

PalliaSys: Agent-Based Palliative Care

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Abstract—This paper presents the main ideas underlying the work which is being developed at the Spanish research project *PalliaSys*, in which both *Multi-Agent Systems* and *Information and Communication Technologies* are being used to improve the management of the clinical data of palliative patients. A prototype of the system will be tested at the *Palliative Care Unit of the Hospital de la Santa Creu i Sant Pau in Barcelona*.

I. INTRODUCTION

An *agent* is a software entity that applies Artificial Intelligence techniques to choose the best set of actions to perform in order to reach a goal specified by the user. It should react in a flexible, proactive, dynamic, autonomous and intelligent way to the changes produced in its environment. A *multi-agent system* ([1], [2]) may be defined as a collection of autonomous agents that communicate between themselves to coordinate their activities in order to be able to solve collectively a problem that could not be tackled by any agent individually. Nealon and Moreno ([3]) have argued that the main properties of agents (autonomy, proactiveness, sociability, reactivity) make them appropriate to tackle problems in the health care area, since they usually have the following features:

- The knowledge required to solve the problem is spatially distributed in different locations.
- Several entities, while keeping their autonomous behaviour, have to join their problem-solving abilities to be able to solve a complex problem.
- The problems in the domain may be decomposed in different sub-problems, even if they have some kind of inter-dependencies.

This argument is supported by the fact that there are many recent papers on the application of agents in health care (see e.g. [4], [5], [6], [7] and [8]). In this article we provide an example of the use of agents in a medical setting, which extends [9]. We describe the first steps of the Spanish research project *PalliaSys*, in which agent technology and information and communication technologies will be used to improve the management of the clinical data related to the palliative patients of the *Hospital de la Santa Creu i Sant Pau*.

The paper begins with a description of the tasks within the Palliative Care Unit of the hospital. In section III we explain the architecture of the multi-agent system which is being implemented, and the basic types of agents that it includes. After that we comment the services provided by the system. The paper concludes with a brief discussion and an outline of future lines of work.

II. PALLIASYS PROJECT

The main objective of the *PalliaSys* project is to design and build a prototype for helping the personnel of the *Palliative Care Unit (PCU)* of a big hospital. This unit is specialised in dealing with people with terminal illnesses, and its aim is to ease their pain in the final phase of their lives. A person can be included in the list of patients of a PCU with different degrees of illness and suffering. Depending on the initial medical diagnosis the patient can be treated in one of the following places:

- In *one of the beds of the PCU*. The number of beds available for this purpose is usually quite reduced (e.g. there are only 10 beds at the PCU of the Hospital de la Santa Creu i Sant Pau). Thus, only patients that must be under continuous monitoring can occupy these beds.
- In *another unit of the hospital*. This situation occurs if the patient has some illness that is usually treated by another unit. For example, a patient that suffers from cancer can stay in the Oncology unit of the hospital.
- In *socio-sanitary hospices*, which are medical centres specialised in dealing with patients that need palliative care for a long time.
- *At home*. If the family of the patients can take care of them, and the patients do not require continuous medical attention, then they are allowed to stay at home.

The Palliative Care Unit must provide the best possible care to all the patients, regardless of where they stay. Many people with different roles are involved in the supervision and medical control of these patients: the PCU doctors, doctors associated to other units or to a socio-sanitary hospice, the medical teams that make visits at the patients' homes, the informal carers (relatives, neighbours, friends) of the person, and the patient himself. The work done by these people depends on the situation of the patient. We will distinguish those patients that are at their own home from those that are staying in some hospital or medical centre. The *PalliaSys* system is specially addressed towards the former ones, so that they will have the possibility to access some services from their homes.

All patients must be visited regularly. Some of the patients that are living at home go to the Palliative Care Unit of their hospital in order to be visited by a doctor. There also exists an auxiliary medical team that can send a doctor to the home of the patient to visit him, if his mobility is reduced and he cannot go to the hospital. In Catalonia this auxiliary medical team is called *PADES* (from the Catalan acronym of *Home Attention Program - Support Team*).

Patients that are hospitalised in any unit of the hospital (specially including those in the rooms of the PCU) receive regular visits of the medical personnel of the PCU. However, those patients that stay in some other medical centre receive the medical care from the personnel of this centre instead of the members of the PCU. Therefore, these doctors must communicate any important change in the evolution of the patient to the responsible doctor of the PCU in order to be able to follow his status.

