The Croatian Telemedicine

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Abstract. Telemedicine developed in Croatia in two phases. The first phase during the 1970s was limited because of insufficient technology and scarce resources. But that phase was important as a learning process and the preparatory stage for the promising future. The communications infrastructure was heavily destroyed during the 1991-92 war but it was reconstructed and rebuilt as a modern technology based on optical fibres. The new technical and technological infrastructure was the base for the development of CARNet (Croatian Academic and Research Network). CARNet was linked to the Internet and enabled the international exchange of information for the scientific community. Telemedicine projects started firstly as pilot projects around the same time as in other countries. They were financially covered mostly by the Ministry of Science either directly or through the CARNet. The telemedicine projects, like telepathology, teleradiology, teleneurosurgery, teleeducation, developed in a very sophisticated way and are now in the phase of implementation into the routine health practice. Some projects are still in the pilot phase, but thanks to highly trained professionals, they are promising and it can be expected that with the growing economic stuation they will be implemented soon.

1. Introduction

According to WHO (1988), "Telemedicine is the delivery of health care services, where distance is a critical factor, by health care professionals using information and communications 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 healthcare providers, all in the interests of advancing the health of individuals and their communities"[1]. This broad definition was used during the preparation of a one-day conference, November 13 1998, in order to summarise the status of telemedicine projects in Croatia. The Conference was attended by more than 1200 participants, physicians, engineers, computer experts and other disciplines in three cities (Zagreb, Split and Osijek) using the system of video teleconferencing. The Conference was organised by the Croatian Medical Academy, Croatian Electrical Engineering Academy, Faculty of Electrical Engineering and Computing, and CARNet (Croatian Academic and Research Network). Since that time the telemedicine projects in Croatia have continued to be developed and implemented and several new projects started. The Croatian Medical Academy established the Board for Telemedicine within the Public Health Department in order to disseminate information, initiate and support new projects and other activities and to exchange experience. Also, the Croatian Telemedicine Association was recently established within the Croatian Physician Society.

2. Communication Infrastructure in Croatia

The communication infrastructure in Croatia consists of a network, which connects a large number of cities and small places in Croatia. The network is owned by the Croatian telecommunication company, Croatian Telecommunications. The backbone of this network connects all major cities and many smaller towns in Croatia and uses optical fibres. This optical network constitutes a basis for other wide-area computer networks in Croatia such as the Croatian Academic and Research Network (CARNet) and HiNet. CARNet is a wide-area network based on ATM and Ethernet technologies and TCP/IP protocol. CARNet provides modem dial-up access and connection to the Internet for academic and research community. The backbone of the CARNet is switched network based on optical fibres and ATM technology at speeds 155Mbps and 622Mbps. The network has bees developed and managed by the government institution having the same name. The first ATM connection in CARNet has been realized in 1995. CARNet mission includes development of computer network infrastructure in Croatia, experimental applications of information technology in various areas. and popularization of information technology in Croatia. In 1998, Croatian Telecommunications realized HiNet which is commercial network offering services to companies and individuals. HiNet services include switched lines for dial-up modem access in major Croatian cities, ISDN services, and high-speed leased line connections. Both of the above mentioned networks enable a wide range of basic communication services required for telemedicine applications. CARNet ATM network also enables quality transmission of video and audio signals that is important for medical teleconferencing applications. CARNet ATM is also used for distant learning and distant lectures between Croatian universities. All these networks are connected to the Internet and provide users access to all information services available on Internet including various telemedicine-related services. Thank to advanced wide-are network infrastructure Croatia has all the prerequisites for development and application of various telemedical applications.

3. Background – Organizational Aspects

Telemedicine in Croatia developed in two phases: the early phase was during the 1970s with the application of ECG signals developed for transmission through telephone lines, for transmission of statistical data, and some other mostly pilot projects. Those projects were of limited effects because the technical infrastructure and the available technology were not developed enough. The second phase started during the 1990s with the technology development in Croatia. Before 1990, the telecommunications infrastructure in the country was obsolete and, in addition, during the 1991-92 war was heavily destroyed so that its reconstruction was of the country's high priority. In the following years some 11,000 km of optical fibre cables were constructed all over the country [2]. At the same time, *CARN*et started as the country network, which enabled exchange of information at high speed. Universities and research institutes throughout the country were connected to the network free of charge. Since 1996, the local offices of the Croatian Institute of Health Insurance were also connected to the network using 2 Mb/sec technology.

4. The Telemedicine Projects in Croatia

4.1. Telemedicine in Neurosurgery

18 general, regional and university clinic hospitals are equipped with 33 computerized tomography (CT) units, as a basis for the high quality diagnostic procedure. But only 10 university clinics and regional hospitals have the neurosurgery teams, which can treat the complex patients. In order to improve the quality of diagnostic procedure and the consultancy between the hospitals and experts there has been established the telemedicine system in which all 33 CT units are connected. The system started to operate as routine in August 1998 after several months of pilot work. By the end of 1999, the Neurosurgery Department of the University Clinic in Zagreb collected CT archive slides from 2,071 patients. The Neurosurgery Department is also linked to the Radiological Department with daily consultancy. On an average, there are 4 consultancies in neurosurgery. The most frequent hospitals are in Koprivnica (83 consultancies), Bjelovar (74), Dubrovnik (39), Varazdin (35), Karlovac (35) and Zadar (32). The most frequent reason for the teleconsultancy were craniocerebral injuries (39 %), followed by cerebrovascular diseases (24 %) and tumors (25 %). After teleconsultacy, 80 patients were immediately transported from the local hospital to the Neurosurgery for intervention. For 180 patients the appointment for intervention was made and for 181 patients it was decided to treat them in the local hospital. To the Croatian patients, the use of teleneurosurgery network has meant higher quality of care, rationalization in the use of equipment, and improvement of knowledge. The use of telemedicine neurosurgery network is expected to be even more frequent in the future.

