TeleInViVo
3D Ultrasound Telemedical Workstation

Resume of the TeleInViVo project

The UNESCO component:

Telemedicine in Kazakhstan and Uganda

1 The participation of developing and transitional countries in the project

1.1 Objectives of the project in Developing and Transitional countries

TeleInViVo is a prize-winning research and development (R&D) project. The project consortium, led by Fraunhofer IGD, has designed and manufactured an innovative low cost, low weight, portable telemedical workstation for use in isolated areas such as islands, rural areas and crisis situation areas. This constitutes the environment of many people and communities in developing countries. The workstation has integrated in one custom-made device a portable PC with telecommunication capabilities and a light, portable 3D-ultrasound station. The TeleInViVo equipment is currently being tested and evaluated in four isolated trial locations.

UNESCO's objective in this project is to apply this cutting edge telemedicine technology in countries where telemedicine has a potentially important role in health care. On the one hand, the trial sites in Uganda and Kazakhstan test the compatibility of this equipment with the needs and conditions of developing and transitional countries. On the other hand, the project is ensuring access for remote hospitals to telecommunications infrastructures, the training of local technicians and doctors in modern technologies and providing experience in and telemedicine equipment and procedures.

Remote, isolated communities need to have access to health care services, but they are either inaccessible or very difficult to obtain, often requiring long travels and staying in medical centres. This access is only achieved through the use of applications that allow remote expert consultation providing a faster response in emergency and crisis situations or in isolated areas.

Through the project, the following needs in these areas are being addressed:

- to have better access to computerised scanning techniques to perform better diagnosis;
- to have online consultations with their colleagues abroad and enhance international medical collaboration;
- to obtain feedback on the efficiency of the prescribed treatment in order to constitute a personalised medical record and database of cases;
- for the local physicians and nurses, to be directly trained in the most recent techniques and help them throughout the difficult diagnosis process;
- to increase the territory of possible intervention for the doctors;
- to build databases for statistical analyses which could help when analysing tendencies in the health care sector and detect possible emergence of epidemics;
- to optimize the organisation of doctors' work by keeping them in closer contact with one another, and by increasing the number of virtual patients as an effective modern method of medical consultation and diagnosis;
- to develop data bases of cases for medical training

1.2 Role of UNESCO

UNESCO CI/INF (Division of the Information Society), based in Paris, has a special mandate to promote cooperation in the fields of communication and Information Society, and particularly to assist developing countries to narrow the gap in access to information, separating them from the industrialized world. This involves exploring the possibilities for wide scale use of technologies, improving access to public domain information, transferring skills and know-how related to Information and Communication technologies (ICTs), and enhancing education and training relative to the information society.

Our role in EC Information Society projects such as TeleInViVo involves extending European research and technology to less industrialized, non-EC countries through training, technology provision and international cooperation.

To implement TeleInViVo, UNESCO works closely with its field offices in Almaty, Kazakhstan, and Nairobi, Kenya, where Regional Communication Specialists are providing on-site assistance in infrastructure development and project implementation. In Uganda, the project officer for the joint UNESCO/ITU Multipurpose Community Telecentre project in Nakaseke, a representative of the Uganda National Commission for UNESCO, is ensuring that the TeleInViVo project is being developed in tandem with the rural telecentre project.

UNESCO's objectives in TeleInViVo:

- facilitate remote access to medical specialists in central hospitals – thereby breaking down geographical barriers to rural healthcare
- enable use of technologies through training of human resources in the project
- establish the infrastructure necessary for telemedicine in isolated regions
- collect and organise TeleInViVo medical ultrasound image files for ongoing medical referral and medical training

To promote the use of telemedicine, UNESCO and the World Health Organisation (WHO) should engage in joint activities, with WHO's responsibility based around the medical aspects of such projects.

Some UNESCO CI/INF projects

Telematics and computer communication have become important themes in UNESCO activity through, for example, efforts to develop methodologies for the establishment and use of databases, virtual libraries / museums and communication networks. To help achieve its objectives, UNESCO has sought cooperation with other international organisations.