Due to the highly distributed character of palliative care, it is really interesting to have a computer system that allows the exchange of information among the medical professionals that participate in the treatment of a patient. Moreover, a system like *PalliaSys* may help the people of the PCU to coordinate and control all the processes that are taking place related to their patients. In the next subsection, we explain the different steps that are followed in the treatment of any palliative patient.

A. Steps in Palliative Care

The medical record of the palliative patient is initialised in his first visit to the PCU. It includes personal information (name, address, phone, religious beliefs, ...), family data (marital status, number of sons,...), which illness is the cause of the need of palliative care, and any medical information about previous treatments related to this illness.

The following visits are always preceded by the filling in of an *auto-evaluation form*. In this document patients have to rate (with a value between 0 and 10) ten different subjective aspects related to their health: the degrees of pain, weakness, depression, anxiety, vomit, sleepiness, hunger, well-being, breathing problems and dried mouth. If the patient is not able to enter this information, then another person can do it on his behalf (e.g. a relative or a personal carer). During the visit, the doctor will check all the values and will complete them with his personal opinion about the same concepts. In addition, the doctor will also evaluate the so-called *complexity criteria* (personal characteristics of the patient, special medical problems, therapeutic strategies, family issues). Finally, the doctor can decide to take any of the following actions:

- To order some extra clinical tests.
- To continue the same medical treatment or to modify it.
- To schedule another visit for the future.
- To recommend that a PADES is sent to visit regularly the patient at home.
- To change the location of the patient (for example, hospitalise him in a socio-sanitary hospice if his health has deteriorated too much).

All the information that the PCU receives about a patient (provided by the PCU doctors, PADES or other doctors) must be kept in a centralised medical history in the PCU. At the moment, sometimes it is difficult for external personnel to access this data easily and timely, because it is written on paper and kept in the PCU filing cabinets.

Due to the characteristics of palliative patients, the last step of their care consists of registering the data related to the death of the patient. The doctor in charge of the person completes a form with information about the drugs that the patient has taken to ease his final pain, the role of the family, etc.

B. Goals of the PalliaSys Project

One of the basic aims of the *PalliaSys* system is to improve the process of gathering and collecting the information of the palliative patients. The data will be stored in a central data base located at the PCU of the medical centre. The system will provide access to those medical data to the users that participate in the care of a palliative patient (different kinds of doctors, and the patient himself).

On the one hand, patients that live at home will be able to see the details of their last prescription, to change some personal data or to arrange the date of the visit with the doctor without having to move from their home. On the other hand, all the doctors involved in the care of a patient will be able to see and modify his medical record from any place and at any time.

To provide this access to the data, it is very important to consider the new communication technologies. We are considering three different tools: mobile phones, personal digital assistants (PDAs) and computers. For example, when a PADES doctor visits a patient at his home, a PDA can be used to retrieve the medical record of the patient and to modify it with the result of the new examination. Patients that live at their homes can fill in the auto-evaluation forms using a mobile phone or a computer. Finally, traditional computers are going to be

used by the doctors of the PCU to access the data of the patients that are examined in the medical visits that are done at the hospital. It must be stressed that proper measures will be taken in any of these ways of communication to ensure the security and privacy of the medical information ([10]).

The second goal of the project is to improve the information at disposal of doctors and patients. Using a multi-agent system we will be able to continuously monitor the status of each of the patients and provide more structured information to the doctor. For example, the patient can regularly fill in the auto-evaluation form without having to wait to have a visit with the doctor. The form can be analysed by an agent, who automatically notifies the doctor if some problem is detected (for example, a big change in values given by the patient to some symptoms). If no urgent problem is detected, the auto-evaluations will be stored and a proper report will be sent to the doctor periodically.

Following some ideas proposed in the emerging *Ambient Intelligence* paradigm ([11]), we have also considered the possibility of receiving data from some sensors installed in the bed of each patient in the PCU. With this information, a specialised agent could monitor the state of the patient and regularly send reports to the doctor. This issue will be studied in the last stage of the project.

