Ways to implement large scale telemedicine: The Santa Catarina Experience

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Abstract

This article discusses the technological means needed to build and deploy an effective Large-Scale Telemedicine System. The structure and management model used is the Santa Catarina Telemedicine Network which has achieved good results since its implementation.

Key words: *Telemedicine; Telehealth; Brazil Telehealth Program; Santa Catarina, Brazil.*

Resumen

Caminos para la Implantación de Telemedicina en Gran Escala: La Experiencia de Santa Catarina

Este artículo aborda los medios tecnológicos necesarios para construir e implantar un sistema efectivo de Telemedicina en Gran Escala. Se utiliza como modelo de estructura y gestión el de la Red Santa Catarina de Telemedicina que ha alcanzado buenos resultados desde su implantación.

Palabras clave: *Telemedicina; Telessaúde; Programa de Telessaúde Brasil; Santa Catarina, Brasil.*

Resumo

Caminhos para a Implantação de Telemedicina em Larga Escala: A Experiência de Santa Catarina

Este artigo aborda os meios tecnológicos necessários para construir e implantar um sistema efetivo de Telemedicina em Larga Escala. É utilizado como modelo de estrutura e gestão, o da Rede Santa Catarina de Telemedicina que tem obtido bons resultados desde sua implantação.

Palavras-chave: *Telemedicina; Telessaúde; Programa de Telessaúde Brasil; Santa Catarina, Brasil.*

INTRODUCTION

The State of Santa Catarina, located in the South of Brazil, has a physical area of 95.4 thousand km² and it can be compared in size to small countries of the European Community, such as Austria, Hungary, Ireland or Portugal. With a population of approximately 5,8 million people, it is divided into 293 municipalities.

Due to the centralization of medical staff and equipment in the coastal area, patients from the inner part of the state have to be taken by ambulance or by helicopter when they need specialized treatment, an additional cost for the state health system. It is also clear that the removal of patients from the inner cities to the coast causes overload in the health service of the large urban centers. As a consequence, healthcare system is full of patients and with delays. Currently, this delay may take up to several months, according to the data provided by the Santa Catarina State Health Department.

Among the different telemedicine models, the one with a more immediate quantitative impact on Public Health is the Asynchronous Assistance Telemedicine. This model offers wider diagnosis services in digitalized exams through the optimization of the services of specialized physicians responsible for diagnosis, through the increase of exams capillarity and data capture devices, implementing them in remote areas and sending the exams reports through internet.

If healthcare public sector in developing countries, specially those systems with a single paying source as it is the case of the Brazilian National Health System (SUS), wants to benefit from the resources offered by teleradiology and other models of Assistance Telemedicine based on images, the public network of hospitals has to have access to an open, cheap and easy to use technology.

This technology should also enable remote reporting activities. It should not depend on the geographical location of the user nor need the installation of complex software tools, such as radiologic workstations. At the same time, technology must be of low cost, robust and scalable, and it should offer a profile that is easily integrated with other types of exams and activities of the public health service.[1]

METHODOLOGY

For the operation of the telemedicine network within the context of the National Health System in Santa Catarina, it was necessary to define the communication technologies between the institutions and the RCTM central, in order to consider the operational model proposed. These specific technologies are:

- **Telemedicine Portal:** a telemedicine system based on the use of internet that offers easier ways to prepare remote reports, second opinion, case discussion, among other aspects;
- **Telemedicine Security Model (TSM):** a security model that guarantees reliability of digitally certified data;
- **Medical Images Server DICOM[2]:** called Cyclops DCMServer, a service that receives medical images sent by medical-hospital equipments;
- **Dicomizer:** a tool that exports to the Telemedicine Portal exams performed with equipments without support to the DICOM[3] standard.

Below there is a description of these technological tools.

