

E-Health systems for the continuity of care from the hospital to the home care

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Abstract: The technological progress and the need to save and to get better the services offered by Health National System are the basis of the present work. The goal of the project is to give to the patients, in need of continuity of care, the possibility to be controlled and to have health care assistance outside of the hospital, with important advantage, economical ones for Health Structure and environmental and psychological ones for the patients.

The Homecare is a very important application of Telemedicine for improving the quality of life patients and their relatives. The present paper describes a project of Homecare, financially supported by Italian Ministry of Research and University, characterized by a strong integration between Hospital Structure and Homecare Services. The aim of the project is to offer continuity of care to the patient who leaves the hospital even if he's in need of assistance.

An integrated telematic solution for hospital and homecare assistance has been developed through a web portal. A special attention has been reserved to organizational problem, especially inside the Hospital, and for a close cooperation with the GPs and expert nurses, who are the actors of Homecare in Italy.

I. INTRODUCTION

THE fast and frenetic technological progress in Information and Communication Technology (ICT) field opened new environment in modern health care system [1,2,5]. The births of new communication protocols and technologies, more easy to use and more cheap, make possible now applications which in the past were unbelievable. The telemedicine has the aim to utilize these new technologies to reduce distances between patients and centers of care. In this environment Homecare is the privileged field for new telemedicine applications.

Italy has a public financed health care system quite similar to the United Kingdom and to the Canada, where the access to the homecare services are addressed to population that satisfies particular criteria reported to pathology and social condition. The main goal of the homecare is the improvement of the quality of life of the patients and their

relatives, through a continuous monitoring and assistance [15].

Face with an ageing population and rapid innovation in medical treatments, healthcare providers are looking for cheaper and more responsive ways of delivering services than through large, centralized institution. The main aim is to give a service everywhere it's required, not only in Hospital or in centres of care, guaranteeing at the same time a high level of quality.

Obviously the most important place of this environment is patient's home. This situation is very comfortable and reassuring for the patient who can be monitored and cared directly from his domestic ambient. On the other hand hospital structure's cost for each patient goes down because it doesn't have to care the patient in his ward's bed for more days if it's not necessary.

Telemedicine services, oriented to homecare, certainly are the main base for a satisfied continuity of care. Hospital structure can reduce time of hospitalization and also costs of management.

To create a good home care service it's necessary to utilize the most advanced technology. This is used mainly for monitoring of vital parameters [7]. The study of new telecommunication protocols and new technology for biosensors is very important to make a better system.

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

In these areas 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 general regional hospitals don't exist, but there are only infirmaries and some small primary care unities.

The situation could be particularly severe, due to the time of transportation by hovercrafts or ferryboats, especially

when the atmospheric conditions are bad. 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.

The telemedicine system, proposed in this project, has the aim of integration between hospital assistance system and home care system, giving continuity to each others. Medical records of each patient of the hospital are stored in a central database and they are available after the discharge of a patient, so they can be examined also from remote client trough internet network. ADI operators have the possibility to consult and to continue the collecting of the data from patient's home.

II. MATERIALS AND METHODS

A. Architecture of the telemedicine system

The project has been implemented at private hospital "Clinica Villaba" of Naples, which has no profit program cooperation with "University Federico II of Naples", where there is Health Care Information System designed following the previous guide lines and it has been an useful tool to be improved with the use of different input devices (PDAs and Tablets Pc) designed to insert clinical and data records. The system has friendly user interface in the respect of attendance of personnel nurses. The devices are connected to the central database through a wireless network in order to give mobility to all the system in the wards of the hospital [10]. Outside of the hospital connection is guaranteed by GSM, GPRS and UMTS protocol for mobile device and by ADSL, ISDN and PSNT internet connection if they're at patient's home.

Particular attention has been reserved to the clinical diary, to the drug therapies and diets. Moreover an application spin off has been designed for the planning and booking of clinical examination (ECG, LAB, TC, etc).

A wireless network has been designed and realized to improve the mobility of health care operators in the hospital wards. With appropriate ICT, there is no technical reason why health information cannot be delivered to the decision makers as soon as possible wherever they are sited [3,4,5,6].

Many hospitals are already using the support of ICT for the utilization of Electronic Medical Records. This approach is solving many problems, but not completely. For instance it's difficult to have all the information at the bed side of the patient during a consultation or the medical examination. At the same time, it's not possible to transfer in real time the new medical records or other informations in the Data Base.

These aspects may be causes of repetition or loss of information concerning the drugs, the pharmacological therapy and whatever. Doctors and nurses make more efficient clinical decisions about their patients if relevant information is carried to them promptly [1,2,]. The present paper describes a project addressed in this direction making accessible the clinical data in any moment at the point of care and therefore to the bed of the patient whatever he is located.

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.