Finally, another longer term goal of *PalliaSys* is to apply data mining and machine learning methods to make an accurate intelligent analysis of the historical data gathered in the PCU. For instance, we can study the evolution of certain symptoms or treatments along time, define different patient models according to their evolution, or obtain valuable information about the reasons given to change the location of the patients. At the moment, the coordinators of Palliative Care Units do not have any information of this kind.

C. Current Status of the Project

The *PalliaSys* project will run from December 2003 to November 2005. Some preliminary work ([12]) has already been done, with the design and implementation of an information system for the doctors and patients of the Hospital de la Santa Creu i Sant Pau. This system automates the access and modification of the medical patient record, which until now was always done manually. The prototype can be accessed by doctors and patients through a web page in Internet or wirelessly using the WAP technology. This work corresponds mainly to the first goal mentioned in the previous section. We are in the first stages of the implementation of the multi-agent system that will provide additional intelligent functionalities to the patients and doctors. This system is the main topic of the rest of the paper. The third goal, the automatic extraction of useful information with data mining techniques, is left to a more advanced stage of the project.

III. MULTI-AGENT SYSTEM ARCHITECTURE

In this section we describe the *PalliaSys* system and its different components. The basic architecture of *PalliaSys* is shown in fig. 1 on the next page.

Two main parts may be distinguished within the system:

- 1) *Information and Communication Technologies* (for instance mobile phones, portable computers, PDAs), which will be used either by patients at their homes (to provide medical data, send requests or receive information from doctors) or by doctors making visits at the patient's home (to look up the medical record and update it with the results of the last visit).
- 2) A *multi-agent system*, that will be used to manage the clinical data of palliative patients, monitorise the status of the patients or analyse the patients' evolution.

