A New Shared Care Telemedical Solution Dedicated to Elderly Patient Nursing Services for Remote GP Decision Support

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Abstract

Thanks to the development of homecare facilities, elderly prefer to stay at home, and the age at which they are admitted in retirement homes is steadily increasing. As a result, a very large number of these persons are going to live in such dedicated centers because they have several health problems and need a daily assistance. But, a great number of these institutions for the elderly do not necessarily include medical services with a permanent on-site physician. These citizens/patients may be located in isolated geographic areas and sometimes need a GP intervention within less than two hours. In this context, we have designed a telemedical solution, called Tele-Nurse, based on a medical trolley equipped with several sensors (ECG, blood pressure, weight scale, SaO2, glucometer, videoconference) connected to a laptop which allows to collect and transmit the data to the GP via a J2EE server and a MySQL database. In this paper, we describe the global architecture which has been implemented and the various models that have been designed to support the user requirements, the use-case scenarios and the functions of the core system.

1. Introduction

As we move further into the 21st century, in western societies, the number of elderly populations is steadily growing and the mean age at which the retirees are entering elderly nursing homes is also steadily increasing (≈ 84 years in 1998). On the other hand, the elderly are staying as long as they can at home, so that almost 78% of the entries in an elderly home are for medical reasons. The paramedical staff is thus increasingly confronted with medical requests that usually result, because of the absence of medical in–house support during more than 60% of the time (ie during the rights, week-end, holidays, etc.), in sending the patient to the hospital for security reasons. It has been estimated that the set-up of a medical tele-assistance system could avoid the need for an hospitalization in 25% of the cases. It is thus felt that the development of a remote decision support system for the elderly homes is strategic in the context of increasingly rising health costs, the lack of doctors and health workers and the re-urbanisation of the GPs. In addition, it is also felt that such a system would allow the valorisation and the optimization of the competences of the nursing staff and thus contribute to the increase of the quality of health care.

In this paper, we first describe the use cases and the user requirements for a remote, elderly care decision support system. We then present the architecture of the proposed Tele-Nurse, telecare system and the first evaluation results.

2. Use cases and requirements

The goal of the Tele-Nurse project is to set up a remote decision support system connecting the old peoples rooms or apartments in the nursing homes to a PC based, easy to use and to deploy clinical workstation for the remote GP in order to provide quicker and more effective actions or treatments in case of disease episodes leading to emergency situations such as a heart attack. Some of these nursing homes are located in isolated areas and require more than two hours before the nearest doctor or general practitioner can visit the patients. In order to resolve these coordination problems, we have designed a medical trolley equipped with several medical instruments and video-telephony. The medical trolley allows data transmission and information exchange, via an intelligent server, between the doctor and the nurse. The doctor can thus establish a diagnosis within minutes after he has been called and remotely decide the actions to be taken and instantly carried out by the nurse. To meet these targets, the system must allow real time information sharing as well as bilateral medical data update, such as for example the recording and the upload of an ECG by the nurse whilst the remote GP is keying in the clinical signs. We distinguish three principal actors: the nurse, the patient and the doctor (fig. 1).

The nurse and the patient are located within the medical facility, whereas the doctor is nomadic and must therefore be able to answer a request from his office, his

home or from any location within the nursing institution whenever he is on duty or visiting a patient in the nursing home.

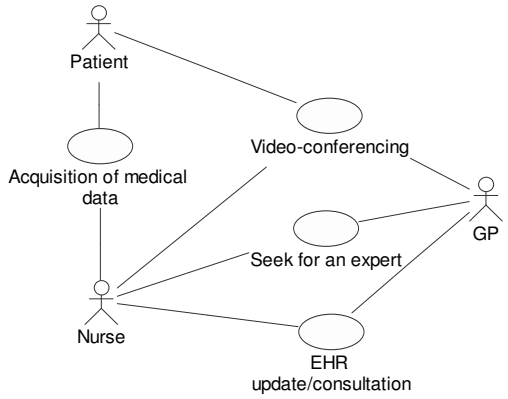

Figure 1. Global system use cases

To develop an adapted solution, we have imagined three scenarios. The first concerns the routine data collection (fig. 2). The nurse can record an ECG or the blood pressure and transmit information directly on a server via a medical trolley equipped for the transmission. When he is available, the GP can consult the EHR and take a decision if it's necessary.