Methodology

Since the beginning of the nineties, the Cyclops Group[4] of the Santa Catarina Federal University (UFSC) has been working to develop exam technologies with safe, easy and simplified access through the Santa Catarina Telemedicine Network (RCTM).[5] This network has several services to assist the patient's health. The Santa Catarina Telemedicine Network has services such as telediagnosis, medical second opinion, collaborative reporting, among other services that are on the developing stage (Figure 1).[6] This model allows healthcare professionals at geographically distant municipalities to carry out different types of exams, such as electrocardiograms, hemodynamics, nuclear medicine, CT Scan or MRI, that can be sent to a centralized server. The users of the Telemedicine Portal are able to access the stored data since the portal is a web tool that enables to see exams, to offer reports and to have contact with other medical professionals.[7]

TSM - Telemedicine Security Model

The security model of the Telemedicine Portal uses encryption components that guarantee the confidentiality of the exchanged information.[8] It also uses digital certification to guarantee the authenticity of stored information in order to prevent eventual attacks to the system, according to the Resolution 1890/2009[9] of the Brazilian Medical Federal Board.

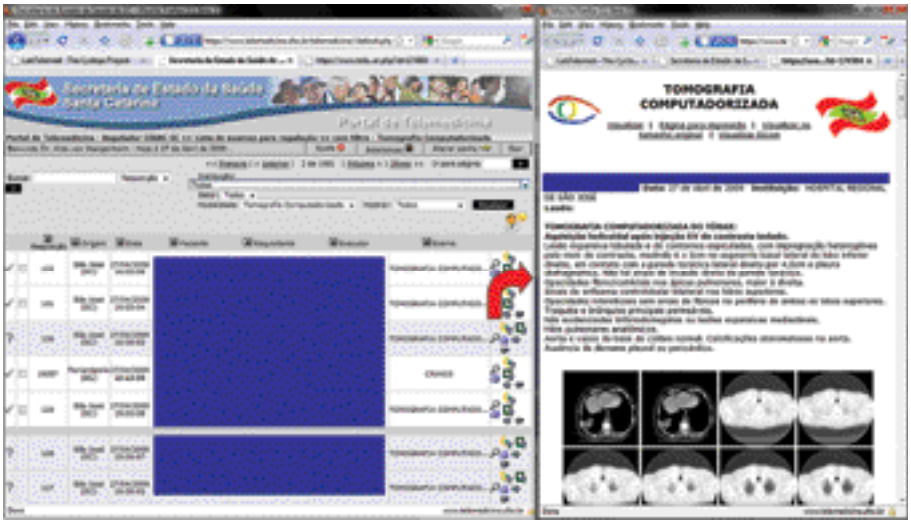

Figure 01 - Screens of the Telemedicine Portal of Santa Catarina Telemedicine Network with anonymized sensitive data.

DICOM Server

The standard DICOM was a joint work developed by medical equipment manufacturers and the academic community, with the aim of offering guidelines for storing image exams in digital files and for the communication between the hospital equipments and the servers. The server in the DICOM standard was developed by the Cyclops Group, and it is called Cyclops DCMServer. It is a tool that enables communication and storing of images in this standard and it also makes possible to convert NEMA formatted images to DICOM. The applicative is the central point of the server network and the imaging equipments that exchange information and send exams to the Telemedicine Portal. Each hospital integrated to the Santa Catarina Telemedicine Network has a "bridge" (a bridge server between the equipments and the Portal), that is responsible for receiving, storing and broadcasting images sent by different equipments inside the institution. This enables the temporary storage of information in the "bridge", to reduce the risk of external attacks and to keep the communication regardless of the connectivity to internet, providing more reliability and safety to the communication process.

Conversion Scheme of DICOM images

Many equipments operating at Brazilian hospitals nowadays are not capable of exporting exams in DICOM standard. The Cyclops DICOMizer is a tool developed to deal with this problem and to integrate these equipments into the Santa Catarina Telemedicine Network. Using a computer connected to the equipment it is possible to capture and store images and videos in DICOM format and to send them directly to the Telemedicine Portal. Among the several resources available in the applicative, we can mention exporting to CD. Figure 2 shows two screens of the DICOMizer. On the first it is shown the report editing screen and on the second it is the viewing interface of the images captured.