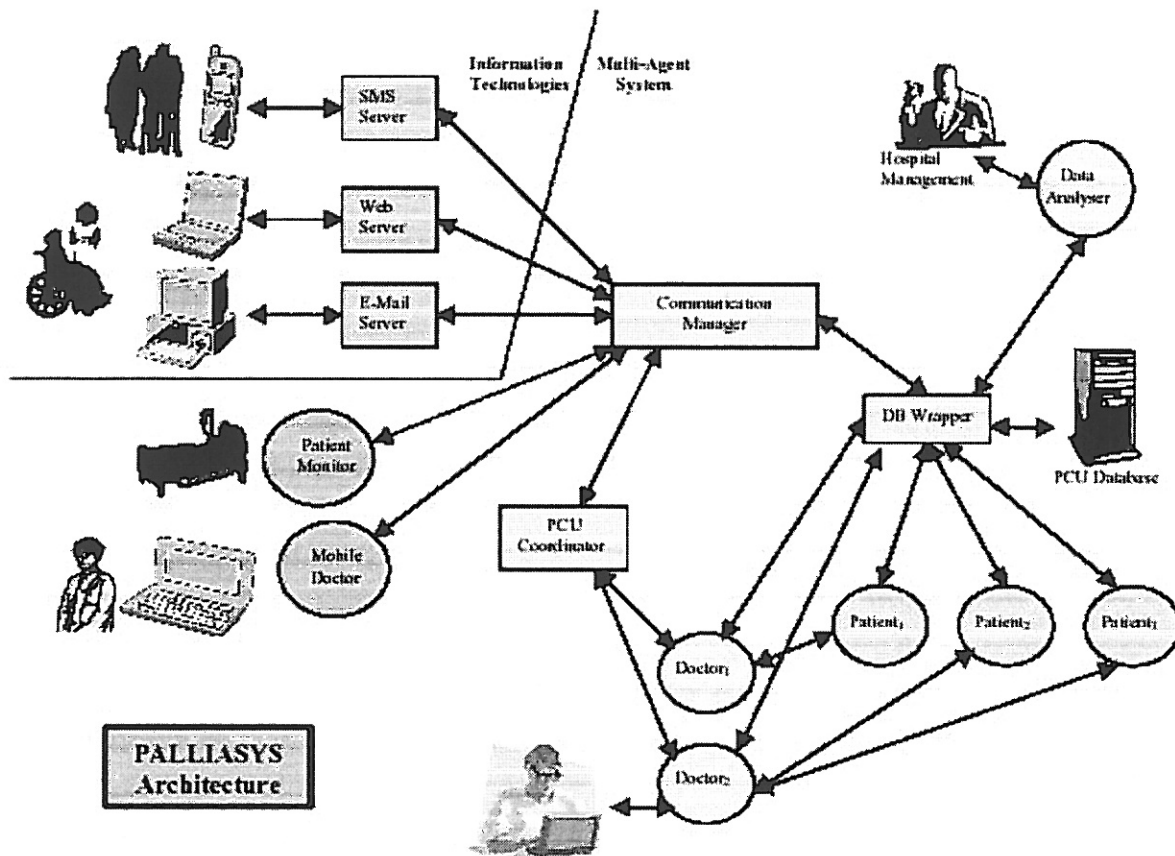


Fig. 1. Architecture of PalliaSys

The multi-agent system contains agents of the following types:

- The *Communication Manager*, which is the responsible of providing an interface between the agents of the multi-agent system and the servers that deal with different types of information technologies. It will receive the information from patients (auto-evaluation forms, requests) and will send this information to the appropriate agents in the system. It will also receive all the information that has to be sent to a patient (e.g. a reminder of a scheduled visit to a doctor at the PCU) and will deliver it using the communication technology selected by that patient. In a later stage, it will also receive the information from the sensors that monitor the state of patients and from the mobile doctor agents running on PDAs.
- The *Data Base Wrapper*. This agent controls the access to the data base of the PCU, in which all the information of the palliative patients is stored. It will receive all the data that has to be stored in the data base, as well as all the requests of information. It will include authentication mechanisms that ensure that only properly authorised agents can read or modify the clinical data (in the line of those suggested in the *HeCaSe* system, [10]). Some preliminary security mechanisms, such as the definition of different kinds of users, the assignment of different permissions to each of them, the use of logins and passwords, the encryption of messages using a public key infrastructure and the use of SSL (*Secure Socket Layer*) have already been implemented in the first prototype ([12]).
- One *Doctor Agent* for each doctor of the PCU. This agent will be executing in the desktop computer of the doctor. It will have a graphical interface that will allow the doctor to easily obtain the information of his patients, request information from the data base, control his schedule of visits, or see if the system has raised any alert regarding the deterioration of the health of a patient.
- The *PCU Coordinator*. This agent provides the interface between the *Communication Manager* and the *Doctor Agents*. It should know which doctor is associated to each patient, and use this knowledge to forward all the data relevant to a patient to the responsible doctor. For instance, if a patient who is living at home wants to book a visit to his doctor at the PCU, it can send this request to the *Communication Manager*. The *Communication Manager* would send this request to the *PCU Coordinator*, who would send it to the *Doctor Agent* associated to the doctor that is responsible of that particular patient. This agent would find an empty slot in the doctor's schedule in which he can make the visit, and this information would be sent to the patient following the same path.
- One *Patient Agent* for each patient. Each of these agents is responsible for continuously monitoring the evolution of the patient. These agents can make sure that the patient sends the periodic auto-evaluation reports concerning his health status; they can also send reminders to the patient if they forget to send their reports on time or if they have a scheduled visit by a

doctor. If the *Patient Agent* detects any problem (e.g. the degree of pain has increased heavily in the last auto-evaluation), it can send a warning to the *Doctor Agent* responsible for that patient, so that appropriate measures (e.g. a phone call or a visit to the patient's home) are taken.

- The multi-agent system also includes an agent, the *Data Analyser*, specialised in Data Mining, Knowledge Discovery and Machine Learning techniques. Its main task will be to perform intelligent analysis of the evolution of the patients and uncover interesting and useful medical knowledge. Some specific studies that this agent could make are commented on section IV-C. Some preliminary work on the analysis of the flow of patients within different units of a hospital may be found in [13] and [14].
- The PADES teams, that make visits to the palliative patients at their homes, will use PDAs in which a *Mobile Doctor Agent* will be running. This agent will be able to access the data of the patient before the visit, or update it after the examination has been performed. These tasks will be executed by sending wirelessly appropriate messages to the *Data Base Wrapper* through the *Communication Manager*.
- As mentioned before, in a longer-term perspective we will possibly introduce *Patient Monitor Agents*. These agents would be attached to each bed of the PCU, and they would continuously monitor the status of the patient and capture important information so that it can be stored in the patient's clinical record or sent immediately to the doctor if some unexpected value is detected.

