DESIGN OF AN INTELLIGENT SYSTEM FOR MONITORING AND ASSISTING OF NEOPLAZIC PATIENTS

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Abstract: The aim of this work is to create an intelligent client-server structure through which the neoplazic persons that use the opioid medicine to be monitorized and assisted at home, and also to efficiently intervene to lend the essential assistance. The patient has at his/her disposal an interface which allows the transmission of some information regarding his/her healthiness through a reception server. This information is analyzed in accordance with some treatment criterions and protocols well regulated, and decisions for adjusting the doses of the opioid medicine are taken function of the intensity of the algic symptomatology.

Keywords: *Intelligent client-server system, oncology, biometry, opioid medication.*

I. INTRODUCTION

Recent developments of wired/wireless communications networks infrastructure allows implementation of valid and robust services using broadband data transfer [1]. One can multiplexed on same channel different types of data: voice, video, data, by providing a high quality of service (QoS). For instance, in Romania such services are available in urban area almost to 100%, and about 70% in rest. As well, client-server architectures allow the implementation of complex application through which the information can be received from more users at one time; the received information is processed in accordance of some criterions, and the results of those analysis can be used for taking decisions and/or for transferring some commands back to the user (the same user).

In accordance to the legislation and the conditions insured, the actual treatment of the neoplazic patients is done in specialized medical surgeries or, in exceptionally cases, through care at the patient home. In many situations, these medical advices are of routine and are not necessarily the concomitant physical presence in the same place of the patient or of the medical staff. On the other hand, any further information help for a better diagnose and treatment of the patients. Due to the chronicle stage of the disease, the cases in which the medical man response to the patient request must to be suddenly are enough rare; most of the treatment decisions can be taken in the day of request, but not necessarily on-line.

There already are many monitoring and assisting systems implemented for different applications. A large number of computer-based clinical decision support have been developed and their usefulness evaluated in the last 40 years. Many of these have involved simple types of decision support like recognizing that a laboratory test result is out of normal range, or that a medication being ordered has a dangerous interaction with another one that a patient is taking, or determine that a patient is now due for a flu short [2]. Beyond diagnosis, the computer can support a variety of other complex decision-making tasks. It can help determine optimal workup strategy [3] in sequencing of tests and procedures for evaluating a clinical problem. It can assist in selecting treatment [4], or in evaluating alternative treatment strategies [5] in order to select an optimal one for those conditions. It can be used to perform detailed plans, in terms of dose calculations for chemotherapy [6] or detailed $3D$ modelling and dosimetry calculations for radiation therapy [7]. It can provide estimates of prognosis and risk of complications for alternative treatments [8].

The proposed project is completely different and represents a novel way of the medical service assurances problems and also of the treatment at home for the neoplazic patients. The innovating communication system patient belongs-medical man assures the fast information change between the patient and the medical man, with benefic consequences in the control of algic symptoms of the patient.

In complex decision-making problem areas such as workup, diagnosis, treatment, and long-term management, just the ability to organize and coordinate the sequence of steps for performing various actions, evaluating results, and making choices of next steps is valuable. Decision support in the form of clinical practice guidelines is of interest. Guidelines also can be used to embody best practices, with the hope that their use will improve health care quality, reduce variation, and improve efficiency and workflow.

The paper is organized as follows. Some medical aspects are presented in Section II. The design of the overall system is discussed in Section III. Implementation of components of the system are detailed in Section IV. Feasibility and maintenance of the system are considered in Section V. Finally conclusions are provided (Section VI).

II. SOME MEDICAL ASPECTS

In national level, the oncology patients treatment is done in specialized medical surgeries or, in exceptionally cases (recently by legislation 2003/2004) through care at the patient home. Recent researches done in the paliative care domain and in the symptoms control demonstrate that most of those neoplazic patients (until 85% in accordance to the recent international researches) have uncontrolled pain. It has to be noticed that in the last two decades, from the elaboration of the analgesic scale OMS in three steps, there were no noticeable progresses in this domain. However, the aim was to find solutions for alternative ways of solving this major medical-social problem as the medical home care for the neoplazic patients [9]. Moreover, another systematic goal from the oncology point of view is the optimum treatment of the pain.