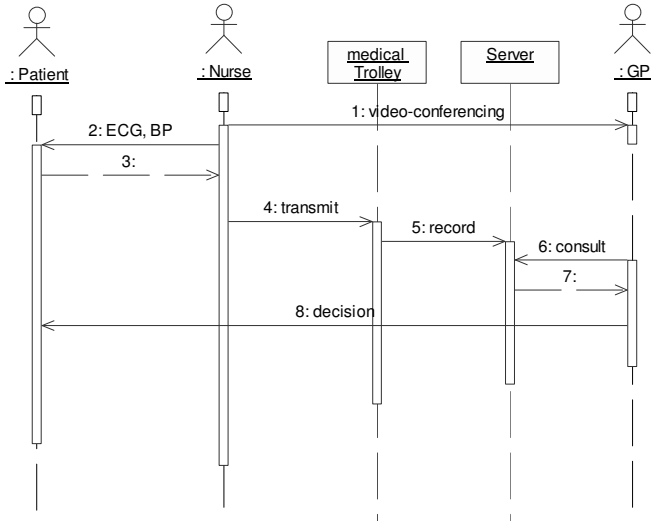

Figure 2. Routine data collection scenario

The second scenario concerns the tele-consultation request (fig. 3). A patient has a problem and the nurse wants a medical support. She can contact the GP with an audio or video system. During the discussion, she can record an ECG and upload it on the server. The GP can consult this ECG and take a decision about the patient problem.

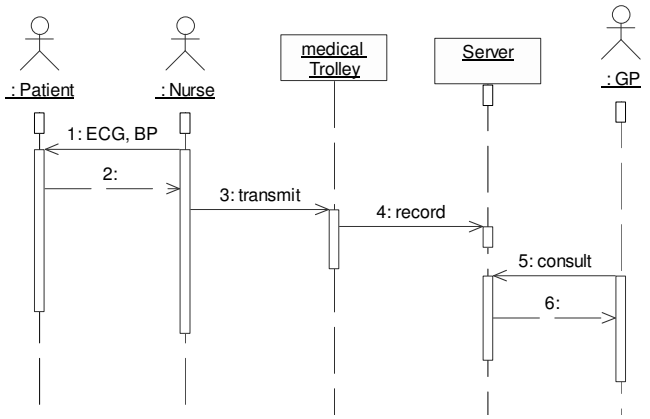

Figure 3. Tele-consultation scenario

In the third scenario, the patient has an important heart problem and the nurse wants a specialist intervention (fig. 4). She can record a digital ECG and transmit it to an emergency department where the patient will be taken in charge quickly. In a second time, the event and the ECG will be recorded on the server via the medical trolley.

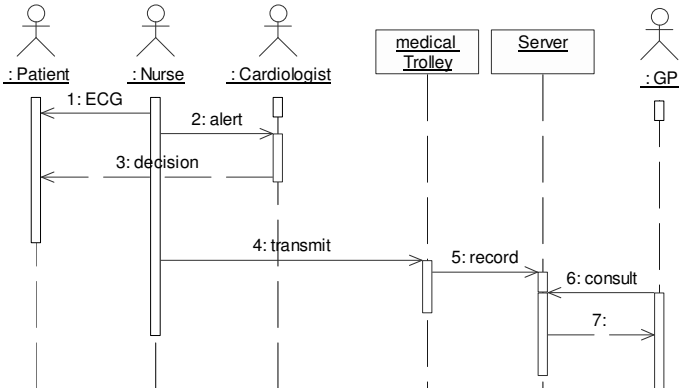

Figure 4. Emergency scenario

Another requirement was that the architecture allows the contact between a nurse and a GP who may fill simultaneously the Electronic Health Record of a patient. The EHR is the core of the system. It can be seen as a collection of medical, annotated encounters, sometimes accompanied by recordings coming from sensors. The EHR contains 3 main parts: administrative data (name, sex, age, etc), a collection of clinical information such as biological data, ECGs and X-Rays, and document files coming from the scanning of old, hand written or typed paper EHR files.

