Brief Communication

Provincial Telemedicine Network via Internet with Free Opensource Software

Pacher Armando[1,2]; **Ronchi Roberto**[1,2]; **Lombardo Roberto**[1,2]; **Müller Irina**[3]; **Lell Gabriela**[2]; **Ceballos Mariana**[2]; **Magariños Eliana**[2]; **Imoberdorff María Victoria**[2]

1. Universidad Nacional de Entre Ríos - Facultad de Ingeniería-Bioingeniería - CETIFAC - Grupo de Telemedicina. Paraná, Entre Ríos, Argentina
2. Federación Argentina de Cardiología - CETIFAC. Paraná, Entre Ríos, Argentina
3. Gobierno de Entre Ríos - Ministerio de Salud - Dirección General de Informática. Entre Ríos, Argentina

Abstract
Introduction: In an Argentine province without interconnection among Public Hospitals (H), as a previous step to a Health Provincial System, a telemedicine network (TMN) was created at a low cost via Internet, using modified free opensource software (FS) and the installed capacity in H, by an agreement between a Provincial Government (PG), a National University (NU) and a Medical Scientific Society (MSS).
Material and Methods: In NU and MSS was adapted a Moodle (M), free FS for educational purposes, used by them since 2006. Moodle applications, user roles and terms were modified, and it was installed in PG server. The NU and the MSS delivered classroom training (CT) for 6 months to the coordinator of the TMN of the PG, and 8 hours of CT to the personnel of the H, followed by a constant distance training (CDT) via M. Basic H technical requirements: conventional computer, Internet available, scanner or digital camera. The communication is asynchronous by mail, with forms and multimedia attachments; for limited synchronous activities chat, audio and videoconference. Main activities are centered in interconsultation, outpatient appointments, derivations, continuous distance education and drug adverse event reporting. Social work services are effectors in central H, in the rest the profiles sought are social workers, nurses and sanitary agents. The responses to interconsultations are scanned and sent as attachments, being filed for legal purposes the original signed by the consultant physician.
Results: 8 out of 64 H are interconnected at present, and CT and CDT is made for the others. The coordinated interaction, timely, of the participant institutions presents special as well as general difficulties.
Conclusions: The TMN can be performed at a low cost and basic installed capacities and M can be used for the TMN. The interaction of the participant institutions requires special considerations in the design, as well as in the execution of similar projects.

1. Introduction.

The province of Entre Ríos is located in the eastern central region of Argentina, bordering with the República Oriental del Uruguay. Its surface area is 78,781 Km2, with a width of 240 Km and a length of 430. Its population amounts to 1,235,994 inhabitants, spread over numerous cities with less than 300,000 inhabitants. Health care in the province has public and private effectors, the former comprising 64 hospitals, both central and peripheral, and 208 health care centers, with precarious and scant possibilities of communication among each other. Thus, patient referrals originate toward central hospitals, the clinical symptoms of whom, in a high percentage, could have been solved at the source hospital or center, had there been a chance for interconsultations with diagnostic and therapeutic guidance. The lack of communication also generates problems to assist ambulatory patients referred to central hospitals. The health care authorities have planned a long-term implementation, with a significant investment, of a communication network for a future health insurance.[18] Likewise, they are planning to regionalize and protocolize referrals between centers with varied complexity.

The CETIFAC Group was created from an agreement between the School of Engineering-Bioengineering of the National University of Entre Ríos – FIUNER, Argentina, and the Argentine Federation of Cardiology – FAC, a non-governmental scientific organization (NGO). Its premises are at the FIUNER, Oro Verde, Paraná Department, Entre Ríos, and it carries out telemedicine activities since 1994.[1-11] CETIFAC generated an interhospital telemedicine network project that was implemented within an agreement between FIUNER and the Health Ministry of the government of the province of Entre Ríos – MSER..