The realization of an intelligent system might ensure the interoperability and information exchange between the main factors involved in the health system (patient, medical staff, accredited societies for taking care at the patient home, medical centers, house insurance for health) and the establishing of some modern concepts of the pain physiopathology and pharmacology of the opioid medication.

The recording medical systems (RME) features are to improve the medical care efficiency, together with a reduction of costs and risk. The standardization of Medical Electronic Database (MED) involve many international organizations as:

- ISO/TC 215 Health Informatics
- CEN (European Committee for Standardization)
- Open EHR (Open Electronic Health Record Foundation)
- ETHO European Health Telematics Observatory
- ETSI - European Telecommunications Standards Institute
- IMIA International Medical Informatics Association

Romania has adhered to CEN, ETSI and ISO and CEI through the Romanian Standards Association affiliation.

III. DESIGN OF THE SYSTEM

The main scope of this section is to show some technical solutions which respond to the patients treatment needs. This may be fulfilled by using of modern resources for documentation and communication between medical staff, and the improvement of the quality of the storing, transmitting and secreting data of the patients.

The assurance of the quality of services offered by the computers network is realized through all the management measures of the activities [10]. The specific features are found in the configuration of a modern system of distributed design, in respecting the quality of services and security standards in the medical domain, in the growing up of using the research infrastructure through the implementation of the specialized software and instructing the personal with the new developed technique.

As it was mentioned previously, the aim of this work was to create an intelligent client-server structure through which the neoplazic persons condition which used the opioid medicine to be monitorized and assisted at home and also to efficiently intervene to lend the essential assistance. The patient has at his home an interface which allows the transmission of some information regarding his/her healthiness through a reception server. This information is analyzed in accordance with some treatment criterions and protocols well regulated and decisions for adjusting the doses of the opioid medicine are taken function of the intensity of the algic symptomatology. The medicines clearance is realized through a mere machine that exists at the patient's home and that are distance controlled by the server application.

The proposed system solves in main part as well the patient care needs and as well the safety protection in using the narcotic medicines that satisfy the current legal criterions. The development of the distributed system of GRID type assumes the design of a secure and multilevel access module, with personalized interfaces, in which the users groups have shared access to information, in accordance to the standards regarding the security and confidentiality of electronic medical registrations.

Based on Workflow Management System (WfMS) principles and developed with component management system, the system will assure dedicate access to the specialized medical persons who have rights to use the available data base and to consult the documents archive for next statistical processing of major importance in the medical and social domain. The data base can be used in complex analyze processes regarding not only the treatment of chronically neoplazic illness, but also in the evolution in time of the patients disease.

Taking in consideration the restriction distribution, legally governed for the opioid, this system will assure the secreted access for the patient or for his belongs through some individual biometric characteristics as fingerprints, completely removing the possibility of unauthorized using the medicines. The data's patients' confidentiality and also their treatment are assured by software protection of the applications that are part the proposed system through the present project. Depending on the clinical history of every patient, reflected in the registrations from the clinical medical attendance papers, respectively in the medical letters, in clearly specified cases from the oncology medical man, the system can assist the patients' treatment fast and direct, without the intervention of the medical staff.

The proposed system in the present project contains several components (Figure 1):

1. Patient graphical Interface (PI);
2. client-server application with Patient Monitoring (PM);
3. Tele-Consultations (TC);
4. Analysis and Statistics (AS) module;
5. Network Management (NM) module;
6. Specialized Medical graphical Interface (SMI);
7. Interface with medicines Distribution device (ID);
8. Web and Data Base Server (WDBS);
9. Data Base Management System (DBMS);
10. Patients Data Base (PDB)

Everyone of the components is developed in such a way that every one assures the easy access to the application from the patient and from the medical staff point of view, according to the EHR standards.

