Integration of the Cognitive Knowledge of Activity in a Service Oriented Architecture in the Home Care Context

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Abstract.

The complex nature of a home care (HC) situation induces an important need for cooperation between the health care professionals. But even if this need is sometimes evoked in reports on HC issues, it is more difficult to get precise knowledge on this cooperative activity, and, consequently, propositions for computerized HC organization and management systems. We did some researches on this topic area. Previous phases of work let us highlight the actual need for cooperation, and obtain precise information on the HC activity processes and data. In this paper, we focused on the integration of this cognitive knowledge on the design of a HC cooperation architecture. Different levels of requirements for the cooperative system are mentioned: coordination, communication of information, delegation of activity, integration of services and personal access to the tasks to perform. A description of the usefulness and use of the cognitive knowledge is proposed, the architecture design, modular, distributed, and able to integrate external services is presented, and the results of a validation test of the implemented prototype, performed with actual HC professionals in an evaluation laboratory are presented.

Keywords:
Medical information technologies; Cooperation; Coordination ; Information; Communication; Homecare

1. Context

The need for the Home Care cooperation.

Most countries encounter an increase in the number of elderly people and the importance of HC services in the follow-up of chronic diseases or end-of-life situations [1,2], and at the same time, encounter major problems with health care costs and ratios of Health Care professionals. So, improving HC as an alternative to classical hospitalization appears as one of the main challenges for the 21st century. Good coordination of healthcare professionals is known as an essential element in quality health care. In HC settings, the improvement of the cooperation of workers becomes highly essential : first we observed that most of the requirements of the HC workers deals with the organization and management of the homecare system, second that HC induces a complex cooperation. A flexible and temporary therapeutic team works with rare common meetings, in asynchronous way, and includes new actors such as family, coordinator and equipment providers. In the context of
Homecare, researches are mainly focused on the ability to improve the follow-up of the patient or invent some distant care via less or more sophisticated tools such as video camera, captors, intelligent houses; some control on the medication via intelligent pill boxes, and so on. [3,4,5,6]. Different reports relate the importance of homecare cooperation to improve the continuity of care between acute and home care and the improve the quality of home care[7,8]. But home care applications able to manage cooperation are still rare.

So we decided to perform a cognitive analysis of the homecare process and to use the results to model then implement and test a prototype: the Home Care Cooperation Platform. Previous papers detail our analyses[9,10], so they are presented very briefly. In the current paper we present the requirements for the architecture, we focus on how we used the description of information in such a system and how we modeled the activity management, so that distant applications could be launched and visualization of the processes could be used. Then we describe the first tests which were performed and discuss about the associated results.

**Analysis of the Home Care processes.**

We realized a cognitive analysis of the HC activities in order to define the main requirements for the development of a computerized tool for HC. We got different results:

1°) Description of the processes of HC: HC is built from two processes, i) the logistical process: decision for and organization of HC, supervised by coordinators, ii) the care process which manages the therapeutics activities.

2°) Description of each phases of both processes.

3°) Description of the information used and on the way it is used.

**Some requirements for the home care architecture.**

To improve the coordination of HC, one HC application (i) has to provide an easy access for all the HC participants given that it may be used by different workers, with different devices, at different places; (ii) has to help the participants to organize and launch the complex coordination activities (iii) must be capable of linkage to different and distributed applications, and may be called upon to interconnect different information systems (IS): hospital IS, GP’s IS, laboratory IS, etc.; (iv) has to provide secure exchanges of data. We refined these requirements using our cognitive analyses to select some strong requirements for the HC system:

- **Coordination** - Proposing a coordination tool that could inform about the state of the HC processes: what are the performed tasks and what are the known information, could help the HC workers to control these processes. For the health care providers, it is highly important to maintain a common frame of reference about their patients. Care workers should also find some information or some help on what tasks are to perform and how to perform it. It is really important to propose such help in the social context of HC: due to a lack of experienced and very well organized HC organization, and due to the increase of HC needs, it could happen that unused people are devoted to the organization on the HC.

- **Delegation of activity** - Proposing some way to delegate the activity. It is well known that one individual could not know all the information about the patient or on what to do, and one important activity of the coordinators in HC situation is to ask some information to other people (GPs, hospital physicians, family) until they could gather enough data to organize the care in good conditions. Nowadays, most of such delegations or requests are made through phone calls, but phone calls are often disruptive and, as they are synchronous, the availability of both caller and requested people is needed. It is possible to use a computerized system to delegate some activities to other people. For example, it seems relatively easy to send a
request to the GP so that she/he could give some complementary information on the medical history of the patient.

- **Communication of information.** Medical information comes from different Information Systems, different people, and it should be communicated in a secure manner and be easily integrated in the HC information systems.

- **Integration of services.** To perform the HC processes, a huge amount of different tasks should be performed. But it is not always necessary to know all the details about how to perform such tasks, the objective of the cooperation platform is not to deal with the specific abilities of each HC worker, but to aggregate the indispensable information required to manage efficiently the care. For example, the care coordinator doesn’t mind how a medical bed provider inform about the availability of such a bed, but just want to know if it is possible to book such a bed. And it could exist as many ways of knowing about the availability of the bed, as the number of medical bed providers. The feasibility of the cooperation platform for HC is strongly linked to its ability to interoperate with external systems. The platform is in charge to explain which activity should be perform and which data are requested. Nowadays, a promising way to deal with these issues is to use Service-oriented Architecture (SOA) to “address problems related to the integration of heterogeneous applications in a distributed environment” [11]. Each activity could be performed by an external service, which may be complex, and should return the expected information. As most of the time, the activity deals with entering of new information in the system, the simplest services to propose are forms.