Four prerequisites were retained to develop our platform:

1. Robustness and reliability: the handled information should not be deteriorated, and its coherence must constantly be ensured by the

system. Incoherence on a data value should not paralyze the functioning of the system.

2. Safety and traceability: the data must be inaccessible to unauthorized users. The users and the traces of their intervention shall be recorded via the medical trolley. The communications protocols must be able to ensure a minimum level of safety preventing the exploitation of information by unauthorized third parties.
3. Evolutionarily and maintainability: The system must be dimensioned and conceived to accept future evolutions, in particular at the level of the biological measurements recorded in the EHR files.
4. Performances: The system must provide a minimum level of quality of service. The access times to the EHR must be compatible with the emergency time requirements of medical interventions.

3. Results

The Tele-Nurse architecture that we have developed consists in three main components: a sophisticated medical trolley, an intelligent J2EE server and a remote station.

The medical trolley includes useful equipments allowing the medical staff to collect information. It consists of a specific, high quality audio-visual equipment [1] functioning like an enhanced video-conferencing system with the possibility to remotely control the position and the zooming of the camera, and of several medical acquisition devices: tensiometer, standard portable 12-lead interpreting electrocardiograph or a simplified 4 electrode intelligent personal ECG monitor (PEM device from the EPI-MEDICS project [2]), Oxymeter, Glucometer, Thermometer, digital Stethoscope and a Weight Scale. Most of these devices automatically transmit their measurements wireless via Bluetooth or an industry standard radio link to the laptop PC that is embedded in the Trolley which sends the collected data to the server. The real time audio-visual data exchanged between the two clients are however not recorded on the server. The server may be hosted anywhere, but for security reasons preferably inside the old people's home. The connection between the medical trolley and the server is an Ethernet connection using any easy to deploy, standard communication media such as Power Line Communications (PLC), WiFi or cable connections if available (fig. 5).

The Server can be accessed by means of a secured Internet connection by any authorized institution, having one or more trolleys. The EHR information are shared between the actors. In the case of a tele-consultation, the nurse and the GP can simultaneously access the patient's EHR and visualize the data collected by the devices of the medical trolley in quasi real time. Moreover, each actor can manually modify the EHR by adding information. The modifications performed by the last actor supersede the modifications of the preceding actor. Each user is identified and has established rights. No free access is allowed. All interventions carried out on the EHR are indexed. To implement the server, we have used the JOnAS (J2EE) open source platform [3].