Functional requirements imposed by the telematic and tele-medical systems are fulfilled and they implies:

- the interactivity with the patient in case of need;
- the autocontrol at patient and medical staff level;
- data transmission between the actors involved in the system (patient, specialized medical staff, Assurance Medical House);

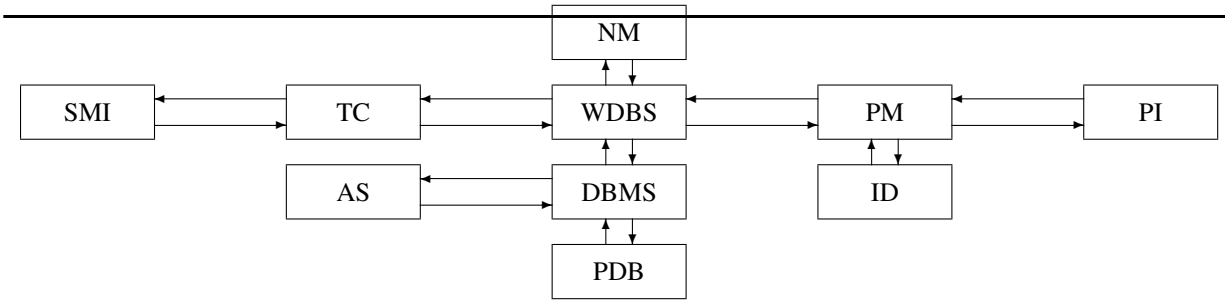

Figure 1. The architecture of the intelligent client-server: Patient graphical Interface (PI), client-server application with Patient Monitoring (PM), Tele-Consultations (TC), Analysis and Statistics (AS) module, Network Management (NM) module, Specialized Medical graphical Interface (SMI), Interface with medicines Distribution device (ID), Web and Data Base Server (WDBS), Data Base Management System (DBMS), Patients Data Base (PDB).

- tele-advices;
- medical reports;
- electronical medical recordings;
- security and control.

The implemented solution uses the distributed system paradigm. The design solution which is adopted is based on the principle of personalizing the graphical user interface, at patient level, specialist medical man level, and system administrator level, but also provides the availability of the interconnections with other systems by the virtual organizations principles and by GRID systems.

IV. IMPLEMENTATION OF COMPONENTS OF THE SYSTEM

First we should note that the algorithms through which the medicines and posologia are chosen, and also the statistical analyze of the obtained results are realized in accordance with the international standards by the research medical team. Due to the fast medical man-patient communication, and also because there is no need of the movement of the medical team to the patient's home or periodic going to the hospital for the patient the costs for hospitalization and treatment will be reduced considerable.

In the design of every from the components of the system, the goal is to choose more solutions, such as in accordance with the concrete situation of the patient or with the patient's home location to be able to implement the most efficient solution. For example, where the internet access is not able, the intent is to take into account a GPRS solution also; the interface for the medicaments control will take into account de variety of the dose equipments, and also the using of a simple, but safe protocol. For designing the patient-system interface we will take into account the variety of the patients, some of them haven't experience in using the intelligent terminals or having precariousness seeing. This will lead to personalized interfaces.

The application based on a multilayered architecture is responsible with communication between server and multiple clients. The client application sends to the server information from patients or physicians and it receives from the server commands to be transmitted to the interface of the medicine hopper in case of a patient or it receives various reports and statistics in case of a physician. The server-client communication uses a special communication protocol based on EHR (Electronic Health Record) standards. At patient's request the client application opens also a voice and video enabled connection to the medical interface that offers, in this way, multiple functionality and creates a better communication between a patient and a physician.

The server application provides the communication management for all the system and grants secured access for the patient and for the physician. Depending on the information received from the patient, the server establishes the necessary medication using well-determined rules and protocols. After this processing, command signals are transmitted towards the client application used by the patient which controls the medicine hopper that gives the necessary quantities.

The server application, also, takes care of the database with the patients which stores confidential data and information about treatments and progress of the disease. At physician's request, the system generates various useful reports and statistics regarding the treatment efficiency. The communication protocol used is based on TCP/IP. Components of the system have their own IP address. The physical data link can be the public internet or a VPN (Virtual Private Network) - for a secured connection. In case of malfunctions with the main communication line, the system goes through a GPRS connection.

The graphical user interface for the patient (Patient Interface or PI) offers easy access independent of the educational or professional level of patient. The best access device is a touch-screen LCD display connected to a computer powerful-enough to implement on it complex software solutions and, also, offering various interfaces for peripherals like webcam, fingerprint scanners, PDAs.

