

Telemedicine activities of BME Unit at Naples University Federico II

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TELEMEDICINE - ISLANDS PROJECT

Abstract—The islands of Procida and Ischia, in the gulf of Naples, are well known resort in South Italy. The little hospital of Ischia and especially the outpatient department of Procida are not always equipped to face all clinical cases. Regularly, the patients from Procida are directly transferred to the mainland, even only for diagnosis. The small dimension of the health service structures is related to the little population of the islands. This problem is more perceived during the summer season with the tourist increment of populations. A cardiological and radiological video-teleconsulting system, which links the two islands to mainland hospitals (Pozzuoli and Giugliano), has been established. This telemedicine network allows a 24-hour connection between the main hospitals of Pozzuoli and Giugliano and the islands' health centres. This telemedicine solution aims to provide a prompt and qualified health service in the islands, and to reduce the risks and the costs of patient transportation to the mainland. This project represents a pilot and demonstration site for future applications of telemedicine in emergency.

I. INTRODUCTION

The islands of Procida and Ischia are well known tourist places in South Italy. During summertime the number of habitants largely increases. To answer to the demand of qualified healthcare services in emergencies and in routinely activities, a cardiological and radiological video-teleconsulting system, which connects the islands of Procida and Ischia to mainland hospitals (Pozzuoli and Giugliano), has been established [1][2]. This telemedicine experience allows to connect 24 hour per day the main hospitals of Pozzuoli and Giugliano and the island health centres for virtually transferring the professionalities which are not present in the islands. This aspect is particularly important for the little island of Procida, which does not have a hospital, but only a very simple and small ambulatory service, which is certainly undersized during summer and unsuited for specialistic controls [1][2][3].

This telemedicine solution aims to provide a prompt and qualified health service in the islands, and to

reduce the risks and the costs of patient transportation to the mainland. It offers also the possibility of transnational interconnections, particularly important for the foreigners during the tourist season.

The Island Project is a pilot Telemedicine experience in Italy. It is remarkable the fact that the Island Project was totally financially supported by the Local Health Unit "ASL Napoli2", to solve practical problems (problem solving) and to improve the healthcare delivery (user oriented) in the islands.

Figure 1: Territory of the Islands Project

II. METHODOLOGY

The Telemedicine Network

Each site (Procida, Ischia, Giugliano, Pozzuoli) is equipped with AETHRA telemedicine



videoconferencing stations (Telecom Italia approved) connected by an ISDN (3 BRI) network [2]. The system is based on a H320 standard for videoconferencing. Recently the network has been extended to the Vascular Surgery Dept. at the Policlinic of the University of Naples "Federico II", the private Hospital "Clinica Villalba" and finally to the Electronic Engineering Dept. of the University "Federico II". These two new clinical sites provide expert consultation in the field of vascular application and for patients with implanted pacemakers.

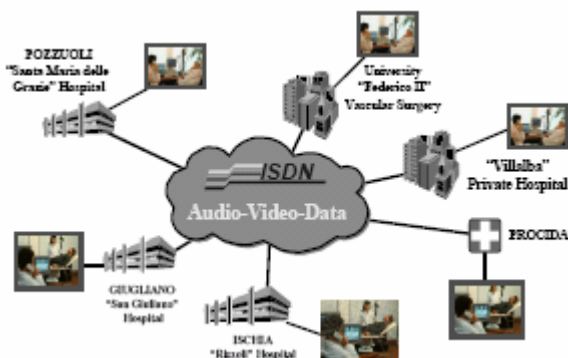


Figure 2: Telemedicine videoconsultation Network

The telemedicine videoconferencing station provides a continue video and audio connections, to permit interaction and consultation between physicians, for a second opinion approach. This system is enriched with remote controlled high-quality videocameras for an interactive patient inspection. Radiological digital scanners are also integrated in the teleconsulting system in order to acquire and transmit radiographs. A computer shared whiteboard allows simultaneous interaction on the radiological images. Concerning the tele-cardiological facilities, portable electrocardiograph devices are connected to the telemedicine system via standard telephone lines to transmit ECG signals directly from the house of the patient (Home Care) or from the GP office.

