A collaborative web-based Application for health care tasks planning

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Abstract. Hospital emergency wards such as Gynaecology and obstetrics maternities are extremely complex to manage and pose serious health risks to patients. Related tasks which are mainly focused around patient management are basically achieved through a cooperative way that involves several health care professionals. Such team members with separate skills and roles should work together during patients' management. In this paper, we firstly discuss our study of work in-situ within an Algerian maternity ward to better understand the usual way under which tasks are effectively achieved and identify the artefacts used. Such observation allows us to highlight the vital collaborative medical tasks that need to be modelled. The following sections outline basic design concepts of our collaborative planning system, which is designed to provide a flexible group interaction support for care coordination and continuity.

Keywords: Healthcare tasks modelling, cooperative work, shared artefacts, synchronous/asynchronous interaction, social planning and coordination.

1 Introduction

In Algeria, many healthcare institutions across the country suffer from multiple dysfunctions. Despite the reforms initiated by the authorities to improve the quality and effectiveness of patients care, the changes promised by the reforms initiators slow in coming and health care wards still do not meet the expectations of the patients. Certainly, no one can ignore the achievements made in this sensitive area that is public health such as rehabilitation of old infrastructures and reception of new ones, opening of new services, training of more physicians, medical specialists and skilled staff, etc., but problems persist and severely affect the medical activity and globally the health system.

It is here about an observation that cannot be restricted to the isolated counties within the country like south for example, which use old medical equipment and lack in terms of qualified personnel, but also concerns hospitals in major northern cities which are nevertheless materially well equipped with the availability of the required

skills. Indeed, the study[1] that we led on this vital question revealed various reasons that are mainly linked to mismanagement of the related activities, equipment, human and material resources.

First, it is necessary to note that the artefacts used during work are essentially restricted to paper sheets which are often not updated and sometimes even get lost between the different services because of the infernal work load imposed on the personnel .The observation study has also explicitly showed that most of the medical activities we supervised were group-based. Likewise the main deficiencies in patients monitoring precisely arose from the lack of coordination between the various members of the involved medical team, which thus constitutes a key factor as it has been so well confirmed several numerous studies carried out on this issue[20] [21].

Based on this observation, we believe that the task management should require from us a special attention. We must therefore address the issue of the targeted maternity ward under a new perspective, that of the medical staff needs, taking into account the economic and performance constraints as well as socio-health hospitals mission objectives of providing optimal care and well-being of patients. Providing a technological answer through cooperation, coordination and communication facilities seems to be the most appropriate initiative. However the past experiences reported in this area that work in-situ [19] should be first carefully analyzed from a social point of view [4], and through a structurally opened cooperation vision that enables users to build their cooperation workspace structure in order to interact within it [18]. Consequently, we focused our interest on collaborative practices of patient care teams [14] as well as their organization [16] to better understand the usual manner with which tasks are actually performed.

Several collaborative medical care needs have been identified by a wide body of researches in informatics and medical science fields. There are common processes that are more difficult and complex in collaborative situations, because they need to integrate many parties. Such as decision making process that needs involvement of several persons to arrive to a decision, which can take long time [15]. In [13] authors showed that the collaborative nature of the executed process, determines the type of information management necessary for this process [15]. Though, a poor structure of information can lead to coordination and communication breakdowns [15].

Maternity services are highly risky and still very hard to manage. They require coordination among several teams whose tasks achievement most of the time confront them to conflict situations [19].The exploitation of information and communication technologies proves to be an effective approach if it is appropriately used [11]. It will enable us reduce the effects generated by the coordination problems that directly disrupt the patient's care chain and degrade their quality as noted Scupelli [10] through his study. Consequently, coordination breakdowns among the medical staff members inevitably that have an impact on the quality of care provided to patients and put them in a potentially vulnerable and dangerous situations should be significantly reduced with the availability of a medium of communication, cooperation, and coordination.

[1]We led an investigation mainly based on observations and interviews with a medical staff within a gynecology and obstetrics emergency unit.