The application runs a monitoring module (MM) with a security component based on authentication by fingerprint scanning using an attached device and comparison with stored versions in the database. The application collects data from the patients using a graphical mode: the patient indicates step by the step the problem by showing the region of the pain, the intensity of the pain, and the period of the time since the pain appeared. All this data is transmitted to the tele-medical evaluation module (TM). The collected information forms a packet that is sent to the client modules and then stored on the server module that contains a SGBD component.

On the display, the first image that appears is a human body on which the patient indicates by pressing the touch-screen the region of the pain. Then, he/she selects on a scale the intensity of the pain and in the end he/she points in a table the duration of the pain. The patient has the option to open a video-voice channel through which he/she can communicate directly with the physician by transmitting verbal and visual useful information.

The graphical user interface for the physician SMI offers secure access in the system by authentication using a

password. The physician can access all the data obtained from the patient in the treatment period and he/she can have in this way a clear image of the disease progress and the prescribed medication. This data can be used to generate reports and statistics very useful for studying some diseases or special cases.

The graphical interface for the physician aims to offer fast access to the data and fast statistical computation and presentation. The physician's interface runs on computers with internet connection to the server application offering, also, the possibility to open/accept a video-audio connection from the patient. If the physician considers that it is necessary, he/she can send direct commands to the medicine hopper which runs at patient's home.

The interface with the medical dosimeter ID must distribute the medicines in a safe and secure way, so that unauthorized persons cannot have access to them. This goal is obtained using a secure access to the system via biometric data and through a robust construction for the dosimeter. The interface with the medical dosimeter consists of hardware equipment containing a programmable microcontroller so that it can be adapted to different types of dosimeters. The interface receives commands from the server via client application from the patient and these commands are interpreted in order to get the required medicine drugs.

V. ABOUT FEASIBILITY AND MAINTENANCE ISSUES OF THE SYSTEM

Although the project's thematic represents a national first attempt, it will incorporate concepts and recent discoveries from the tumor clinics and pathologic in the algic process physiopathology. The acquiring of some results with application in the therapeutic practice would have a favorable effect on the population state health.

The project suggests the research of the pain control at the neoplazic patients. The pain control is achieved by opioid medication and the total elimination of the possibility of unauthorized utilizing of the psychotropic and narcotic substances. The benefic effects of the opioid substances consuming in the chronical pain therapy appeared in chronical (malign or not) disease can be of several types:

- the reduction of the pain intensity;
- the reduction of the used dozes;
- the noticeable increase of the quality of life for these patients;
- the treatment of the persons depending on narcotics consumption.

It is expected that the obtained results will allow the implementation of an efficient solution of monitoring, assisting and treatment of the neoplazic patients which used the opioid medication, at home, and will also allow the improvement of the care for them.

The project presents a great complexity degree and includes a lot of aspects which need the performing of a unitary integration between the medical, electronics, statistics, artificial intelligence concepts and different distribute systems design solutions. The design process and the realization of the intelligent system is a heavy task and its experimentation impose an attentive observing and intensive collaboration.

The technical complexity is given by the data registration manner, the interactivity doctor-patient solution, the electronic transmission, the data security process and the correlation between clinical observations and the analysis results. There should be a strong collaboration between specialized medical doctors in the treated domain and scientific researchers with different professional profile: electronics specialists, multimedia applications, distribute systems design for security and confidentiality reasons for the wireless systems. High performing equipments will be used, together with European standards laboratories and modern design solutions with respect of the international tele-medicine standards.

VI. CONCLUSIONS AND FURTHER DEVELOPMENTS

In this paper we have presented the design and parts of the implementation of an intelligent client-server structure through which the neoplazic persons that use the opioid medicine to be monitorized and assisted at home, and also to efficiently intervene to lend the essential assistance. The patient has at his/her disposal an interface which allows the transmission of some information regarding his/her healthiness through a reception server.

Appropriate increases in the use of information technology in health care - especially the introduction of clinical decision support - could result in substantial improvement in patient safety, especially in this case for neoplazic persons which used the opioid medicine.

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