requires huge funds because it includes IT and telecommunication support besides medical science. In spite of these financial expenditures, it is certain that the telemedicine represents the future of connection between medical centres. The project of telemedicine in Bosnia and Herzegovina can succeed only as a part of a wider project of communication network for the entire health care system. With the lack of it or its development, it will not be possible to build an IT-based society.

This top global telemedicine achievement is providing Bosnia and Herzegovina with an opportunity to get involved in the trend of improvement of medical services with the help of information technology on time. In practice, that means a more simple approach to some services and data for patients, a better and faster circulation of information and experience of medical experts and health care workers with cost control at the same time. A reliable health care system, the possibility for better quality distance-learning as well as the application of such systems in other branches and spheres of human activity would reduce the current problem of brain drain to a great extent, facilitate the return of refugees, especially young people who are often reluctant to leave big urban centres for the war-destroyed less populated urban and rural areas. The rehabilitation and development of these parts of Bosnia and Herzegovina as well as the rehabilitation of the entire country will depend on the application of such systems. That is why they are of the strategic importance and must not be considered luxury. Instead, they must be made available to each individual user who will, in that way, make his/her work more accessible and improve its quality. (15-17)

The experience gained through this project may serve as a model for other medical procedures, which, with the help of the Internet, have more space for further development of telemedicine in various fields of medical science.

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