Final Structure

Figure 3 shows the integration model of the tools for accessing and using the Telemedicine Portal. The Telemedicine Portal has an access certification issued by the certifying entity UFSC/RNP, in Brazil. Any transaction made in the Portal is guaranteed by the certifying authority that issued this certificate. This model enables requesting, executing physicians, regulators, technicians and nurses to access the Portal using identification, a password and also a digital certificate. The exams and reports available in the Portal are all recorded by a team called Digital Recording of Electronic Documents (PDDE).

The process of sending the exams to the Portal can be made in two different ways:

- manual – the exam is made in a medical equipment without a digital format data exporting standard (as for example JPG or PDF). After the exam is done, the technician sends to the Portal the patient's exam that is digitally recorded by the PDDE and stored in the database. Any exam that can be digitalized in one of the formats mentioned can use this sending mode (Figure 3, Chart 1);

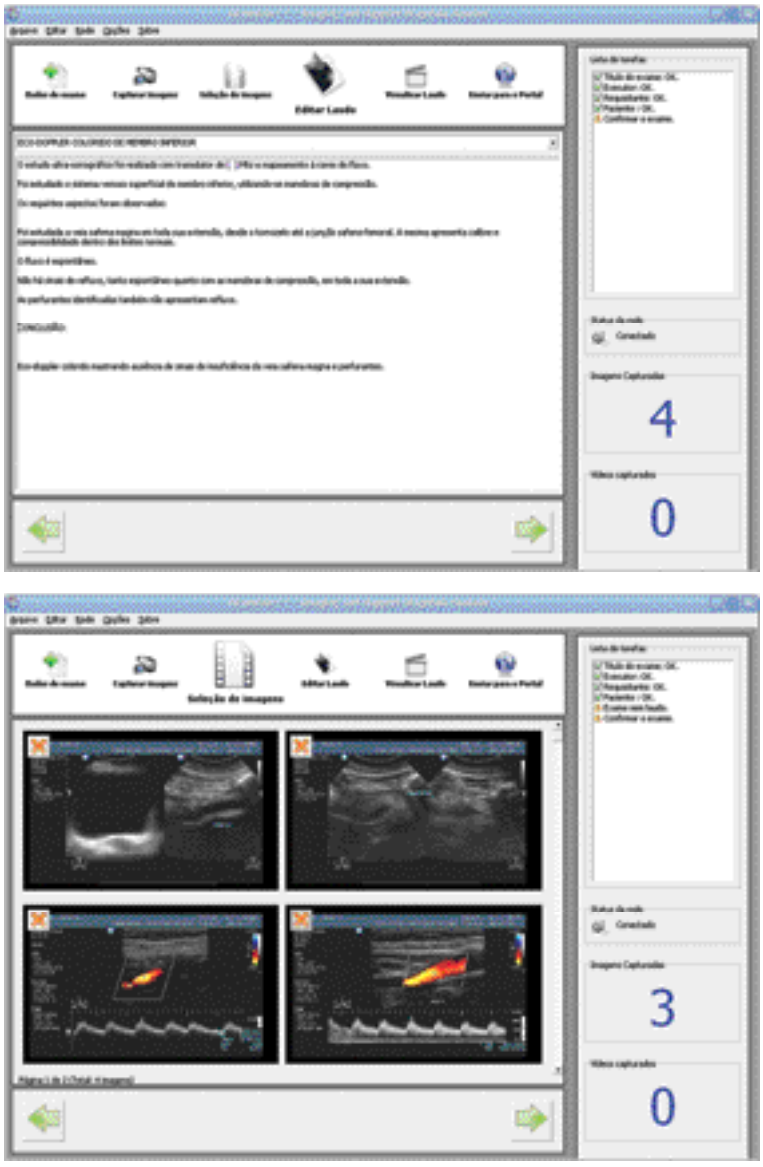

Figure 02 - Editing and viewing screens of the DICOMizer images.

- automated – an image acquisition equipment with DICOM digital format data export, as for example a CTScan, sends the exams directly to a "bridge" (Figure 3, Chart 2).

A physician with access to the "executing" profile is able to access the patient's exams published in the Portal and to issue a report for each exam. This physician can also issue a second opinion on an exam for which another medical professional issued a report, if required. The physician can also check a report issued by another medical professional. Any operation of report issuing, second opinion and report checking is digitally signed by a digital certificate. PDDE records the report and sends back a receipt that is stored in the database together with the exam report and the doctor's digital signature.