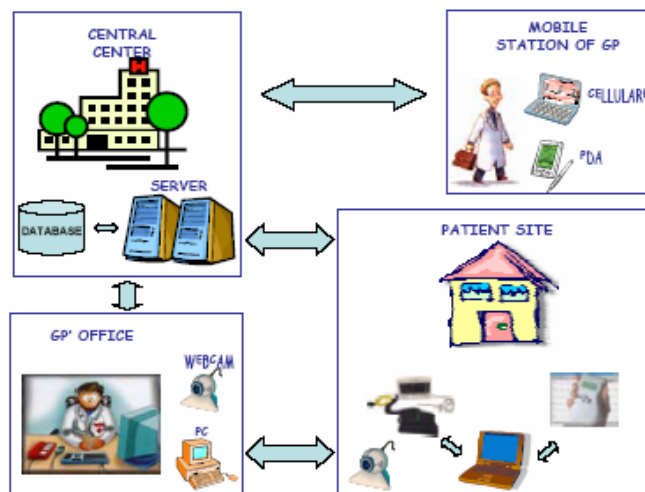


Fig. 1. The components of the system.

These instrumentations are transportable to support the health personal when they must go to the patients sites.

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 portal 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 centre 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.

Using a dedicated software it's possible to connect the system to a Multi Parameter Monitor by Welch Allyn. This software is "Monitoring 3.0", it has been implemented for the regional project "Telemedicina Regione Campania" and it is integrated in this platform. The device connected to the monitor, through Bluetooth connection, received biomedical signal from the monitor and it send them to the FTP Server of the Hospital, in order to store the data in the central database. The collected data are linked to the medical record of the patient and they are available for future consults.

Monitoring 3.0 has been written using Microsoft Visual C++.



Fig. 2. Software interface for the acquisition of the data from the Patient Monitor Welch Allyn



Fig. 3. Patient Monitor by Wech Allyn

B. The web portal of the telemedicine platform

The Portal manages electronic medical records, which are collected in the hospital and at patient's home. The portal allows to manage in real time: personal data, anamnesis, vital parameters, diagnostic examinations, diary of therapies, general note about the patient, diary of nutrition. The system provide also a preliminary data processing so that abnormal values are highlighted by the use of different colours in the

reports (figure 4). This function assists the physician in the process of decision making, giving a fast overview of the clinic situation.

Ora e Data	Temperatura	Utente
13:09 8/05/2005	38.00 °C Febbre	3
13:09 8/05/2005	37.20 °C Febbre	3
15:14 1/05/2005	37.20 °C Febbre	3
0:31 1/05/2005	38.00 °C Febbre	7
15:53 30/04/2005	41.00 °C Febbre Alta	3
15:53 30/04/2005	39.00 °C Febbre	3
15:53 30/04/2005	36.00 °C	3
15:41 30/04/2005	38.00 °C Febbre	3

Fig. 4. Clinic information about patients. The temperature is represented in red if the value registered is over 37 and in blue if it goes over 40.

Moreover data are organized in a graphical representation for a fast analysis of the vital parameter's trend (Figure 5).

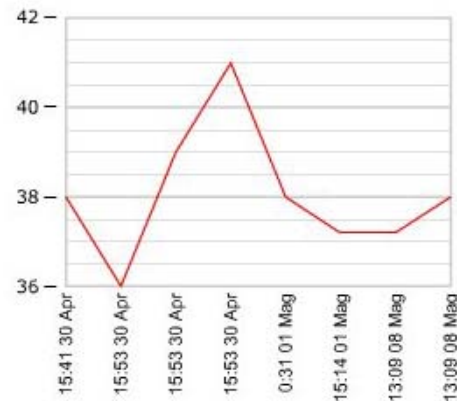


Fig. 5. Graphical representation of temperature trend in the time. On the vertical axis is expresses the temperature in C° on the horizontal the time date of the measurement.

The Graphical User Interface (GUI) is user's friendly and it is not needed to use keyboard in order to insert data: the digital pen of the devices it's enough.

A secure access to the medical records is implemented by a multi level authentication of the user, by the entry of username and password. An electronic job's session follows user during all his operation, without losing his authentication data. The portal manages various hospital wards supporting an effective inter- and intra-communication. For example when the physician decides a particular diet for the patient, in real time the information reaches the kitchen. The same happens when the physician prescribes a determined diagnostic examination for the patient. The booking of the examination is immediately sent to the afferent ward, the same operation provide data to the Director, to the responsible of the Services and to all the other figure that cooperate in the Management of the Clinic.

The GUI has been optimized for the visualization through tablet PC or PDA. Obviously the GUI designed for the PDA is simplified but however complete in the functionalities.

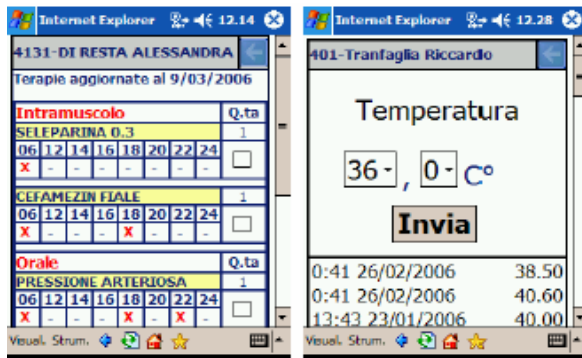


Fig. 6. Screen Shoot of the web portal for PDAs.