UNESCO CI/INF continues to implement EC funded projects in non-European countries including:

- "Network of Central Asian Cultural Institutions" (HeritageNet) 1998 – 2001
- "Trans European Tele Education" (TEN) 1998 - 2000
- "Development of New Markets for Telematics Applications Products" (DENEMA), 1997-1999
- "Support for Telematics Applications Cooperation with the Commonwealth of Independent States" (STACCIS) 1996 –1999

Since 1992, UNESCO and the International Telecommunications Union (ITU) have conducted various joint activities and research related to the improvement of access to and use of Information Society Technologies including:

- Multipurpose Community Telecentres (see below, page 12)
- ITU Focus Group analysing the global impact and development of the Internet (1999)
- "The Arab World and the Information Society" Congress, Tunis, Tunisia, in 1997 (with cooperation from the European Commission).
- African Regional Symposium on Telematics for Development, Addis Ababa, Ethiopia, 1995 (with cooperation from UNECA).
- Pilot project on Access to Telematics Facilities, based in English-speaking countries in the East Carribean.

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2 Trial site description

2.1 Kazakhstan

2.1.1 Almaty Diagnostic Centre (ADC)

The Centre was founded in 1988 at the initiative of Academician and 1985 Nobel Laureate Dr. Eugueni Chazov. It is a leading diagnostics institution in the Republic of Kazakstan. The Centre has a highly qualified staff and modern diagnostics equipment. It is also a well-recognised establishment for education and training of medical professionals. More than 125 doctors working in three consultative Departments (Therapy, Surgery and Paediatrics) running about 1000 consultations and medical examinations daily.

2.1.1.1 Site description

The Centre comprises Functional and Ultrasound Diagnostics Departments, Computer and Magnetic Resonance Tomography Departments (CT & MRT), X-ray Diagnostics Department, Endoscopy Department, as well as Cytomorphological, Immunological and Biochemical Diagnostics Laboratories.

The Centre has the first MR tomograph in the Republic of Kazakstan, with magnetic tension of 0,5 Tesla. Dr. Jury Grushin is the Head of the CT and MRT Department. The Centre is the first medical institution in Kazakstan to introduce latest technologies and Internet in its daily practice.

Dr. Grushin previously co-ordinated the DENEMA project, funded by the European Commission. Katelco and UNESCO were the other project partners and all five Central Asian CIS countries participated in the projct (http://www.katelco.com/UNESCO/denema_en.html).

The services provided under the DENEMA project were:

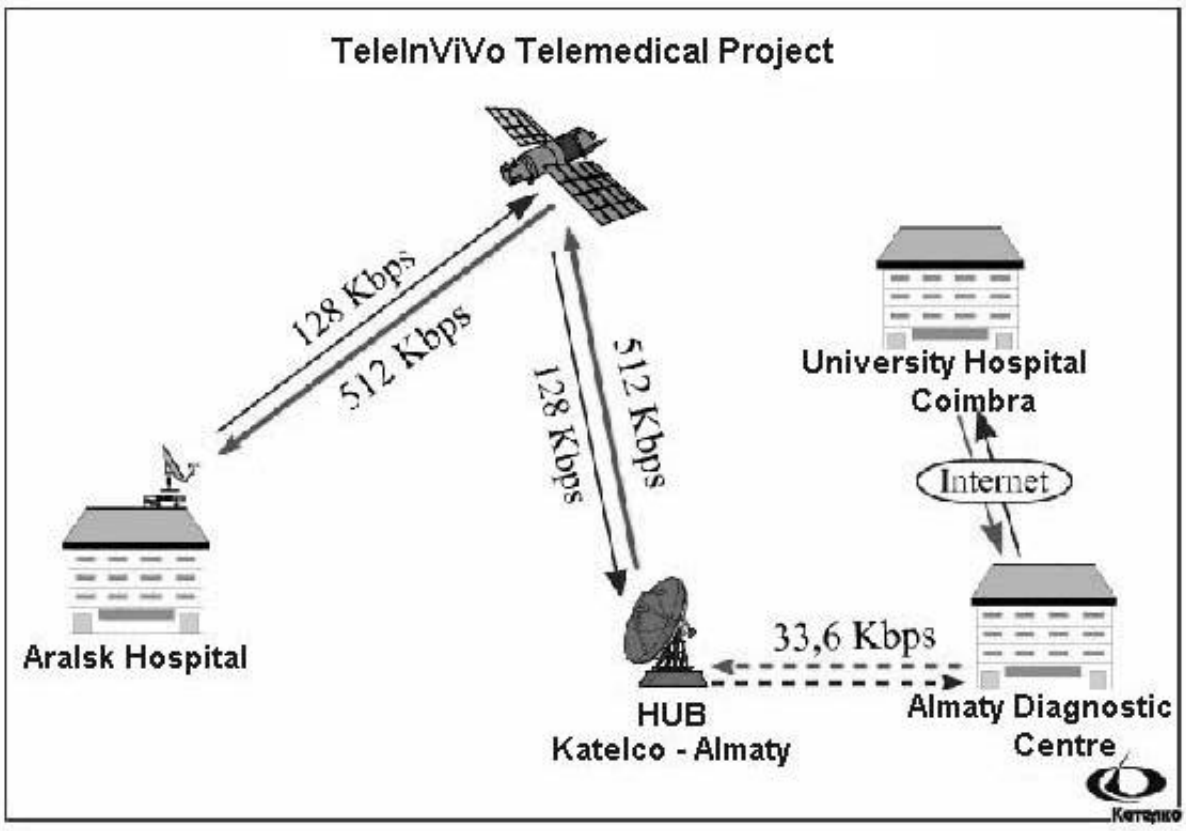
. tele-consultations;
. easy retrieval and exchange of documented medical information via Internet (electronic mail and in real time (on-line)) both internationally and in the Central Asian region; exchange and process information on methods of diagnostics:
. access to world wide specialised biomedical, and other, information banks;
. tele-training.

TeleInViVo Room in the ADC

2.1.1.2 Equipment

A fixed TeleInViVo workstation connects to Coimbra Hospital (HUC) in Portugal through a 64 Kbit Internet connection and a 64 Kbit satellite channel both provided by Katelco.

The satellite equipment, composed of a satellite dish, modem, computer, fax and printer, is to be installed in the Aralsk regional hospital. Data will be transmitted to the Katelco technical office and then to the Almaty Diagnostic Centre (through an especially reserved wire) and, if necessary, back in to the Internet through the Katelco office and, finally, to the Coimbra hospital in Portugal.



2.1.2 Aralsk

2.1.2.1 Site description

The Central Regional Hospital of Aralsk (CRHA) is located at the edge of the town and the road is quite sandy and rough (especially if one drives there in a jeep). There are 2 main buildings in the CRHA, about 50m apart (across the street). Two ultrasound units exist and are operated by 5 doctors and assistants in total. The number of patients examined during 1998 was 6040. Of these, 2601 were abdominal studies, 2936 endovaginal (1984 of them during pregnancy) and 503 post-natal cases.
According to Dr. T. Medetov, Director of the Hospital, in the Aralsk region there are 176 physicians for a total population of about 74200. There are 5 hospitals in the country region, 7 family ambulatory doctors, 1 diagnostic polyclinic and 1 regional hospital (CRHA).
A room dedicated to the TeleInViVo portable device is located on the first floor. It is spacious, newly renovated and security measures are in place.

2.1.3 Overall technical environment in Kazakstan

Kazakstan Telecommunications (Katelco: http://www.katelco.com), was established in 1995 with headquarters in Almaty and is an authorised operator of "INTELSAT" in Kazakstan. It is providing support and all the equipment required for the telecommunication needs of the TeleInViVo project in Kazakstan. It owns and operates the Digital Satellite TV and Radio Broadcasting Network in Kazakstan and develops high-speed data transmission networks throughout Kazakstan, Central Asia, a large part of Russia and other neighbouring countries. Katelco is providing a 64 kbits satellite channel based on TDMA technique between the sites in Almaty and Aralsk and Internet connection.