RESULTS AND DISCUSSIONS

The number of benefits provided by the telemedicine service used in the Santa Catarina Telemedicine Network are countless. However, one of the main features is its large scope in terms of the diversity of exams that can be done. It also guarantees specific benefits for each type of exam, for example image mobility, processing and handling.

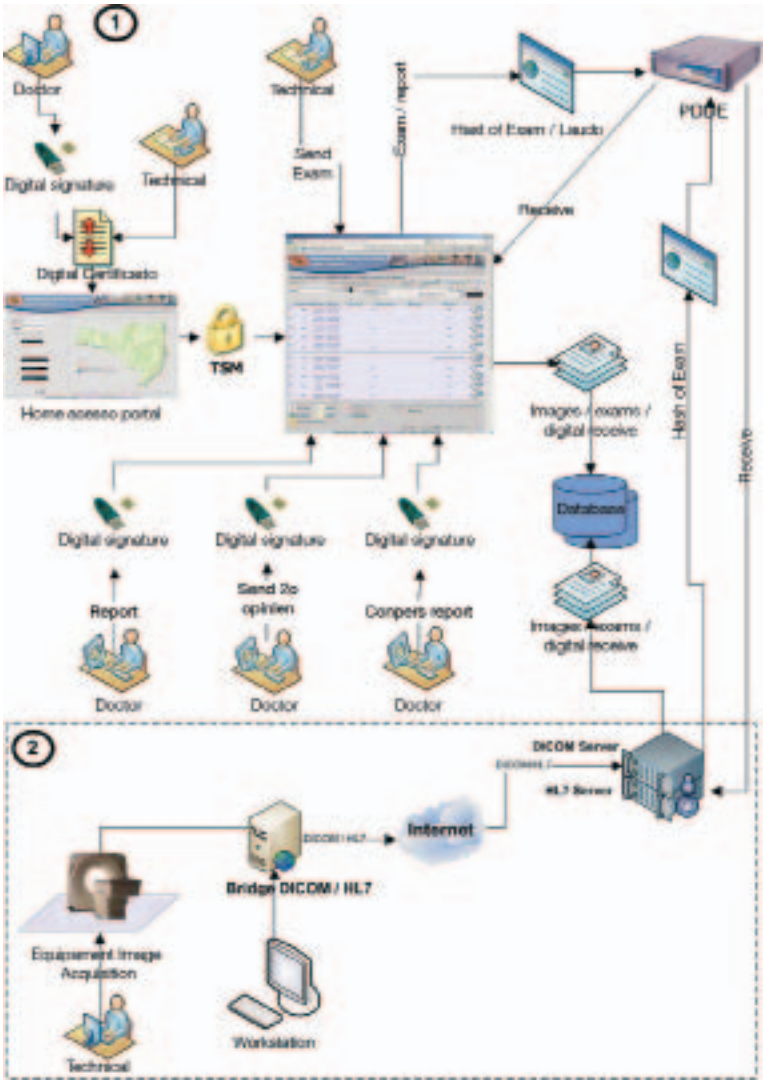

Figure 03 - Integration with the technologies developed.

This technological solution model allows healthcare professionals to have access to images and video exams of his/her responsibility from anywhere. The only requirement is to have a computer with internet access and a web navigator software. The model favors the fact that the physician who requested an exam can have access to its result, report and images, as soon as the physician who carries out the exam states that the procedure is finished; on the other hand, the patient uses a unique exam identifier to have access to his/her exam, allowing the patient to follow up his/her exam at any time (even without report).

The implementation of this model enables cost-reduction for the state, the municipality and to the professionals involved in exams. The increased availability of these exams and the geographical distribution of the equipments reduced the number of referrals to other municipalities, reducing the transportation costs as a consequence. This model is also very attractive for the professionals due to the possibility of issuing reports, having access to exams, case discussions and medical second opinion.