IV. SYSTEM FUNCTIONALITIES

This section provides a list of the functionalities that the system offers to each type of user, with a brief description of each of them.

A. Services Available to Patients

The following services are addressed towards those palliative patients that live at their homes. All these services might be used either by the patients themselves or by their carers. The access to the system will require a login and a password, which will be provided to each patient in his first visit to the PCU.

1) *Patient Auto-evaluation*: It has been explained in section II-A that there are many palliative patients that live at their homes, under the care of relatives or friends, and that these patients are requested to send periodic reports (*auto-evaluations*) of their health status to the PCU of the hospital. With the use of *PalliaSys* patients will be able to send these reports through a form available at a Web page or using a mobile phone, via WAP. The evaluation will be received by the *Communication Manager*, that will forward it to the *Data Base Wrapper* so that it is stored in the patient's clinical record. The *Communication Manager* will also send the evaluation to the *PCU Coordinator*. This agent knows the doctor that is responsible of each patient; therefore, when an evaluation is received, a request is sent to the *Doctor Agent* associated to that doctor, in order to complete the evaluation with objective expert criteria.

2) *Access to Personal Data*: The system will provide access to the patients to some personal data of their medical record. On the one hand, the user will be able to look up and modify the information related to his contact details (address, phone, e-mail), his family situation or his personal carers at home. On the other hand, the patient will also receive information provided by the doctor. For example, complete details about the medicine prescriptions will be given to the user (name, dosage, frequency), as well as any other kind of

comments that the doctor considers that the patient must take into account for pharmacological and non-pharmacological treatment (e.g. advises about the life style the patient must follow, physical exercise proposals, remarks about hygienic and eating habits).

To perform any of these actions, the *Communication Manager* will receive a notification from one of the communication servers (e.g. the Web server or the WAP server). The request will be sent to the *DB Wrapper*, which will query the data base or make the modification requested by the user.

3) *Patient Monitoring*: Sometimes it is interesting to send some alerts to the patients that are at home. These alerts will be preferably sent to a mobile phone, because this is the most immediate way of communication with the patient nowadays. Alerts can be activated directly by doctors if they want to send some urgent information to the patient. For example, *Doctor agents* can send a reminder to all the patients that have arranged a visit for the next day, or the doctor may suggest to the patient that he should make a visit to the hospital in the next days if the agent detects (by studying the auto-evaluations or by reading a report of a home visit made by a PADES team) that the patient's status has worsened too much in the last days. In addition, as it has been explained in section III, each palliative patient has his own *Patient agent*. These agents are in charge of monitoring the status of the patient and make sure that the patient health is not deteriorating too quickly. In order to achieve this goal, *patient agents* will receive different information by way of the *Data Base Wrapper*. Their basic source of up-to-date information will be the auto-evaluations made by the patient. Since doctors will only check the auto-evaluations from time to time, the *patient agent* can make a continuous control of the values given to the different aspects of the evaluation. If any parameter is out of the expected range, an alert will be sent to the corresponding doctor. Something similar can be done with the information provided by the *Patient Monitor* agent, that is sending information from the sensors that control a hospitalised patient. Finally, the *Patient agent* can also send to the patient a request for filling in an auto-evaluation form if the patient has failed to do it in the expected period of time.

4) *Visit Scheduling*: We are studying the possibility of allowing a patient who wants to set up a visit with his PCU doctor to make all the necessary arrangements with *PalliaSys*. The *Doctor agents* can maintain a daily agenda with the list of patients to be examined. If any palliative patient wants to arrange a visit, the *Communication Manager* will receive the petition and send it to the *PCU Coordinator*. This agent knows who is the doctor responsible for the patient that has sent the request, so it can forward the request to the corresponding *Doctor agent*. This agent can check his agenda and send some proposals of time slots for doing the visit (these slots will be temporarily blocked until a final selection is made). When these proposals are displayed to the patient, he can choose the most appropriate and then the *Doctor agent* includes this new visit in his agenda, and the rest of time slots are unblocked. A similar booking procedure was already implemented in *HeCaSe*, another agent-based medical system developed by our research group ([15]).

B. Services Available to Doctors

The following functionalities will be used by the doctors of the PCU, who will also need a personal login and a password to access them.