Katelco is also providing support during the installation of devices in both sites and technical assistance to the TeleInViVo network in Kazakhstan.

Katelco is providing its full support to the trial site in Aralsk and has installed the necessary equipment (satellite dish, telephones, etc.) to the CRHA. Katelco will also provide Internet access to the hospital and all support equipment necessary (computer, fax, printer, etc.).

2.2 Uganda

2.2.1 Mulago Hospital, Kampala

The TeleInViVo site is located in the Radiology Department of the Mulago Hospital in central Kampala, the capital of Uganda. There are about 10 physicians in this Department who are experienced in the use of ultra sound equipment. About 40-60 patients are scanned here every day of which 10 cases per week would be suitable for referral and teleconsultation with the Centre of Excellence in Coimbra (Portugal).

2.2.1.1 Site description

Mulago hospital has a computer laboratory of about ten PCs. The Uganda project team has proposed the purchase of 2 PCs, 2 fax machines, 2 laser printers, and 2 un-interruptible Power Supply (UPSs) systems to be shared between Mulago and Nakaseke hospitals for normal Internet and office use in support of the project.

Air conditioning has been installed in the room to help prevent the build up of dust. An appropriate trolley and table have been selected to support and mobilize the equipment.

The TeleInViVo device being installed for tests during the HUC mission to Mulago Hospital

2.2.1.2 Equipment and connection

Equipment for this site is composed of a portable TeleInViVo device connected to the HUC site through an Internet connection. This link is maintained by InfoCom, ISP provider. This connection has been unstable at times, but several tests have been successful. It is a fast link (2Mbps) between Mulago and the ISP and the uplink to the Internet is a 128 Kbps shared connection, providing a fulltime connection to the Internet.

2.2.1.3 Technical environment

Makerere Univerity

Adjacent to the Hospital is Mulago Medical School of Makerere University (Web site: http://www.muk.ac.ug/faculty/medicine/index.html) located at Makerere Hill. The University is one of the oldest Universities in Africa, with a track record of academic excellence. The Computing Centre of Makerere University is providing technical and organisational support for the project in both Mulago and Nakaseke Hospitals, during equipment implementation and during the trials with HUC. Technical specialists assisted in a training period in Germany with European partners in the use of TeleInViVo technology. They have ensured:

- technical follow-up of restoration of premises
- provision of logistical support for equipment installation
- data collection during trials
- provision of electricity stabilizer for equipment, provision of equipment insurance
- follow up of trial schedule.
- Coordination between the ISP and European technical support

2.2.2 Nakaseke

The second (satellite) TeleInViVo trial site is located at Nakaseke, which is located 64 km north of Kampala and 16 km off the highway to Luwero. The last 16 km are on a rural, unpaved road.

2.2.2.1 Site description

Nakaseke has 7 health units including a 100-bed hospital, 5 doctors, 6 Medical Assistants, 23 Midwives and 33 Nurses. It has access to clean water by a network of 28 boreholes and protected spring. The hospital is a typical construction at one level and is connected with other local health units by a radio.

All preparations for the telemedicine room were completed ensuring a secure environment. The ceiling in the room was fully repaired and fans have been fixed in the room to guard against the build-up of dust and maintain a cooler temperature. A land-line links the hospitél equipment purchased under the project to Internet.

Previously, doctors in Nakaseke hospital had never had experience with ultrasound equipment. Dr. Mwaka Erias has since been trained and has worked with missions through out the TeleInViVo project period to ensure a smooth progression in the use of the TeleInViVo equipmnet. Additionally, doctors have been trained to use computers and basic software.

2.2.2.2 Equipment and connection

Equipment for this site is composed of a portable TeleInViVo device, which is being connected to the Mulago Hospital by the Uganda Telecommunication Company (UTL) with support from the International Telecommunication Union (ITU) site through an Internet connection. Nakaseke Hospital, now installed with PC,Internet connection, fax etc. only has a dialup connection which has been problematic and not yet able to support the transmission of heavy image files. As a practical temporary solution, images will be loaded on to MO disks sent from Europe so that they can be transported manually to Kampala and then consulted at a distance. Such practical measures are ensuring that workers become accustomed to use of telemedicine methods, even if the telecommunication environment is not always sufficient to support it. Work continues on achieving a sufficient Internet link, which would be a great step in rural development in Africa. A landline is currently installed and being tested.