4.2. Telepathology

Telepathology was one of the first telemedicine projects developed in Croatia. It started in 1993 developing the programs for the image transmission and education of experts in several hospitals. The focal point for the network was the Department of Pathology of the Zagreb Medical School. In 1994, it was connected to the Pathology Departments in Dubrovnik and Slavonski Brod, then in Rijeka, Vinkovci and Split. At the same time, the international collaboration started. The first connections were established with Sarajevo, Heidelberg, Bruxelles, Umtata (South Africa) and Pittsburg (USA). The software allowed first the transmission of the "frozen" picture only, and later the transmission of "live " pictures using the remote control microscope. As a result of the development of telepathology in Croatia, the Pathology Institute of the Zagreb Medical School was the organizer of the third European Congress in Telepathology in Zagreb in 1996 [3].

4.3. Health Insurance System

The Croatian Institute for Health Insurance (CIHI) is the main health insurance company operating as an obligatory health insurance with coverage up to 90 % of the health risks of the 4.7 million Croatian citizens. The CIHI financially supported the telemedicine projects, e.g. teleneurosurgery and teleradiology. In 1996, the CIHI initiated and supported the development of the Health Information System in Croatia [2]. The project is now in the phase of implementation, what includes on one side the

connection of all the Institute's branches in the field with the central office in order to have information on the insurees, and on the other side the connection of the health institutions for different purposes (consultancy, health statistics, education).

4.4. Teleradiology

The development of teleradiology was connected to the implementation of CT, ultrasound, and NMR technology in the health care in Croatia. It was developed correspondingly with the teleneurosurgery project. Since 1997, most of the Croatian radiological departments have been connected to the network using the DICOM standards and high-speed transmission.

4.5. Pace-maker Remote Control

As a *CARN*et pilot project, a team of cardiologists and engineers developed a pacemaker remote control at the University Clinic in Zagreb. ECG real time transmission and pacemaker reprogramming from the Zagreb University Clinic to a patient in Split (500 km distance) was done in 1999. Both the software and hardware were recently further developed, so it is expected it would be possible to treat the patients at remote control units routinely. For patients, this means monitoring of cardiac dysfunction in time, faster change of therapy related to health needs, less expensive medical treatment, and improved quality of life. For the health care system, this is a more efficient use of trained personnel, a simple way of continuing training of health professionals, and rational use of resources [4].

4.6. Medical Education

During the last several decades, education at a distance, "distance learning" in medicine, became one of the most important questions in quality of health care assurance, especially in rural and less populated regions of the world. But it is also the question of efficient use of educational centers and experts. It started using standard communication technologies, such as mail, radio and television. Telematics technology with speedy transmission of information, transmission of complex signals, slides and images, and two-way interaction in real time, gave to a new dimension to this area. In Croatia, this approach started systematically, and developed by linking the video and computer technology with the printing technology within the project for continuing education in primary health care of the Educational Multimedia Center (EMC) at the Andrija Štampar School of Public Health, in collaboration with the experts from Japan in 1987 [5].

The second example of such an approach is the international project EuroTransMed, developed within the PHARE project. During the last 6 years the A. Štampar School of Public Health has been one of the more than 50 centers in Europe, members of the satellite network for weekly 2-hour program of continuing training of medical experts in different fields of medicine.

The Split Medical School is developing the project Virtual Medical School with the main objective to support self-education and will be available on the CARNet and CD [6].

The EMC is developing an interactive hypermedia CD for education in quality of health care, which can be used by individual experts or in organized groups mostly in primary health care settings.

The Institute for Diabetes "Vuk Vrhovac" is developing an interactive teaching material on CD, both for medical students and medical professionals in the field to improve knowledge and skills in diagnosis, treatment and organization of health services for diabetic patients. The learning material can also be easily transferred into *CARN*et and the Internet.

In 1999, a teleconference that linked four Croatian medical schools was organized as an part of education in medical informatics. In two hours of interactive transmission different topics of telemedicine were presented to the second-year medical students.

4.7. Medical Informatics Symposium as a Videoconference

The Croatian Society for Medical Informatics (CSMI) is a voluntary and nongovernmental organization whose members are medical informatics experts, physicians, statisticians, mathematicians, and experts from other fields working in health care. Every other year, the CSMI organizes a symposium in medical informatics. In the 1997 there was the first such symposium organized as an interactive videoconference that linked two cities in the Croatia – Zagreb and Split. The 1999 symposium had the topic on standardization in telemedicine and telecommunication. It was organized also as an interactive videoconference that linked four cities – Zagreb, Split, Rijeka and Osijek.

4.8. Digital Library

Croatian medical libraries operate in an environment, which is characterized as peripheral research communities, small in size, underfinanced, and out of the international scientific community. The application of the new information technology is not of a high priority in health policy [7]. The eight medical libraries started the project of establishing the biomedical network in 1997. The first step was to have the publications of the Croatian biomedical authors since 1986 available as a computer catalog, and to update the Biomedicina Croatica. A part of this material is available on the Internet.

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