2. Objectives.

The general objective of the project consisted of implementing in a short term, a communication network between hospitals and health care centers, at a low cost, through the Internet, devoted to interconsultations, referrals and ambulatory appointments, as an intermediary step to the abovementioned health insurance.
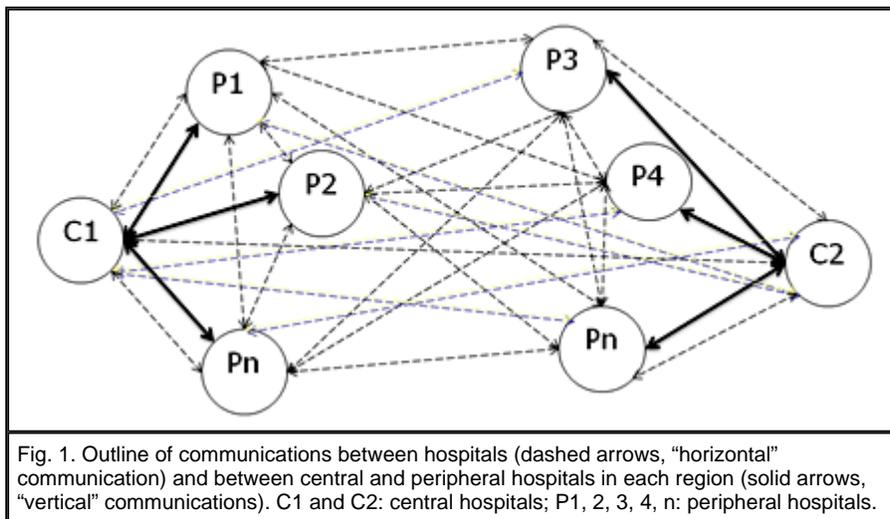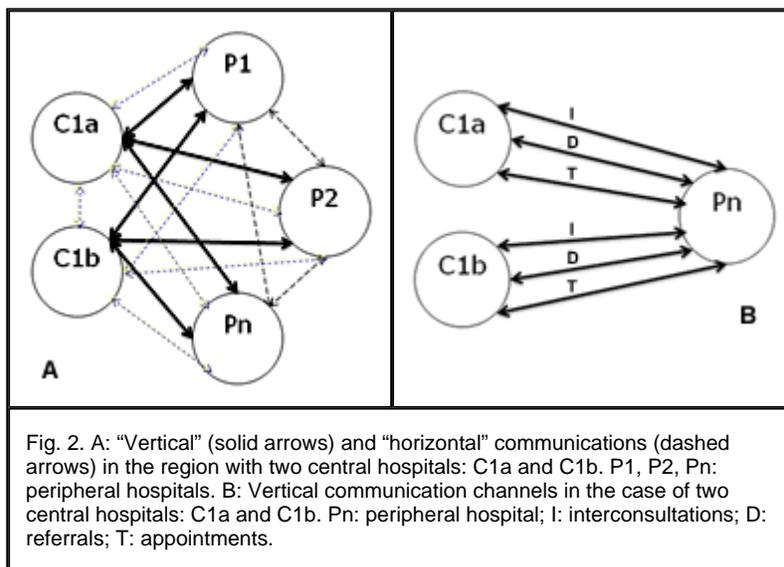
3. Material and Methods.

Choice of the system
This being a low-cost and short-term project the choice by the group was, from the technical point of view, using a free and opensource software and communications through the Internet (from dial up to broadband), ruling out the use of dedicated lines, of new physical connections, and of existing or developing paid software. Likewise, the work was carried out with the human and physical resources available in each institution, which had to have at least, an Internet connection and an image scanner (ordinary scanners or multiformat printers) or a digital photographic camera (with any resolution). As a platform, Moodle was chosen, due to the experience the group has from having worked with it in distance education over six years and because it is opensource software, having verified its possibilities and advantages over other platforms.[12-17] Since Moodle is opensource, which means that access is granted to the whole programming, it was possible to perform several modifications.

Moodle was installed in a server of the General Direction of Informatics of the Government of Entre Ríos.

The work was initially carried out in two regions that divide the province in two similar areas, one of them with two central hospitals for adults and children ("Paraná shore") and another one with a central hospital for both types of patients ("Uruguay shore"). A sector was generated in the platform, for each peripheral hospital, where they are integrated with the central hospital(s) corresponding to their region. Forums were generated for the communication so-called "vertical" between peripheral hospitals and the central hospital corresponding to them, and for the so-called "horizontal" communication, between all hospitals (Fig. 1).