Nakaseke Multi-Purpose Community Telecentre

The main reason Nakaseke was selected as a trial site is that it hosts one of five UNESCO / IDRC / ITU-supported Telecentre projects initiated in African countries. Nakaseke Multi-Purpose Community Telecentre (MCT) is a three-year project aiming at introducing new information and communication technologies and library services in the rural areas of Nakaseke and Kasangombe in the Luwero District of Uganda. The project is implemented to demonstrate the viability of the current conviction that providing information and communication to rural communities catalyses the development process and results in improvement of the quality of life of rural communities. The overall objective of the project is to stimulate rural development by facilitating access to information; learning resources and communication technologies of Nakaseke and Kasangombe communities and support improved medical services through Telemedicine.

3 Results so far

3.1 Kazakhstan - Tests so far

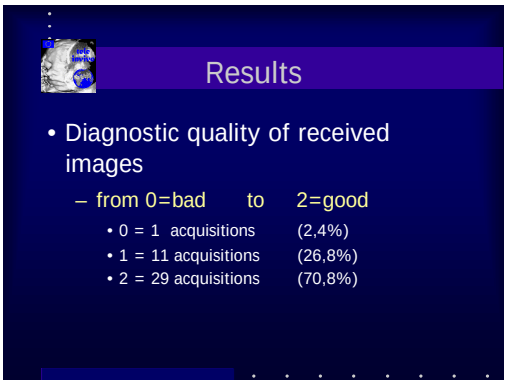
Teleconsltations between Almaty and Coimbra Hospital, Portugal, started in May 2000 and results have been extremely encouraging. Trials take place every Tuesday at 9:00 GMT and the connection between the two sites during the sessions has been good. Even the language problems were quickly solved as colleagues, very interested and motivated, rapidly learn the most important words and expressions and discuss efficiently the volumes of image data.

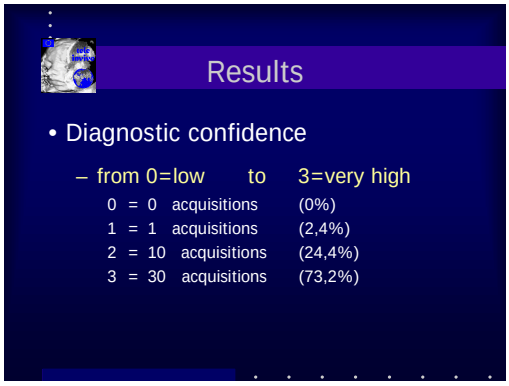
3.1.1 Results

The average time of transmission of the volumes via Internet was 13min 45 sec. The average time for clinical discussion was 9´, with a large range between 1' and 25´.

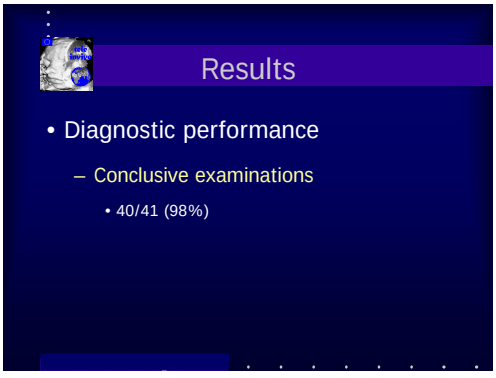
The diagnostic quality of the 2D images obtained from the volumes was considered good in about 70,8% of the acquisitions and fair in 26,8%. Only one acquisition was classified as bad.

