

"Share & Meet" project: An innovative remotization solution for digital imaging and radiotherapy treatment planning

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Abstract:

The incidence of pathologies like tumors and infections is a significant public health burden in developing countries. Although telemedicine implementation largely remains a privilege of developed countries with more economic resources, it could be of great utility and efficacy in developing countries lacking appropriate health care facilities by allowing for the performance of good level health care practices. "Share and Meet" project includes a novel intercontinental telematic platform oriented to oncology and its related branches. The project goals are: to provide telecommunication (TLC) services between health care facilities in developed and developing countries including conference calling, second opinion, and distant learning; to share radiology and microscopy images and patient medical records for diagnostic purposes; and to carry out Good Clinical Practice (GCP) clinical trials through data collection, monitoring, and evaluation. There is currently a longstanding partnership between several Italian institutions and the Bugando Medical Centre Department of Oncology in Mwanza, Tanzania (BMC-Tanzania) with cooperative programs including training of BMC medical staff in Italy through e-learning programs, support in establishing a Radiation Oncology Department in BMC, public health screening programs for the Tanzanian population, and shared clinical and basic science research programs. The telematic platform, developed by Softmed, is strengthening this remote cooperation and partnership. Services currently available include the sharing of workflows and international GCPs, teleconsulting between the specialists of the hospitals, clinical data remote entry, and monitoring of patients enrolled in research trials. The pilot implementation confirmed the project feasibility. "Share and Meet" is characterized by a high level of innovation based on cost-effective solutions which increase efficiency and efficacy of health practices, allow interdisciplinary and synergistic cooperation, and can boost the use of telemedicine in low income countries.

Keywords: telemedicine, digital imaging, remote radiotherapy, telepathology, digital divide

Rationale:

Pathologies like tumors and infections are a significant public health concern in developing countries. Many international institutions aim to promote cultural and scientific actions both in developed and developing countries on human solidarity issues, with a special focus on sanitary related health and social care. One of their main goals is to develop tools and procedures focused on prevention, diagnosis, and treatment. Vittorio Tison Association (Tison), IRST Cancer Research Hospital, Softmed, and Patologi Oltre Frontiera Association (POF) cooperate in the sanitary mission founded in BMC, a hospital located in the city of Mwanza, in the northern region of Tanzania. BMC serves the Victoria Lake Zone, an area with over 14 million inhabitants. The Oncology

Operative Unit supervised by Tison in BMC represents the core of the first Tanzanian National Cancer Institute and a model of sanitary management in Sub Saharan African countries' public institutions.

The complex path of oncologic care requires the support of anatomopathology laboratories to perform diagnostic exams like cytology and immunohistochemistry, and diagnostic imaging.

In addition, radiotherapy (RT) is a critical component of oncologic curative treatment and palliation. However, developing countries currently lack many of these resources and services.

Where distance is a critical factor, telemedicine is one tool used by health care professionals using Information and Communication Technologies (ICTs) to deliver health care services, to exchange information necessary for disease prevention, diagnosis, treatment, evaluation, research and training of health professionals. The implementation of telemedicine could be of great help and efficacy in developing countries that lack the necessary resources to provide high level health care practices. Collaborations especially in digital imaging and radiotherapy treatment planning between developed and developing countries separated by significant physical distance can be enhanced using the "Share and Meet" intercontinental telematics platform.