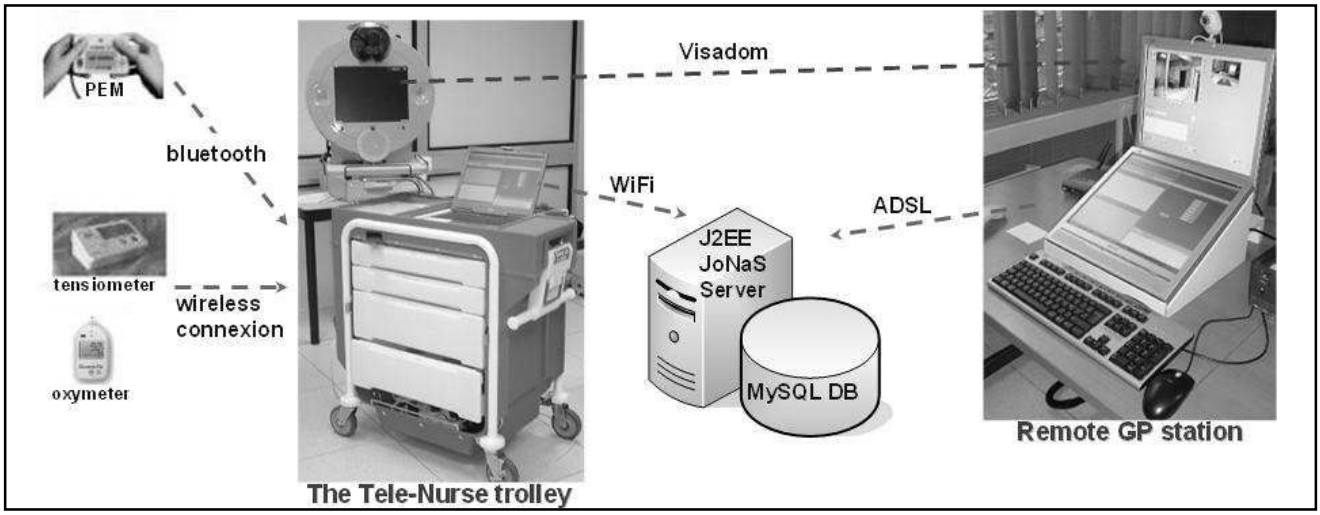

Figure 5. The global architecture of the Tele-Nurse project. The medical trolley is equipped with a high performance visio conferencing system (Visadom), a laptop and several medical devices (ECG, oxymeter, etc.). The remote PC based GP workstation is staffed with two screens, one for the display of the Electronic Health Record, the other for the video conferencing.

The remote GP workstation allows the almost real time display of the digital data being collected by the nurses like the ECG, the body temperature, the blood pressure, etc. Moreover, the GP can see the recording scene, follow the nurses actions, zoom in the video camera to have a close look to any part of the patient's body, and instruct the nurse about the actions to be taken to avoid the hospitalization. The GP can also consult the EHRs at any time and thus remotely follow the patient's evolution. All data are available in quasi real time on the station.

Evaluation results: we have deployed two platforms in two French elderly homes and evaluated the following points:

- usability of the prototype and the devices for the nurse and the doctor,
- acceptability and integration of the devices in the daily work environment,
- quality of the information shared between the nurse and the GP,
- coordination of the medical interlocutors,
- coherence of the drugs prescriptions,
- events justifying the use of the trolley by the nurse.

The main evaluation result was a high level of acceptance of the Tele-Nurse system concept. However, it was felt that, because of the large turn-over of the nursing staff in elderly homes, it would be relevant to further improve the ergonomy of some of the man-machine interfaces in order to reduce the training time. Also, the time needed to start the system, i.e. the time to start Windows and establish the WiFi connection, was sometimes considered to be too long.

4. Discussion and conclusions

The objective of the Tele-Nurse project is to propose medical support to the healthcare staff working in the elderly homes. The purpose is to characterize and evaluate in real conditions, the effectiveness of the proposed "nurse + trolley for remote decision support + doctor station" solution and to assess the concept of "delocalizing the GP".

A key success condition to achieve before deploying such an advanced, remote decision support solution is to obtain the nurses adhesion and to perform the medical staff training. The nurses adhesion and the training of the users participating in the evaluation process were significantly facilitated because the tools we developed are easy to use and well integrated in the users work environment. This could only be obtained by carrying out, throughout the system design and development cycles, analyses and evaluations of the usability of the prototypes, and by performing several optimizations. The overall acceptability of both the nursing and the medical staff was high. Moreover, the GPs also found that the on scene use of this kind of medical system within the elderly homes was of a great utility for their medical practice, ie for consulting and updating the patients records either via the medical trolley during a consultation at the patient's bedside or from a PC based GP workstation located in any of the offices of the elderly homes.

Another result was the confirmation that the deployment of this kind of medical tele-assistance systems should result in taking much faster care of emergency situations (initial diagnosis, medicalized transportation, hospitalization), the demonstration that the Tele-Nurse system should allow a better management of the evolution of the patient's medical state and of the patient's wishes and the possibility to start without delay the treatments prescribed by the tele-assisting GP.

Acknowledgements

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[3] JOnAS: Java (TM) Open Application Server, http://jonas.objectweb.org/

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