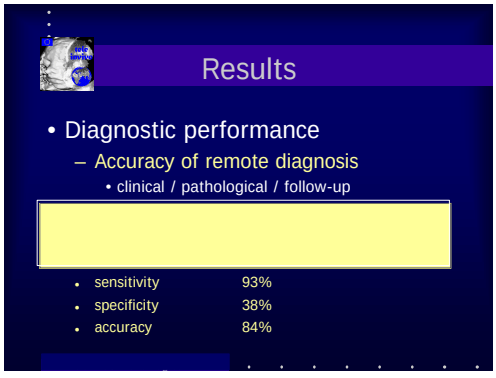
The confidence to produce a diagnosis was very high in 73,2% of the acquisitions and high in 24,4%. In no one volume the confidence was assigned 0 (low).





The diagnostic performance was very high (98%). There was no recourse to the 3D volume displayed in the upper right corner of the screen to produce a diagnostic.
When we confronted the proposed diagnostic of the reading site with the previous diagnosis of the patient there were 40 true positives diagnosis, with 93% of sensitivity and 84% of accuracy.





3.2 Uganda -Tests so far

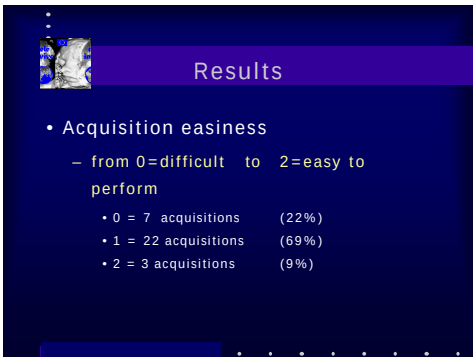
Teleconsltations between Mulago hospital and Coimbra Hospital, Portugal, started in the first days of April, after the HUC mission to this country performed by two doctors. Teleconsultations take place now every Friday. During three months, Internet connection problems were encountered. Indeed, the first Internet provider to

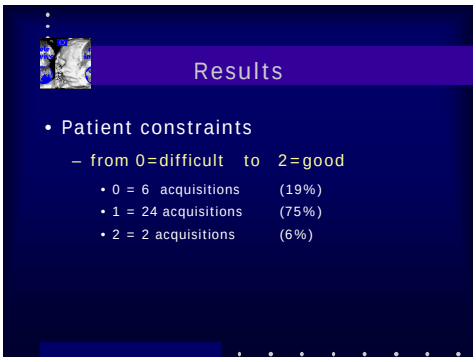
Mulago Hospital (Afsat), had a speed of the line very low (most of the time zero), and it required a lot of hours to receive one single volume. In order to surpass this, connections were brought forward in the morning (9:00 GMT) to avoid bottlenecks in the connection, but the solution did not work. Recently, at the end of June, a new ISP was contacted (Infocom) and the trials have considerably improved.

3.2.1 Results

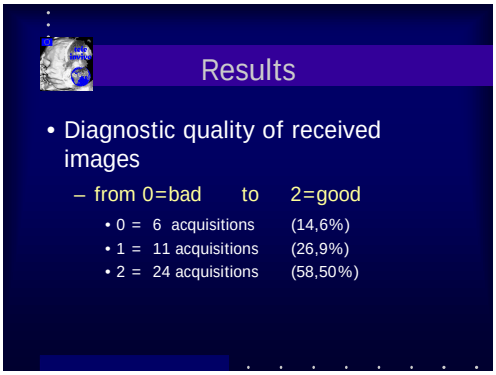
The average time of transmission using Internet was 10´48" for the volumes at 4MB varying in a range from 2´ till 32´.
The average time for clinical discussion, that is, the total time spent for analysing all available data, chatting and to produce a diagnosis and reporting was about 20 min., ranging from 2 to 120 min.

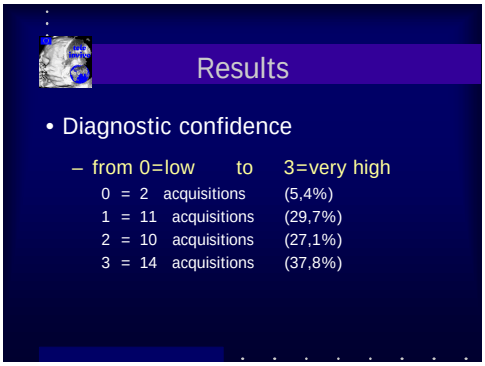
The easiness to perform an acquisition, according to the grade scale of the table below, was considered medium in 69% cases and easy to perform in only 9%. There were 7 cases with difficult acquisition. The patient constraints were classified as medium in 75% and good in only 6% of the acquisitions.