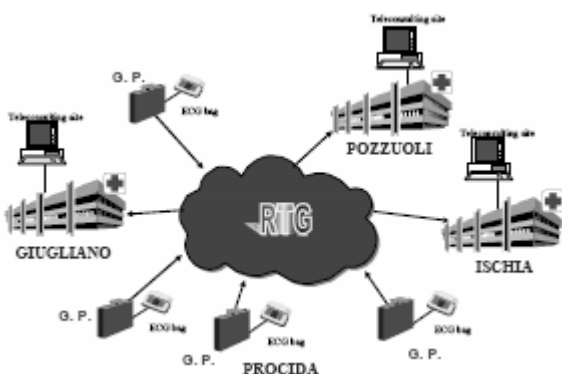


Figure 3: Territorial Telecardiology

Legal and executive responsibilities [4] arise for the health care delivery by means of telemedicine. Recently, to face these problems, specific forms have been designed to record clinical and technical data related to a videoconsultation session. In addition, a specific form for a preliminary screening of generic thoracic pain has been set up to favourite immediate action in case of cardiological emergencies. All the forms are properly formatted for a rapid and intuitive compilation.

III. RESULTS

This project was user oriented, and it has been designed both for effectively solving the real problems of emergency medicine and also for routinely clinical

consultation. This technical solution aims to provide a prompt and qualified health service in the islands, and to reduce the risks and the costs of patient transportation to the mainland. It offers also the possibility of interconnections with foreign health centres. This aspect is particularly important for foreigners during the tourist season, because they could contact medical operators, which speak their native language by Telemedicine. Furthermore, the local operators could also receive patient clinical history and risk information from the remote healthy site.

The workstations and the physical network were installed by the Italian Telecom Operator in cooperation with the AETHRA manufacturer under the supervision of the Bioengineering group of the University of Naples "Federico II". The installation and the setup phase were coordinated by the Bioengineering group in the frame of the above-mentioned contract. In this frame, the Bioengineering group organised workshops and telematic sessions for continuous education. These activities are still running. Even if the workstation is user friendly, a continuous education is necessary especially where the turnover of the nurses and technical personnel is high.

The system was routinely used to connect the islands (Procida and Ischia) to the mainland Hospitals for emergency activities or to obtain second opinions. The highest rate of connection was observed between Procida and Pozzuoli.

Since February until November 1999, twenty-two sessions from Ischia to mainland hospitals were recorded twenty-one were 2nd opinion and only one training session. In the same period forty-one session from Procida island to mainland hospitals were recorded, twenty-one were urgency, twelve sessions were emergency, six were training and two 2nd opinion.

IV. CONCLUSIONS

Technology Assessment activities [1] were carried out in the framework of the previous mentioned contract. They aim to evaluate and measure the performances of the specific telemedicine solution during its operative work.

The results were promising, but the available data are not yet enough large and extensive to carry out appropriate statistics to support cost-effectiveness analysis.

This project, which was carried out until to 2002, represents a pilot and demonstration site for future applications of telemedicine in emergency.

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A PILOT EXPERIENCE IN SOUTH OF ITALY FOR THE REMOTE FOLLOWUP OF PATIENT WITH IMPLANTED PACEMAKER

I. INTRODUCTION

After a pacemaker implants, an appropriate Follow up must be done, in which the main clinical parameters are regularly checked and the basic stimulation parameters have to be regularly monitored (3-4 times every year). It is well known that the stimulation frequency, measured during the application of a magnet in proximity of the device, changes in relation to the charge level. This of course does not allow to precisely foresee the "end of life", but to give, enough in advance, indication for replacing the device. From this, it is clear how is important to regularly monitor the electrical parameters in order to increase the life of the cardiac pacemaker with obvious benefits for the patient and money savings for the National Health Services. At the same time the patient has to go regularly to the "Specialised Centre", this represents in many cases an high cost for transportation and an inconvenience for elderly and disabled patients. So this is the typical case where an home care system can bring high benefits for patient and reducing direct and indirect costs for the National Health Service.