1) *Review of Pending Auto-evaluations*: Before the visit of any patient, his doctor must review the auto-evaluations provided by him. The *Doctor agent* will obtain this information from the *Data Base Wrapper*. Then, to ease the work of the doctor, the agent will

generate a report that includes all the information about the pending auto-evaluations. For example, this report may include graphical representations of the evolution of the values given to the different aspects (weakness, anxiety, hunger, etc.).

When the visit is going on, the doctor will complete his evaluation of these symptoms and will introduce any other information related to the patient's health status (e.g. therapeutic strategies to be followed). He will also record any decision taken at that point (e.g. to change the location of the patient, or to change the treatment). All these data will be automatically stored in the database by means of the *Data Base Wrapper*.

2) *Access to the Patient's Medical Record*: Each doctor is in charge of a group of patients of the Palliative Care Unit. The *Doctor agent* knows which are those patients and displays any information about them that the doctor requests (personal information, family information, diagnosis, treatments, evaluations, previous visits, etc.). The data is provided by the *Data Base Wrapper agent* after making the appropriate query to the PCU database. This information can be automatically retrieved by the *Doctor agent* before the visit of a particular patient, taking into account the doctor's agenda (this mechanism was also used in the *HeCaSe* system, [15]).

During a visit, the doctor usually adds items or modifies the patient's medical record. For example, he can change the medical prescription or the location of the patient. *PalliaSys* will also allow the doctor to make these modifications and keep an electronic up-to-date medical record at all times.

3) *Communication with Patients*: During a visit the doctor can indicate to the patient that he should fill in some auto-evaluations during a period of time, or he can schedule the following visit for a particular date. This information is sent to the corresponding *Patient agent*, which will send an alert to the patient if he fails to submit the auto-evaluations at the proper dates or he does not show up to the scheduled visit.

4) *Reception of Alerts*: As told in IV-A.3, *Patient agents* are continuously monitoring the medical record of the patients. If any of them detects some abnormality during the analysis of a clinical record, an alert is sent immediately to the appropriate *Doctor Agent*. The message will be displayed in the monitor in order to alert the doctor.

5) *New Patient Admission*: When a new patient arrives to the PCU a new record is generated in the PCU database, and a doctor is assigned to him. The system distinguishes between several new patients: there are patients that arrive directly to the PCU when their terminal disease is diagnosed for the first time, there are other patients that come from other specialised services in the same hospital (e.g. oncology, internal medicine, etc.) or those patients which are moved to the PCU from other hospitals where they may not be properly attended. In the first case, there is not a medical history of the patient and the doctor in the PCU uses to order several medical tests in order to define the patient profile and features. This information cannot be incorporated immediately to the patient record, and the process is delayed until the results of the tests are available. In the system, the *Doctor agent* notifies to the corresponding *Patient Agent* about all the tests needed. Then, the *Patient Agent* is aware of asking periodically to the *Doctor Agent* about those test results. In the last two cases, the disease of the patient was detected before he arrived to the PCU and some previous medical information is already available. When the *Doctor Agent* receives these data, it sends all the information to the *Data Base Wrapper* and it is stored in the PCU database.

6) *Patient Discharge*: When a palliative patient dies, there are several terminal data that have to be added to the patient record so

that the social agents can prepare the final arrangements and possibly provide appropriate family assistance. This information concerns the late palliative medication of the patient, the final reactions of the patient and the family, some data about the patient beliefs, etc.

C. Services Available to the PCU Manager

The multi-agent system contains an agent called *Data Analyser*, which has two basic roles:

- The head of the Palliative Care Unit has the administrative duty of writing an annual report detailing all the activity of the unit within the last 12 months. This work has been always done manually, and it is very time-consuming. The *Data Analyser* should provide the manager with all the information he needs to fill this report (figures, statistics, comparisons with previous years, etc.).
- The *Data Analyser* should be a specialist in data mining, knowledge discovery and machine learning algorithms, so that it may access the data of the palliative patients stored at the centralised data base and analyse this information. This agent could define *patient models*, using unsupervised machine learning techniques such as clustering. It could also analyse the medical evolution and the flows of different types of patients, and create *models of these evolutions* that allow to make predictions on the future states of patients (e.g. it could anticipate that the state of a patient will deteriorate too much in a few weeks, and recommend the adoption of preventive measures). These models might be created using techniques of inductive machine learning (some previous works on the analysis of the flow of patients within different units of a hospital are available in [13] and [14]). We also intend to develop algorithms that can construct automatically *medical protocols*, from the models of patients and evolutions obtained in the previous steps (a first step in the construction of medical guidelines is done in [16]).