Objectives:

The "Share & Meet" project utilizes a novel worldwide telematic platform oriented to several sanitary branches with a special focus in oncology. The main project goals are:

- to provide TLC services between healthcare facilities in developed and developing countries, allowing for conference calling, second opinion, and distant learning
- to share radiology and microscopy images and patients medical records for diagnostic purposes
- to design a radiotherapy remotization model to facilitate and enhance radiotherapy treatment planning in developing countries
- to allow the remote control of medical instrumentation
- to carry out GCP clinical trials through data collection, monitoring, and evaluation
- to encourage and support scientific research

Material and methods:

Softmed integrates the core technology solutions and network layouts which the "Share & Meet" project is based on. "Share & Meet" creates intranet links between worldwide operating sites and implements several optimization and redundancy strategies in the transmission layer including: IP Load Balance and links aggregation to group the bandwidth available on the connections to the Internet and to other wide area networks, provided over heterogeneous media; Double Path VPN tunnels to allow High Availability of the international links which can operate in Active/Active redundancy compensating for the latency and variance in packets transmission and overcoming inevitable problems arising from the shortage of connectivity solutions from developing countries' Internet Service Providers (ISPs); duplication of voice and data packets to reduce the impact of packet loss on single Internet connections; IP packet overhead reduction to maximize the effectiveness of the transmission.

Due to specific Quality of Service (QoS) protocols, "Share & Meet" can support simultaneous real time and asynchronous data transfer and can optimize the usage of different connections according to the type of data, the priority of services, the commitment of the network, and in case of failure of a connection.

The privacy for sensitive patient data is assured by the support for the main data encryption protocols and VPN technology.

We performed the first survey of the BMC building in May 2011. This was followed by a general assessment of the internet connection services available in Tanzania delivered on landlines and GSM technologies, the ICT facilities existing in BMC, the needs and lacks in local working procedures, the development plans released by the charities and NGOs operating in BMC involving the Tanzanian public health authorities.

In 2012, a new building dedicated to the Radiotherapy department was completed in a compound adjacent to the BMC main building. This RT clinic includes an IT room where the "Share & Meet" IT core devices are hosted.

Four landlines connections were delivered to the IT room: 3 ADSL2+ copper lines and 1 optical fibre.

The digital link between IRST and BMC has been realized during the early pilot phase.

Some services already available on-site at BMC include: voice over IP telecounselling with international workgroups, secure access to medical records software remotely hosted in IRST datacenter, sharing of workflows and international GCPs, e-learning programs implemented through web conference and remote dashboard tools, and remote entry and monitoring of patients enrolled in research trials.

Development is ongoing for two high innovation facilities: a new approach to telepathology, and a remotization model for RT treatment planning.

Pathologic anatomy laboratory investigation is the foundation of the diagnostic process. Mainly for the reading of microscopic slides resulting from cytological and histological sampling, accurate interpretation relies on both appropriate sample preparation and competence of the pathologist making the diagnosis through visual image inspection and interpretation. In developing countries, there is limited availability of expert medical pathologists, in the range of 1 to 10 pathologists per 10 million people. In developed countries the availability of medical pathologists is in the order of some hundreds per 10 million people. Telepathology is often the main method used to share diagnostic images allowing the double-blind check operated by remote pathologists to reach an accurate diagnosis.

Diagnostic specimen slides are digitized with microscopic scanners, most commonly using magnification rates of 5x, 20x, and 40x. The resulting image file's dimension range between 500 MB and 2 GB.

Since the '90s, POF projects have implemented a model of telepathology based on satellite internet connection to transfer the diagnostic images. Some limitations of this approach include low bandwidth, high cost, and limited service continuity. Frequently, the only available connection is shared with several users so the file transfers must be performed during night hours. All these factors decrease the effectiveness of the telepathology facility.

Based on the experience collected by POF operators on their operative sites, on average, it is possible to upload about 1 digitalized slide per night or a few slides per week. This transfer rate value could be adequate to support basic cytology activity, but is considered inadequate for the workload of a formal diagnostic histologic lab.

"Share & Meet" can provide higher speed and availability for the ICT services. On the operative site of BMC, experimental sessions are underway with the digital microscope [Menarini D-SIGHT_rev. 05](#); a following session will be performed with the Aperio ScanScope scanner which is able to automatically scan slides in unattended mode.

The digital images are codified with [JPEG2000](#) compression.