- **Personal access to the tasks to perform.** Each HC worker should be individually informed about the tasks he has to deal with.

**Cognitive knowledge.**

Three main types of knowledge descriptions have been extracted from the cognitive analyses: HC activities, HC information, and information linked to each activity (characteristics such as the address of the patient is very important for the decision of acceptance of the care during the request phase and it would be a priority to transfer it).

![Figure 1. - The three types of knowledge on the homecare processes.](image)

Such meta knowledge, issued from the activity analysis, is used to develop “user’s activity oriented” system. In particular, the supervision interface could adapt the display of information, not only to the one who is connected, like in most of the current health care systems, but also to the current phase of the HC process. This point is important to help the user to focus on new or useful information, to build an efficient cognitive representation of the patient’s state. Moreover, for each activity, one can find a description of the associated context needed to perform it, such as who could be asked to perform the tasks or what are the needed information. This point is important to build the exchanges between external
services and the HC cooperation system.

1.1. The system architecture

Such requirements have been implemented with a system architecture organized in different levels:

- **coordination level** which highlights the state of the processes, and the pertinent information,
- **routage level** to choose which activity to perform and to delegate information to right people,
- **activation level** to launch the services,
- **transport level** to safely communicate information,
- **access level** to reach to-do-lists.

Exchange For Activity (EFA) messages are defined and used to communicate between the different application, the different Information System and the HC System.

Different modules compose the system architecture:

- **the cooperation module**, it proposes a common and share representation of i) the HC process, ii) the evolution of the HC phases and iii) the related information. It describes recursively the different HC phases.
- The **activity activation module** is in charge of choosing who to request, it builds a request message devoted to launch an activity.
- **The intermediation interface** is done through a commercial system (Rithme™), and provides health care professionals’ directory, patients’ directory, security management, notification and data formatting. It connects the HC workers either to the coordination interface or to their personal to-do-lists.

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**Figure 2. - The enactment loop in the Coquas architecture.**

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• The activity services, it actually “runs” the HC tasks. Sometimes very complex, they are similar to services in SOA architectures, basic ones are automatically defined, using the description on the needed information associated to each description of activity, and propose some simple but dynamically generated forms.
• The integration module integrates the new data in the homecare information system.

2. Prototype.

A prototype has been implemented. It does not cover all the HC situations but tests the main functionalities. The coordination interface displays the HC processes and activities and the information, according to the actual activity. The whole cycle of communication is implemented: hospital extraction of data, integration in the homecare coordination system and the access through the coordination interface or through a to-do-list of the actions to perform. External applications can be launched from the coordination interface. Delegation of activities have been tested. Different technologies and languages are used to perform the complex system (JAVA, XML, ASP, MYSQL, Xforms, LDAP,…).

3. Validation Tests.

We have performed a validation of this prototype. This evaluation aimed to: 1°) Validate the interest of the functionalities implemented in the prototype: display of the whole process in one page, data entry via forms, the capability of asking someone else to complete missing information electronically, integration of the data sent by another individual in the right section, and display of information entered in one section in other sections if pertinent. 2°) Evaluate the feasibility of integrating this prototype in any center for HC.

This evaluation was performed in the Evaluation Laboratory of the faculty of Medicine in Lille, with three HC coordinators, two nurses and a physician, from different organizations. This laboratory allows us to accurately reproduce a work setting (an office in this case), to observe and guide the users (via video cameras, one-way mirrors, and microphones), and to record dialogs, facial expressions, gestures, etc. First the prototype was presented to the users, and they were told what was expected of them. The prototype was then tested through a scenario drawn from their usual activities. At the end of the test, the users were extensively debriefed on their experience and opinions of the prototype.

Video records have been analyzed. The users’ comments were very positive: The system matches with the actual activity; they felt that it could avoid some waste of time, and could make coordination easier. Moreover, those positive comments came from people working in different structures which have completely different organizations (200 employees vs 4) and whose jobs are different (nurses vs. physician). The navigation through the interface seems to be intuitive. Required improvements concern some surface ergonomic aspects and could be easily modified in a future version.

4. Conclusion

HC is a complex cooperative situation. Multi-modal, distributed, multi-participant, asynchronous, the organization and the management of the care must nevertheless satisfy some criteria of quality, confidentiality, security, and so on. We did a cognitive analysis of HC users’ activities to better understand how the actual homecare works and to be able to present some requirements to computerize the cooperation of the health professionals in...
such an activity. We got some interesting knowledge upon the HC, highlighted the need for cooperation, proposed some requirement for the system architecture, implemented a prototype and tested it with actual HC professionals. We hope that this research could help to define efficient HC applications in the future. During the test, the positive comments of the users encourage to continue with such architecture and to promote the integration of the cognitive knowledge in the future developments.

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6. References


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