Fig. 1. Outline of communications between hospitals (dashed arrows, "horizontal" communication) and between central and peripheral hospitals in each region (solid arrows, "vertical" communications). C1 and C2: central hospitals; P1, 2, 3, 4, n: peripheral hospitals.

In the region with two central hospitals, the vertical communications are made as shown in Fig. 2A.

Fig. 2. A: "Vertical" (solid arrows) and "horizontal" communications (dashed arrows) in the region with two central hospitals: C1a and C1b. P1, P2, Pn: peripheral hospitals. B: Vertical communication channels in the case of two central hospitals: C1a and C1b. Pn: peripheral hospital; I: interconsultations; D: referrals; T: appointments.
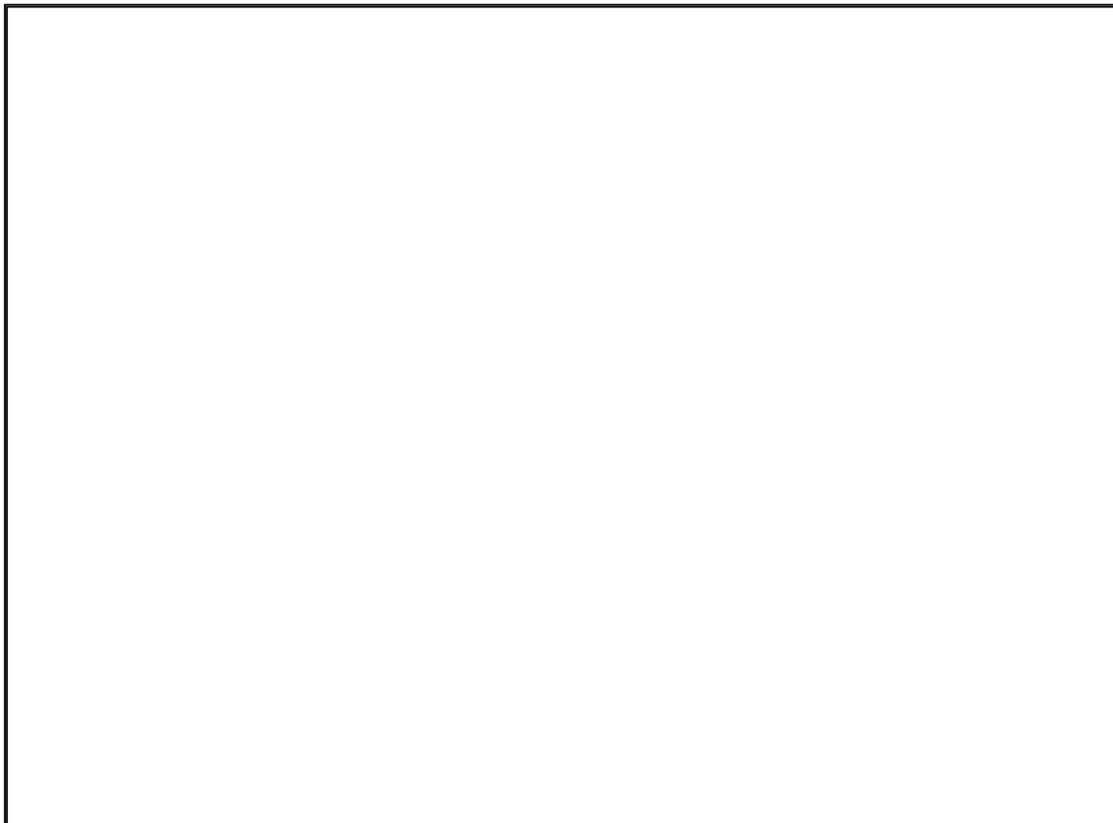
Each sector, that is to say each peripheral hospital, uses forums as communication channels for the three activities: interconsultations, referrals and requesting appointments. In the region with two central hospitals, in each sector there are six forums, three connected with a central hospital and three with the other (fig. 2B; fig. 3) configured in Moodle as different groups.
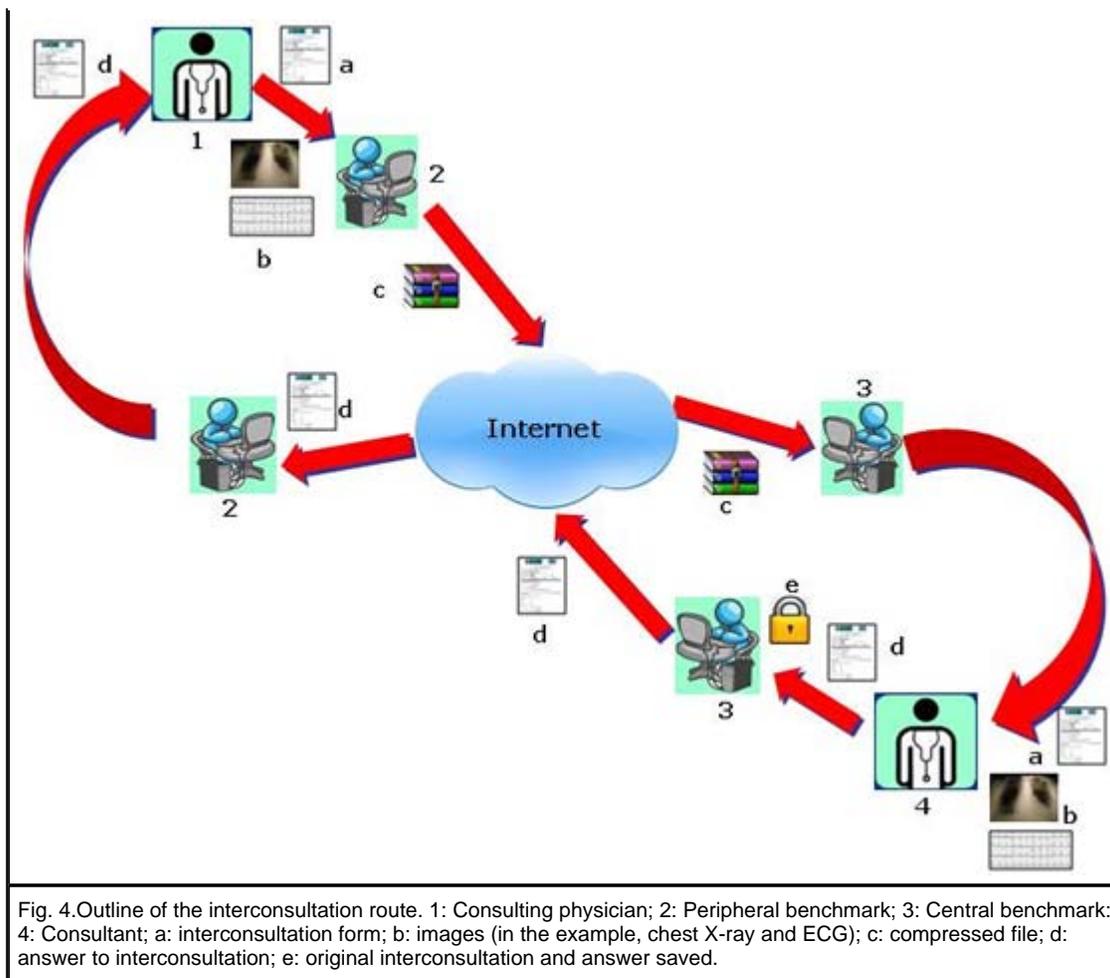
Contenidos

