Using Contact Centers in Tele-Management and Home Care of Congestive Heart Failure Patients : The CHS Experience

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Abstract

The Citizen Health System (CHS) is a European Commission (CEC) funded project in the field of IST for Health. Its main goal is to develop a generic contact center which in its pilot stage can be used in the monitoring, treatment and management of chronically ill patients at home such as congestive heart failure (CHF) patients. Such contact centers, which can use any type of communication and telematics technology, and can provide timely and preventive prompting to the patients are envisaged in the future to evolve into well-being contact centers providing services to all citizens. In this paper, we present the structure of such a generic contact center focusing on the telecommunication infrastructure, the communication protocols and procedures related to the vital parameters and signals, and finally the educational modules that are integrated into this contact center. We present examples of the communication means between the medical professionals using this contact center and the congestive heart failure patients, and elaborate on the telemedicine and educational issues involved.

1. Introduction

Information technology (IT) applications in medicine are rapidly expanding, and new methods and solutions become available everyday since they are considered pivotal in the success of preventive medicine [1]. In the past days, IT applications were mainly applied at the secondary health delivery level, and even at specialised hospital departments. These applications were difficult to use, maintain, and they were quite expensive. Today, due to the fast growing and penetration of the INTERNET and mobile telephone technology, the IT applications in the health care environment are focused at e-consultation [2] and home care delivery [3] and the use of triage systems [4]. Home care delivery is a very important issue, starting from the management of chronic diseases such as diabetes, congestive heart failure, coronary heart disease, etc. These chronic diseases such as CHF demand a continuous monitoring of vital parameters and signals such as weight, blood pressure and ECG. IT based applications for home care delivery, are important media to increase health care quality, increase quality of life, and create a better educational platform with carefully designed and customisable patient prompting which in turn is expected to be instrumental in increasing the collaboration degree between the patient and the physician. However, in the case of heart failure there are ambiguous results regarding the effectiveness of IT technologies when used for telemonitoring and home care delivery [5-7].

Pivotal to these purposes are contact centers, which act as mediators between the medical staff and the citizens seeking advice and/or therapy. Main platforms used for the development of such applications are the INTERNET and PCs, and the telecommunication networks, including mobile solutions. In this work, a generic contact center model is presented, which currently is used in the CHS project for the treatment of CHF patients. A number of modules are used to transmit and authenticate information, filter received data, process and manage queries from both patients and doctors and provide decision support and intervention tools at the clinician's site for quality and timely health delivery.

2. Methods

2.1. Overall system design

The designed system has as an ultimate goal to be user friendly for daily use. Another goal of the design is that the system has to be customisable and each patient's profile should designate the kind of information delivered to/from the patient. Besides, the system has to be open and flexible offering the patients a number of technologies to choose from, in

order to communicate, according to their life style and adaptation to technology.

Although most of the functionality has to be automated, direct interaction with nurse should not be completely eliminated (especially for medical advice).

Information, especially for educational purposes, should be presented with friendly, easily understandable and accessible interfaces, avoiding too much information in printed material. Besides, information should be presented in the user's preferred language.

From a development point of view it is crucial that such a system should be modular and provide integration of different communication means and modules of independent functionality, like the artifact rejection module and the customisation module. Basic modules in each new interface should be re-usable and the overall application should be expandable to new technologies. Finally, system security is crucial since the system deals with sensitive personal data.

The technical architecture for the CHS System is based on distributed, multi-tiered systems. CHS System was implemented using a three-tiered architecture dividing applications into parts that run on different types of computers. The three-tiered architecture is decomposed as follows:

Client Tier: The user component displays information and processes data input. Consists of:

1. Call Center Patient I/F
2. Call Center Clinician I/F
3. Signal/Image Receiver
4. Web Patient I/F
5. WAP Patient I/F
6. Web Clinician I/F
7. Clinician Client Application

Middle Tier: A set of sharable, multitasking components that interact with clients and the database tier. It provides a controlled view into the underlying Database. Consists of:

8. Device Specific Modules
9. Authentication Module
10. Patient Session Module
11. Signals Server Module
12. Clinician Application Server Module

Database Tier: The Database Tier consists of the CHS Database.