II. MATERIAL AND METHODS

The Home Care system manufactured by "Card Guard" and distributed by Hewlett and Packard, has been used for this clinical study.:1 Workstation for collecting information through POTS network, 8 Recording devices (CG7100) able to record pacemaker pulse and able to record up to 3 ecg's with three leads and to transmit those through a normal telephone equipment (even cellular phone), ISDN lines and modems for accessing the main workstation from remote sites.

A number of patient with implanted pacemaker have been selected on the basis of the following criteria: Implant age > 8 months, Predominance of natural cardiac rhythm, Mobility problems represent an election criteria, General conditions not critical, Middle-High Cultural level Once the group of patient has been selected, all the responsible General Practitioners have been contacted, and trained at the first measurement on a common protocol.

The two experts (One cardiologist and One Bioengineer) in remote connection through ISDN or POTS line, look the tracks and perform a number of measurements as: Stimulation frequency Ventricular in Demand, TVA: Stimulation frequency Ventricular in Asynchronous etc, .necessary for the correct assessment of the implant.

After this measurement a computerised medical record is filled and a report via fax is sent by the operator to the GP's.

The Clinical Study is running from 6 months and at the moment 8 patients who were not able to come to the centre are monitored through the system. At the same time a number of experimental recording have been done on patients who regularly comes to the Private Hospital "Clinica Villalba" centre in parallel to the conventional procedure. In the worst case the error measured between the two procedures resulted to be less than 1%. A questionnaire after this period will be distributed to the patient and GP's in order to evaluate the effectiveness and the improvement in life quality. On the basis of this experience up to now, a cost analysis has been draft, it showed that for a population of 100 patient the teleconsultation cost is less than 40 Euro but it becomes less than 27 Euro for a population greater than 1000 patient.

A number of preliminary results can be outlined: Is it possible through an home-care cardiological system to accurately monitor the lifetime of a cardiac pacemaker during the so-called "General Follow-Up"?. It Is greatly expected by disabled patient to replace the conventional cardiac check-up with a telematic one, It is still under discussion which is the best strategy to involve the GP in this service and consequently the co-ordination with the NHS

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A WEB SITE FOR AN INTEGRATED HOMECARE SERVICE

I. INTRODUCTION

Homecare can be defined as a component of medical care, where patients unable to reach physically and healthcare provider receive evaluation and treatment in their homes or, more extensively, at the point of their need. Homecare telemedicine solutions can also give benefits for continuity of the care and, in principle, for possible reduction of the costs, mainly by shortening hospitalization. In order to catch up this goal it is necessary to use technologies which are able to realize the integration and the interaction of the healthcare professional competences with those social ones. At a technological level, homecare requires new telematic environments for monitoring and exchanging information. Personal health systems are also an important feature.

Italian Government is largely involved in stimulating and supporting activities of Health Telematics and Telemedicine as reported in the "National Health Plans 2003 – 2005 and 2006-2009" and in some guidelines titled "Health Care Services supported by Telemedicine in the minor islands and in the remote mountain lands".

In these area the problem concerning the health care assistance is very important and also particularly heavy for the tourist islands, during the summertime, when the population is rapidly increased for the tourist presences not only national, but mainly foreign.

It is necessary to keep in mind that in this remote areas are not existing general regional hospitals, but only infirmaries and some small primary care unities.

The situation could be particularly severe, due to the time of transportation by overcrafts or ferryboats, especially when the atmospheric conditions are bad [3]. Italian guidelines recommend a strong integration between the general organization of the health care systems and the operators involved in the services, supported by an appropriate technological environment to ensure the minimum levels of health assistance. At present Italian Health Care Authorities defined the role of the Homecare Assistance as A.D.I (Assistenza Domiciliare Integrata) indicating the integration of the different activities carried by GP, medical doctors, nurses, technical operators, patients and relatives for improving the assistance and reducing the duration of the hospitalization [4].

The diagnostic basic telematic instrumentation must be also linked with a center for the transmission and the collection of the personal data and the results of the examinations jointly with some vital parameters (ECG, external vascular pressure, glycemia, etc.)

Homecare is also particular important for not self-sufficient or risked persons, considering the following priorities: pathologies referred to terminally-ill patients, which do not answer more to the specific treatments; patients of whichever age, with particular attention to the old ones with chronic pathologies or in particular constrains of social uneasiness; critical levels

of inability. The priorities indicated by Italian Ministry of Health are:

- Cardiovascular diseases and hypertension;
- Post heart stroke;
- Nephropath patients;
- Post cerebral vascular stroke;
- Rehabilitation for neuromuscular pathologies;
- Degenerative diseases of the nervous system;
- Psychological diseases.