At its first step, our procedure begins with the digital acquisition of all the slides at a medium rate of 5x, followed by the file upload on a remote server using an encryption protected channel. Next, the first level of double-blind visual investigation is provided by the international pathologist team to highlight the most relevant slides' areas, then a second step of digital acquisition of these areas at a high rate of 20-40x and the file upload of the updated images is performed, and lastly, the second visual investigation to reach a final diagnosis is performed.

A Radiotherapy department requires a large sanitary staff including medical doctors, physicists, and nurses. The devices used for RT planning and treatments need to be serviced and maintained frequently. The full implementation of an RT department in developing countries remains a significant challenge. Nevertheless, RT is one of the main and critical components of curative and palliative treatments for oncologic patients.

Tison is in the process of setting up an RT unit in BMC. An Elekta Linear Accelerator was already been allocated from Ravenna Hospital to be moved to Mwanza and commissioned in the local RT building in BMC. Subsequently, IAEA will provide a Cobalt therapy machine.

IRST RT and IT staff are in the process of coordinating the commissioning of new RT machinery in Ravenna Hospital RT department, which will be connected to the existing IRST RT department to share the activity between the two sites. The RT devices installed in both sites are Accuray Tomotherapy unit and Elekta Linear Accelerator.

Images and data are codified in DICOM format.

We have begun to outline a remotization model for the RT treatment planning between the twin IRST and Ravenna RT departments, with the further aim of applying this design to the interconnection between IRST and BMC RT departments allowing the Italian staff to support the BMC working procedures.

Results:

Regarding the application of "Share & Meet" in the telepathology field, the preliminary extrapolation and first experimental data indicate an improvement of a factor between 10 and 100 in the overall images transmission rate in comparison to the previous models. To enlarge the data set, a subsequent more detailed experimental session will take place in Mwanza in October 2014.

Our survey suggests the feasibility of a collaboration between remote RT departments to perform diagnostic imaging on a patient at the first site, transfer the data set to a different site where a different staff will design the treatment plan, share the treatment plan with the first site, and ultimately provide the final RT therapy plan to the patient.

Further work is ongoing in understanding the most involved parameters and sizing of the remote RT model.

The early experimental stages revealed some needs. For instance, in the file transfer layer, a specific solution to compensate transfer session disconnections with an incremental strategy, and the multiple file contemporary transmission over the same aggregate multichannel are required.

The most immediate extension of the model concerns the remotization of radiologic imaging, to integrate and complete the diagnostic path.

The remote RT model provides additional challenges regarding the reproducibility of the working set on the remote sites, the exact tuning of devices, a strong quality control procedure, and harmony between therapeutic approach and good clinical practices.

Share & Meet is being implemented in other developing world scenarios, with different availability of basic resources and local infrastructures. This suggests the implementation of a benchmarking procedure to characterize the environmental parameters.

Where only satellite coverage is available, to provide a network connection, the use of data transmission over HF radio carriers between the remote operative site and a concentrator site better served by the ISPs are being evaluated.

The first level project's goal is to ensure the working continuity for the departments located in the developing countries with a small local staff. Subsequently, training programs will be provided to medical and paramedical local staff focusing the working processes towards the achievement of autonomy in the operations. Remote counselling should assume the role of supervising the processes and performing independent quality control.

The long term cooperation experience with BMC is showing the relevance of scientific research in low income countries in helping to better understand the specific pathologies of these populations and mutually enrich the knowledge base.

Conclusions:

Practical collaborations between health care sites in developed and developing countries utilizing the "Share and Meet" program, a novel intercontinental telematics platform oriented to oncology and its related branches, are feasible.

"Share & Meet" is characterized by a high level of innovation based on cost-effective solutions which increase the efficiency and efficacy of health practices, allow interdisciplinary and synergistic cooperation, could boost the use of telemedicine in underdeveloped countries, and reduce the knowledge gaps inherent to the digital divide, in a scenario of virtuous globalization.