This three-tiered approach enables to separate the business logic from the processing logic and business changes to be more rapidly incorporated into applications. New software modules and program objects can be written to work with existing databases, taking advantage of the resident programming logic.

2.2. Implementation issues

For the Contact Center Unit, where the database information includes complicated relationships between several tables and the number of clients grows, a multi-tiered application is preferable. In multi-tiered database applications, an application is partitioned into pieces that reside on different machines. A client application provides a user interface to access data. It passes all data requests and updates through an application server. The application server, in turn, communicates directly with a remote database server. Multi-tiered applications include middle tiers that centralize the logic that governs the database interactions, so that there is centralized control over data relationships. This allows different client applications to use the same data, while ensuring that the data logic is consistent. They also allow for smaller client applications because much of the processing is off-loaded onto middle tiers. Multi-tiered applications can also improve performance by spreading the data-processing tasks over several systems.

The communication over the network between the home-care and clinic-center units is one of the most important parts of the CHS. The server located at the contact center should be able to concurrently communicate with multiple home-clients, to support security and to provide data integrity.

Three different technologies have been chosen for the patient interfaces, so that patients may choose the commu-nication means of their preference:

1) Computer Telephony: Fully automatic telephone Contact Center
2) Wireless Technology through: WAP
3) INTERNET

Each of the communication means has different characteristics, although they all ensure 2-way communication, e.g. user interaction in a simple manner. The cheapest technology with the widest penetration is the use of regular telephone with call-center automation. Web interface is user-friendly but the required infrastructure is not available in every house. Besides, among elderly people, who might be an important target group for chronic disease home-care management, computer literacy is not granted. WAP is an emerging technology which is popular among certain population categories.

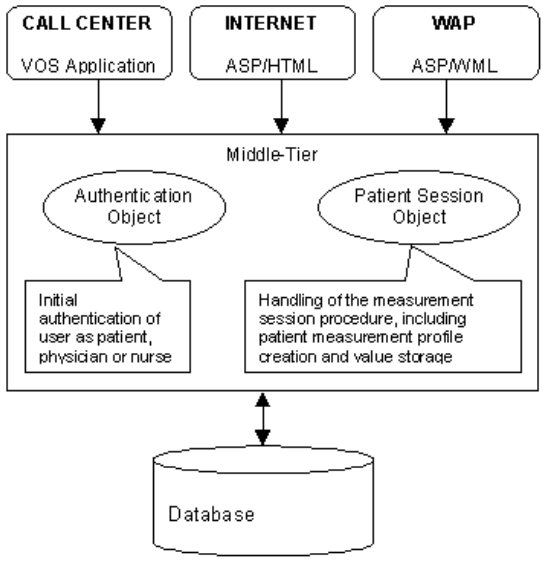

Figure 1: The structure of the communication modules of the CHS contact center.

In order to integrate different interfaces (communication means), an intermediate is required between client interface and database. Thus, a client/server (3-tier) architecture as described in the previous subsection has been selected (Figure. 1). The middle-tier include objects that are compiled software components based on Microsoft's Component Object Model (COM) technology and they are basically modular programs designed to give specific functionality to a parent application. COM is a language independent software component model designed by Microsoft to enable interaction between software components and applications. The key feature of COM is that it enables communication between components, between applications, and between clients and servers through clearly defined interfaces.

The advantages of such an implementation are:

- Encapsulation of business logic in a shared middle-tier.
- Different client applications all access the same middle-tier, avoiding the redundancy of duplicating business rules for each one.
- Client applications can delegate more of the processing to middle-tiers.
- No need for installing/configuring the database connectivity software for client applications.