The diagnostic quality of the 2D images derived from the 3D volumes was considered fair in 11 acquisitions and good in 24 with only 14,6% of cases being considered not satisfactory.
Only in 2 cases the confidence to produce a remote diagnosis was considered null. On the contrary, it was considered high or very high in 64% of the imaging volumes.





The diagnostic performance was good, with 84% of the imaging data considered diagnostically conclusive. There was no recourse to 3D-volume image displayed in the upper right corner of the screen to produce a diagnostic.
When the diagnosis proposed by the reading site was confronted with the clinical, pathological, follow-up or the previous diagnostic of the patient there were 32 true positive or negative diagnosis, corresponding to 62,5% specificity, 60% sensitivity and an accuracy of 71%.

Results

- Diagnostic performance
  - Conclusive examinations
    - 31/37 (84%)

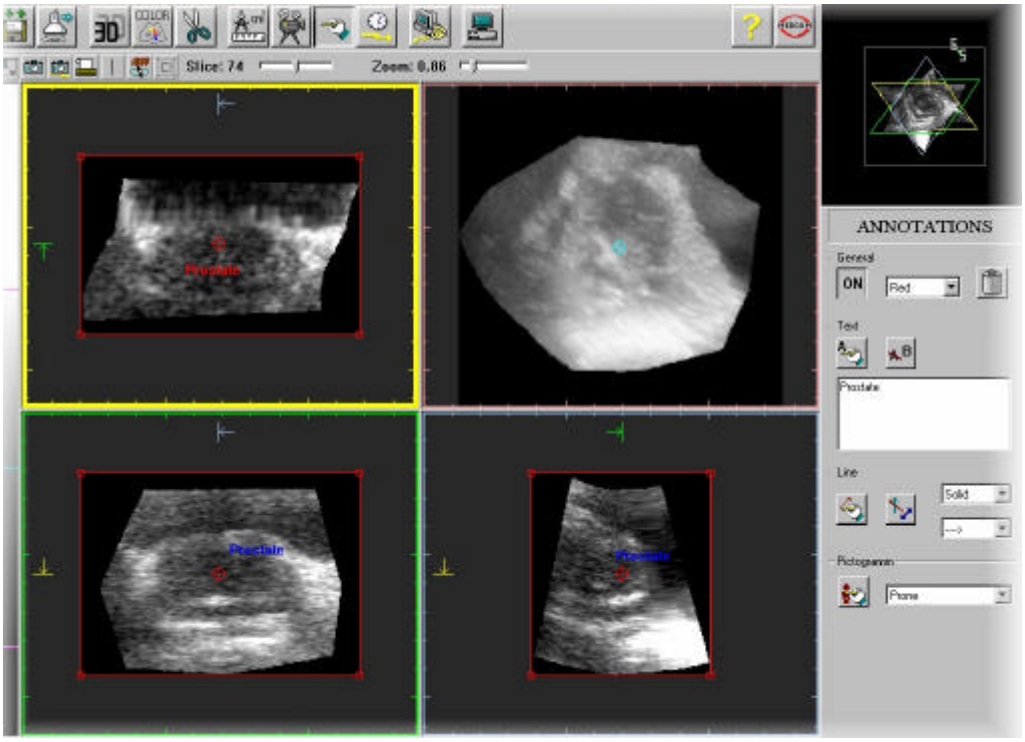
Results

- Diagnostic performance
  - Accuracy of remote diagnosis
    - clinical / pathological / follow-up

- sensitivity 60%
- specificity 62,5%
- accuracy 71%

3.3 Images for Teleconsultation

Transmitted between Almaty and HUC, Portugal



Bladder Tumour