The distribution of the equipments levered the offer and the number of exams performed, minimizing the waiting time for the patient, attacking directly the repressed demand and also reducing the time for doing the exam and issuing the reports (that was the reality before implementing the Santa Catarina Telemedicine Network). Studies to quantify this improvement in a more accurate way are being done at the moment.

Currently the Santa Catarina Telemedicine Network includes 234 municipalities. In Figure 4, the map shows the municipalities that were members of the Network until 2009. The green shades indicate if the municipality was included in the first, second or third phase of the implementation of the Santa Catarina Network.

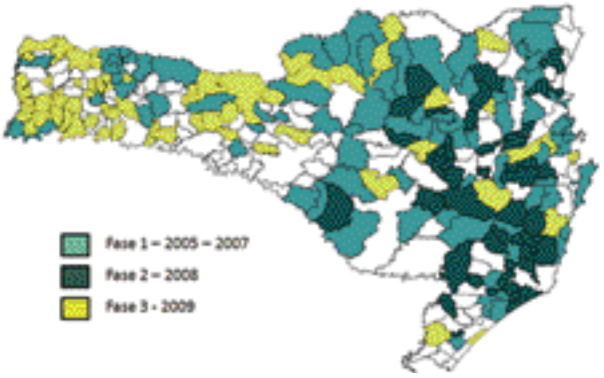

Figure 04 - Municipalities participating in the Santa Catarina Telemedicine Network divided according to the implementation phase.

The availability of exams and its follow up in the Telemedicine Portal through a unique exam identifier, handed to the patient after the exam is finished, means speed and greater mobility for the patient when accessing his/her exam on the web. This is essential for the implementation of a patient electronic record in the state of Santa Catarina. According to the physicians, the speed of the system also made possible to reduce the waiting time for surgeries in the cases of trauma in the hospitals of Florianópolis metropolitan area.

Besides, the Santa Catarina Telemedicine Network enables the collaboration and information exchange between the requesting physicians and the physicians who execute the reports. This interaction is done through a collaborative environment focused on the professionals related to an exam and it is integrated into the Telemedicine Portal, which provides an efficient communication and telecollaboration mean among the medical professionals.

Figure 5 shows a logarithmic graph for better viewing the quarterly values of the exams done in the main types available in the Telemedicine Portal. There are 234 municipalities serviced with Electrocardiography. The four largest public hospitals of Florianópolis metropolitan area carry out CTScans exclusively through the Portal. During the first semester of 2010, ten additional points of Digital Radiology are being added, a MRI service located 200 km from Florianópolis (Lages), in addition to other types of exams distributed around the Florianópolis metropolitan area. Among these types of exams, there are: video-electroencephalography, hemodynamics and oral pathology, besides a tele-dermatology service.

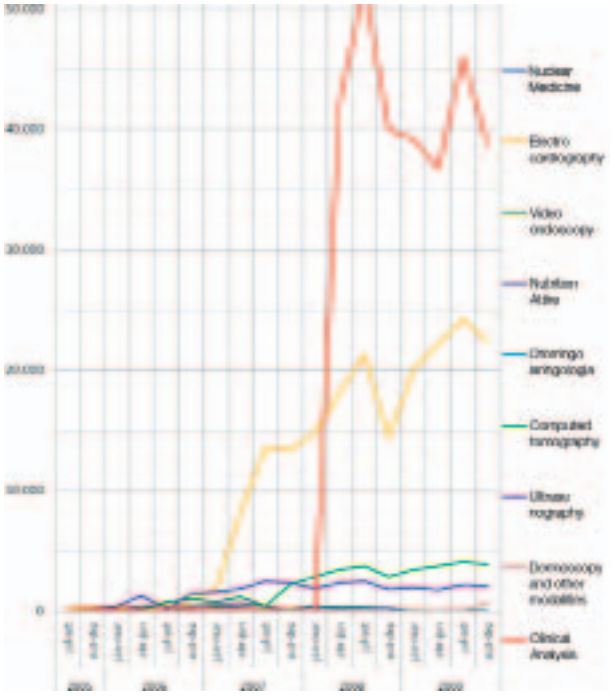

Figure 05 - Graph showing the quarterly production of exams in the Santa Catarina Telemedicine Network.

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