An Italian study of the Health Ministry has put in evidence that approximately 14% of the admissions, which correspond approximately to 24% of the national hospital days, depends mainly by patients over 65 with the above mentioned pathologies. This may be the target of the treatment with homecare assistance.

Homecare can offer new solutions for the management of high incidence chronic diseases, which cause long time of hospitalisation and remarkable social costs. In particular, congestive heart failure is a relevant problem for citizens health, especially elderly, for its high incidence, morbidity and the need of repetitive patient hospitalisation.

In European Union, 2 patients on 1000 suffer by congestive heart failure, but the prevalence dramatically increases with age (over 65 years prevalence rise up to 10%). Also people with implanted pacemaker could take advantage from a service for home-care assistance (for example patients who are not able to easily walk).

In 2004 Region Campania with the local Ministry of the University and Research Affairs started, financially supporting, a regional project of Telemedicine. This paper is a presentation of the part of Homecare application commissioned to our Biomedical Engineering Unity.

II. Materials and methods

This service is especially planned for patients with chronic hearth pathologies and for implanted pacemaker patients. In fact these cases of embitterment are indicate in Italian guidelines literature as target of ADI program.

In our system we developed many services to facilitate the integration and the interaction of the health professional competences with those social ones.

The designed system consists of in the main following parts:

- Central archives to store information;
- Mobile or fixed stations connected by telecommunication network;
- Dedicated instrumentation to monitor the vital signals as ECG, external vascular pressure, glycemia, SpO₂, temperature.

The components of the system are reported in figure 1. These instrumentations are transportable to support the health personal when must go to the patients sites.

In our prototype we used a commercial Patient Monitor manufactured by Welch Allyn. Similar instrumentations may be placed in the pharmacy or in

GP' office, if is requested by the local general health care organizations.

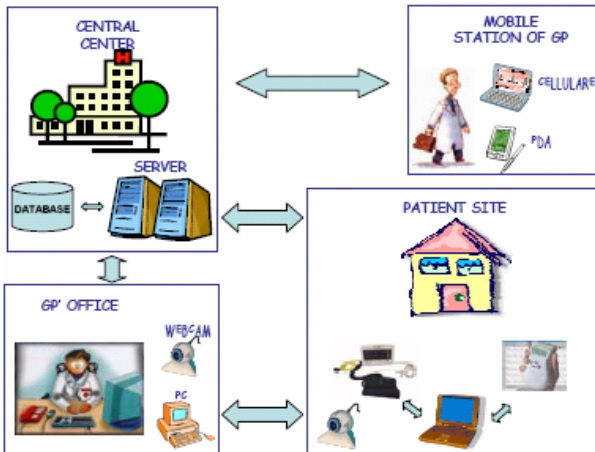


Figure 1: The components of the system

The architecture of the site for the designed Integrated Homecare Service (IHS) is reported in figure 2:

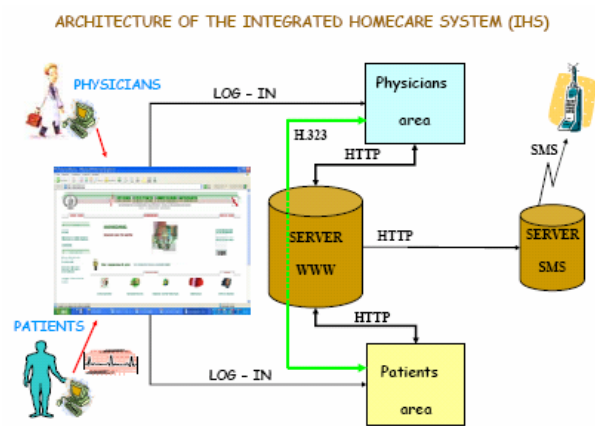


Figure 2: Architecture of the site for the HIS

All the system has been implemented to be also used on a normal telephonic network (PSTN) for giving the possibility of access also from the remote area or everywhere, also in developing countries. By using the web technology, based on TCP/IP protocol, we have a scalable system which will be more efficient when the large band will be present every where, without any modifications of the architecture.