When a patient is discharged from the hospital his medical record is available from remote station. If he needs assistance from his home, doctors and nurses, who must go to visit him, can consult his medical record and stored new information.

The connection to the central database is available through internet network, using mobile device as PDA or Smart Phone. It's also possible to use portable multi parameter monitor and send all the data to the server FTP of the system.

Hospital Doctors can analyze medical record of the patient from his home or hospital's office in order to change therapy, diet or treatments. Also General Practitioner, who is the main actor of ADI, can analyze patient's clinical history in order to decide about treatments for him.

A videoconference function has been integrated in the web portal. Using a commercial web camera, patient and doctors can communicate in videoconference. It's also possible in the same time to send biomedical signals and to analyze vital parameter stored in the medical record in order to have a real time diagnosis of the exam.

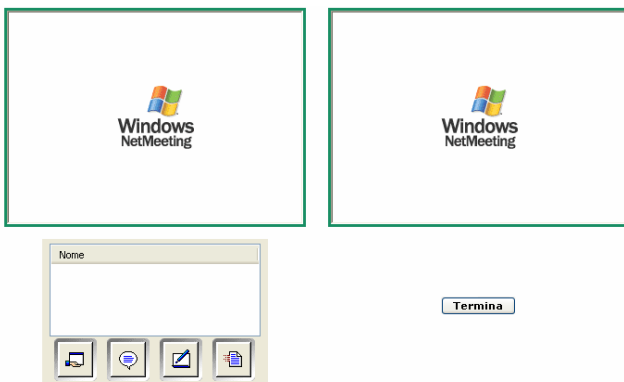


Fig. 7. Screen Shoot of videoconference function on the web portal.

In figure 7 it's possible to see the web page regarding the video conference function. The image of the two participant of video conference appear in the same page. It's also possible to share program and to chat. The page use the software engine of NetMeeting, which is a videoconference program included in Windows operative system.

It's enough to have a web camera and a good internet connection (ADSL or CABLE) in order to do a clear videoconference communication.

The video communication application follows the standard H.323, so to be compatible with other video communication system. The application has been tested with Aethra Telemedicine System, which has been integrated in the Home Care System. This System allows to perform Home-Care applications, Medical video-conferencing, and E-Learning. It allows two main configuration: Medical Station and patient station.

Medical Station, in figure 8, is composed by a videoconferencing device, a Personal Computer or an Analogical Monitor and a Stethoscope (doctor site).

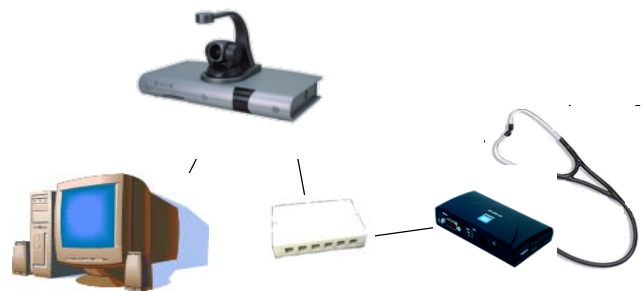


Fig. 8. Medical Station of Aethra telemedicine System.

Patient Station is composed of a videophone, a Multiparametric Monitor, the multiport M.A.R.T.A. and an electronic stethoscope (patient Site).

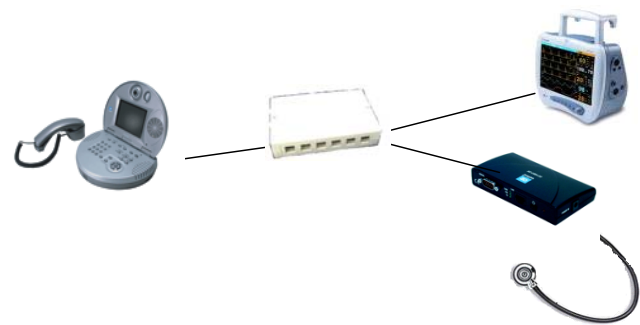


Fig. 9. Patient Station of Aethra telemedicine System.

This Telemedicine station is full integrated to videoconference function of Home Care Web Portal. Patient can use videoconference web page of the web portal and his web camera to communicate to Medical Station.

III. RESULTS

The main services offered by the system are the monitoring of the vital parameters and the integrated

management of all patient's information. Using an user friendly interfaces, the web site for an integrated homecare service becomes an efficient instrument which is able to have a strongly interaction among doctors, patients and relatives.

To validate the designed system it is started a clinical applications in the hospital. Doctors and nurses use PDAs devices to store and visualize data of patient's medical records. This test application has been possible because the wireless network in the hospital and web oriented portal allow to pick data in real time from everywhere.

The system has been opened for Home Care application. Now it's possible to follow the patient even after his hospitalization through the web portal and internet connection.

Homecare can offer new solutions for the management of high incidence chronic diseases, which causes long time of hospitalization and remarkable social cost. Opening the system to internet it's possible to share medical records with GP and other hospital structures providing an effective continuity of the care.

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