The functionalities offered by the *Data Analyser* will only be available to the head of the Palliative Care Unit. Two important and powerful tools that the data analyser agent will supply to the PCU manager are the following: on the one hand, it is possible to study the patient flow through the different care units; on the other hand, we can make an analysis of the medical evolution of the patients.

D. Services Available to PADES Teams

The PADES are the medical teams that perform examinations at the patient's home, rather than in the hospital. They do not depend from the hospital, but from the Catalan Health Service. However, they could interact with *PalliaSys* in the following two ways:

- Before the visit to the patient, they could access his medical record and study his diagnosis, treatments, evaluations and visits in the last months. In this way the doctors of the PADES team would have enough information about the patient (without having to spend many time asking all this data to the patient or their carers), and they could take the maximum profit from the examination.
- After the visit they should be able to update the medical record of the patient with the result of the last visit, or communicate any important aspect of the visit to the responsible doctor.

In *PalliaSys* we propose that the doctors of the PADES teams might carry a PDA with them, and a specialised agent, called *Mobile Doctor Agent*, could be executing on the PDA. This agent could send messages wirelessly to the *Communication Manager* in order to request the data of a patient or send the report of the last visit.

The *PalliaSys* project will deliver an agent-based system that will be deployed at the Palliative Care Unit of the Hospital de la Santa Creu i Sant Pau of Barcelona, Spain. Each year there are 500 new patients in this unit, and they can provide auto-evaluations on a weekly basis. Therefore, the quantity of data to be managed is quite large, and the automation of its processing will undoubtedly be welcome by the medical personnel of the PCU. Doctors (from any unit where palliative patients are staying) will have an easier access to the information of the medical records, and they will have up-to-date medical data and more time to devote to each patient. The multi-agent system has been specially designed to take into account the distributed nature of the treatment of palliative patients (a usual characteristic of the problems in the health care domain, as argued in [3]).

We are not aware of any previous work in which agent-based systems have been applied to the treatment of palliative patients. However, other works have indeed considered the use of autonomous agents in similar problems. For instance, in the *HeCaSe* multi-agent system patients may remotely request an appointment to be visited by an specialised doctor, and medical records are maintained in a centralised data base and updated dynamically when an examination is performed ([15], [17]). The German *Agent.Hospital* project is concerned with the development of an agent-based framework for distributed applications in the health care domain ([18]). Mazzi et al. have proposed ([19]) the use of agents in healthcare applications, including *personal assistants* that provide an interface with users and *patient monitoring agents* that monitor the state of patients, detect situations that trigger alarms, and contact the responsible doctor if necessary. The access to hospital information systems through agents running in PDAs has been proposed by other authors (e.g. [20]). There are many works on ambient intelligence, and some of them postulate the use of agents associated to sensors in hospitals (e.g. [11]). Taking into account that most palliative patients stay at their homes, it could be interesting to study the possibility of integrating *PalliaSys* with the multi-agent system INCA (*Intelligent Community Alarm*), in which there are agents that help to manage all the activities involved in community care ([21]).

Our future work in the *PalliaSys* project includes the following tasks:

- The definition of machine learning and data mining techniques that may be applied by the *Data Analyser* to uncover interesting information about the evolution of palliative patients or the general management of the PCU.
- The study of the implementation of *Mobile Doctor Agents* on mobile devices such as PDAs, so that the doctors of the PADES teams may remotely access and update the medical records of the patients when they are making the clinical examinations at the patient's home.
- The improvement of the security measures of the system, so that only properly authenticated and authorised agents may access the information of the patients of the PCU.
- The implementation of the *PalliaSys* system using the *JADE* development environment, that provides a set of Java libraries that ease the implementation of FIPA-compliant multi-agent systems, [22].
- The deployment of the multi-agent system in the Palliative Care Unit of the Hospital de la Santa Creu i Sant Pau, and its trial with the real palliative patients and medical personnel.

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