1 **Hospital San Martín**
- Interconsultas al Hospital San Martín
- Derivaciones al Hospital San Martín
- Solicitud de turno a Servicio del Hospital San Martín

Hospital San Roque
- Interconsultas al Hospital San Roque
- Derivaciones al Hospital San Roque
- Solicitud de turno a Servicio del Hospital San Roque

Varios
- Servicios del Hospital San Martín
- Servicios del Hospital San Roque
- Guías de procedimientos
- Capacitación y mantenimiento

Fig. 3. Sector of a peripheral hospital, with two central hospitals.

As an example of the operation of the system, the circuit of one interconsultation was chosen (fig. 4). The physician of a peripheral hospital that needs to make an interconsultation (Consulting physician) gathers and delivers the clinical data and supplementary studies about the patient about whom he wishes to make the consultation, to the operator of the system in his/her hospital (Peripheral benchmark). The Peripheral benchmark uploads the personal and clinical data in an *ad hoc* form, digitizes the supplementary studies, compresses the resulting files into a single file, and sends it through the platform by the Internet to the corresponding central hospital. The maximal size per submittance was established in 6 MB; if the result is greater, it is subdivided and if a study has more than 6 MB (for instance videos), it is recorded in a CD or DVD and submitted physically. There, it is received by the Social Service; this forwards it to the corresponding service. The physician that will answer (Consultant) analyzes the case, writes his/her answer, signs it, seals it, and delivers it to the Social Service. The answer is scanned; the original is saved for legal reasons, and submitted through the platform to the Peripheral benchmark, who gives it to the physician who originated the interconsultation. The whole exchange remains documented.

Fig. 4.Outline of the interconsultation route. 1: Consulting physician; 2: Peripheral benchmark; 3: Central benchmark: 4: Consultant; a: interconsultation form; b: images (in the example, chest X-ray and ECG); c: compressed file; d: answer to interconsultation; e: original interconsultation and answer saved.

Training of human resources
The training in central and peripheral benchmarks is made live and at distance; it was requested that those assigned should preferably belong to the social work or nursing areas, although administrative personnel was also accepted if the former were not available; the only requirement was that they should be e-mail users. The person in charge of coordinating the network (agent of the MSER) was trained live for six months, at a rate of 24 hs per week at the site of the CETIFAC Group.

a. Live training. It was carried out at the site of the FIUNER in an eight-hour day, carrying out plenary theory classes, personal practical activities in the informatics lab (each teacher in a PC works with groups of two or three participants) and plenary colloquia about each topic.

The topics and their methodology are:

- General and particular presentation of the project (theory).
- Access to the platform (theory-practice).
- Acknowledgement about the different sections of the network (theory-practice).
- Submittance and reception of interconsultations, referrals, and appointments (practice).
- Capture, processing, submittance and reception of medical images (theory-practice).
- Security issues to handle PCs and networks (theory).
- Methodology and tools to continue through distance training (theory).

b. Distance training. Conducted through the same platform by means of theory classes, sets of questions for self-evaluation, and practical works with execution and submittance of works. The latter comprise digitization, processing and submittance of different supplementary studies and interconsultation procedures.

Once the personnel of a hospital successfully fulfill the distance tasks, their institution is integrated into the network (fig. 5).

Fig. 5. Startup screen.

Other activities: Communication sectors were configured between technical directors and secretaries in hospitals, and of pharmaco-surveillance and techno-surveillance activities. The platform of the network also allows for continuing distance training for the different agents of the health care team: physicians, biochemists, bioengineers, nurses, social workers, technicians, administrative personnel , etc.; activities that are carried out by request of the institutions and the province health policies. For some limited activities between sectors that have broadband available, videoconferences and chats can be conducted.

4. Results.
The project started to be developed on October 2010; in December of the same year the platform was enabled at www.entrerios.gov.ar/redsalud and training activities started, and in February 2011 the first real interconsultation through the system was conducted. Currently (July 2011) 8 hospitals are interconnected vertically and 22 hospitals horizontally, and live and distance training activities are continuing. Human resources appointed by the MSER were nurses: 12; social workers: 6; administrative personnel: 4.

Between February and July 2011, the following interventions were made:

- Vertical communications for real cases: 39
- Vertical communications for simulation cases: 42
- Horizontal communications: 48
- Training forum: 131

The exchanged images had diagnostic quality. The expenditure of the project up to July 2011 U$S 6,021

5. Discussion.
Although currently there are telemedicine systems with technologies that ensure quickness and a wide coverage, unfulfilled requirements, scant economic resources and governmental plans in the long run produces the need to find low-cost and short-term solutions. The network developed in this project was operating after five months and the expenditure was low. The interaction between different regulatory and operative frameworks was complex, such as those from institutions participating in this project, all of which led to repeated procedures that resulted in different adjustments.

6 Conclusions.
In this project a network of telemedicine was developed in a short term, with low expenditures, adapting an educational platform and using already existing human and technical resources. In spite of the mentioned difficulties, it was possible to work between institutions with different natures, such as a national university, a NGO, and a provincial government; its fulfillment increased individual and joint potentials.

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