2.3. Patient's application scenario

The CHF patient can run a session either for measurements submission (i.e. ECG, body weight, blood pressure), can run an educational session, or can run an interactive session.

More specifically, the services provided via the home care system are:

- Measurements. Each patient may send measurements like blood pressure, ECG, pulse or weight. These measurements are taken at home using simple devices (like a blood pressure recorder). Complementary to the measurements are a number of simple Yes/No questions asked to the patients, since the corresponding answers may be explanatory of their condition. The values are keyed in using the selected technology (WAP, WEB or regular phone). The set of required values and questions may be personalised for each patient. Vital signs like ECG may also be transmitted to the system by use of transtelephonic devices. Figure 2 shows sample screens of a typical WAP based session.

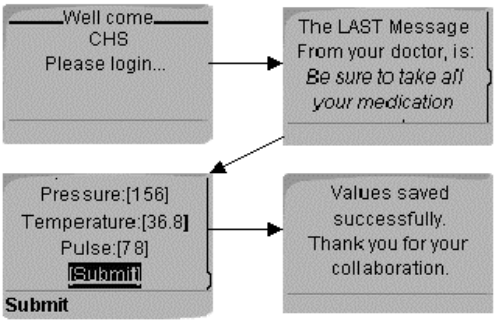

Figure 2. Screens for a patient session using WAP, with the following units: (a) login and authentication, (b) read possible messages from physician, (c) enter measured values and answer questions, (d) save values.

- Education. Each patient can attend educational sessions, either on demand, when he/she needs some information on a specific subject, or scheduled ones where the system calls automatically the patient for more detailed educational sessions on subjects that are of importance. All educational messages are also available in text form, so Internet can be used alternatively for educational purposes. Besides, a pool of Websites with useful information for disease management is available as a reference library.
- Communication with the physician. Depending on the communication media, written or voice messages can be exchanged between patient and physician.

In a customized and personalized system such as the CHS multilinguality is an important issue, concerning both knowledge presentation and interface. The main issues taken into account to ensure control of language used for information presentation are:

- Keeping information in a structured way that is controlled, e.g. in a database.
- Developing configurable systems, (set language as a parameter). Along these main axes, some initial actions were taken towards multilinguality.

Written educational tips/messages were stored in a database in order to be easily translated. Voice educational messages were also maintained in a structured form, so that they are easily controlled and translated.

3. Results

According to the scenario presented above, the patient can send data from virtually everywhere, provided he/she has the portable devices necessary for the measurements of basic parameters such as arterial blood pressure, blood glucose etc. These recording devices are getting smaller and smaller, and many of them are supporting transtelephonic transmission, which may decrease the session duration, and reduce the number of errors due to erroneous data entries. This technology together with prompting physicians can increase the effectiveness in preventive care in the future [8].

Home Care is facilitated since multiple means of communication are offered, and thus different patient groups are not excluded. This increases patients' involvement in their own health, and hopefully reduces the need for hospitalization.

From a technical point of view, the proposed system is a new idea offering multiple platforms and customization according to user's needs and thus contributes to customization of health care delivery (personal profile). The system is flexible, allowing incorporation of new communication technologies, for example mobile telephony and in the future interactive TV, with minimal development effort, thus, serving the idea of an integrated system for health care delivery through any communication platform.

Until today, in its pilot phase the system has been used by 12 CHF patients, who use it routinely for the past 10 months, and who run regular sessions with the system without any problems. The attending physicians intervene when something regarding the trends of the vital parameters is not normal. Interventions are made both as it concerns life style and medication.

4. Conclusion

This paper describes a home care contact center able of extending beyond data collection by generating feedback and supporting patient education. It combines initial screening, use of measurement micro-devices, patient education, decision support, appropriate telephone/WAP/WEB contacts and physician access.

This system is currently tested in a congestive heart failure clinical trial emphasizing the management of CHF patients. Such trials will help assess user acceptance of the system and its clinical effectiveness.

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