The web site has been implemented using the following Open Source software:

- WEB SERVER APACHE 1.3.27
- PHP 4.2.3
- MYSQL 3.23.49

This choice offers the possibility to have a system which, at the present time, has the highest reliability.

The designed database is based on the idea that at the center of the system is the patient and the coordinator of the entire Health Care Service (H.C.S.) is the GP. These hypotheses are indicated in the guideline of the Italian Health Ministry [4].

The most important entities of the system are the administrator, the physicians and the patients. In the web site there is a different access for everyone of these profiles with different privileges. In the following figures (3, 4, 5) there are some screenshots of the designed web site:



Figure 3: Homepage of the web site for the IHS



Figure 4: Patient' area of the designed web site



Figure 5: Video communications area

Administrator is the supervisor of the full system also for the maintenance and for next future other adjustments. Particular attention has to be devoted to the visual communication by commercial web camera to offer the possibility to the patients and all the

operators to be linked in video communications. The images of two participants appears on the same screen as showed in figure 5.

We have designed a software function to have the list of the on line users available to video communicate each other. It is really user friendly because it is necessary only to click on a button in which is reported the name and the surname of the available user to activate the video communication session. We used Microsoft NetMeeting because it is based on H.323 protocol and also because it is included in Microsoft Windows since the '98 version. So it is not necessary to install any dedicated software to video communication on the users' system. Particular attention has been devoted to software interface for the acquisition and the presentation of the vital signals from the patient monitor. In the figure 6 is reported a screenshot of the software interface and in figure 7 is reported an image of the patient monitor by Welch Allyn.



Figure 6: Software interface to acquisition the data from the Patient Monitor Welch Allyn



Figure 7: Patient Monitor by Wech Allyn

In figure 8 is reported an example of some records from an implanted pacemakers patient.

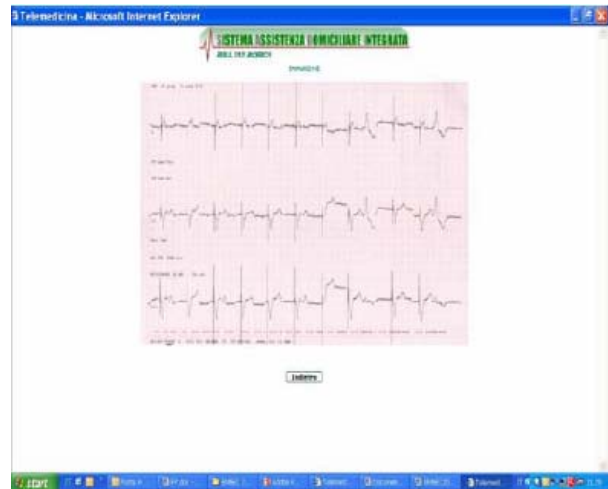


Figure 8: Presentation on the site of some records from an implanted pacemaker patient

III. Results

The main services offered by the system are the videoconference, the monitoring of the vital parameters and the integrated management of all patients' information. Using an user friendly interfaces, the web site for an integrated homecare service becomes an efficient instrument that is able to have a strongly interaction among doctors, patients and relatives.

To validate the designed system it is started a clinical applications to follow up implanted pacemaker patients.

By using this system it is possible to increase the number of routine control in the hospital (typically 3 or 4 in the year). In our validation of the system we have offered to the selected patients a check of their status every month. In fact by the service of the designed web site we are able to acquire the ECG signal from the patient' site and also to present it to the cardiologist to the clinical reporting.

IV. Conclusions

The web-based system that we have carried out offers a large easy to access and it is scalable in function of the physical lines for the connection.

The implementation of a SMS service will increase the possibilities of interaction among several actors involved in the IHS.

In the next future a Technology Assessment survey will establish healthcare delivering quality, clinical results, access to therapy, cost-effectiveness ratios, healthcare actors and patients perceptions.

These results may confirm that the daily tele-monitoring is reducing the number of re-hospitalisations and diagnostic testing requests by optimizing the contact with clinicians.