Such an approach will provide collaborative tools that may effectively address medical staff vital needs and improve the quality of patients' care. Our research work falls then within the CSCW area (Computer Supported Cooperative Work). Thus, with a CSCW-based management strategy [8] we wish to provide an effective support of these activities enabling by the way finer planning features of the related tasks as well as providing real time mutual awareness around the occurring events within the maternity unit which constitutes a priority of our work.

The main objective of this paper is to outline basic design concepts of our cooperative planning system CPlan. In the following sections we will first discuss our observational study achieved within an Algerian maternity ward to better understand the usual way under which tasks are effectively completed as well as identify the used artefacts. We will attempt to analyze the healthcare process to highlight the appropriate design guidelines. Section 3, exposes our conceptual methodology and discusses the choices made as well as the software architecture designed for CPlan. We consider the main components of the different architecture levels as well as the main supported features. We will explicitly attempt to show that CPlan design is mainly focused on concepts of data sharing and exchange to favour coordination between participants. To provide details on our design approach, section4 discusses its deployment issue. Finally, perspectives of the accomplished work are presented in the conclusion of the paper.

2 Targeted context study

Our study of work in-situ led us to consider an Algerian maternity ward to better understand the usual way under which medical staff such as gynaecologists-obstetricians, anaesthetists, midwives, nurses, …, effectively achieve their tasks and identify the main used artefacts to coordinate the work. The maternity targeted is about 200 beds and comprises 4 operating rooms, 4 labour rooms, an analysis laboratory, an imagery service, an emergency service, etc.

We started, therefore, by analyzing the interactions among the medical staff members and attempted to understand how they may interact and collaborate while dealing with patients' cases, and what happens when this work is done with a team of collaborators. Such understanding will undoubtedly allow us to provide the adequate design by addressing the following interrogations:

- How medical staff members' collaboration naturally takes place?
- Which artefacts are used to coordinate work? And how?
- Which impact has the spatiotemporal dimension on staff members' interactions and on the collaboration process among them?
- What means are required to improve the care process within a maternity ward?
- Which computer tools may provide the required assistance for the medical staff members and get them to work collaboratively?

— From a collaboration point of view, what are the specific characteristics of collaborative medical activities?

It is practically impossible to design a computer tool addressing all users' needs. Nevertheless, group work experiences provide us with pertinent information to clarify some useful development ideas about the suitable support tools. The experimentation of these tools, thereafter, will unveil obstacles to overcome as well as perspectives to follow. Our approach is drawn in a direction which aims to favour collective work and enables coordination. Therefore, as we will show it in the following sections, the care tasks analysis will bring us an understanding to concretely increase the commitment of participants that may have a great impact on the whole chain care process.

2.1 Collaboration process

The meticulous analysis of healthcare activities reveals that patient care chain planning is a complex task that has an important impact on their quality and consequently on patients' safety. Such care process must be carefully managed since the patients' admission to the hospital until they recover and leave it. This includes ongoing care chain planning of a pregnant woman since her admission to the maternity until her delivery that can occur naturally (labour room) or through a caesarean surgery (operating room).

When there is a coordination breakdown between team members, this can affect directly the patients care activity. In this study we noticed that there are many sources of coordination breakdowns, that have to be taken is consideration. A change in the patient's physical condition either for the worse or for the better can require a changing in the schedule. For example if a doctor decides that a pregnant woman can need a caesarean operation, this needs an immediate allocation of an operating room. Some coordination problems can come from surgeons. Surgeons do not have often one obligation, but many; such as carrying out a surgery, seeing their patients, or working in other hospitals. When the amount of tasks is big, and there is a lack of awareness and coordination; this can be a source of delays. A not experienced nurse, who is not accustomed with the work in the maternity ward, can make some mistakes, what can affect the schedule. Team members can affect and slow down each other, with unexpected events and requests for information which require updating and adjustment in the plan.

When coordination breakdowns occur, schedule has to be adjusted: reallocations of resources, update of priorities, notifying of the involved medical staff.... Negative consequences can happen when the medical staff fails to act collaboratively to adjust breakdowns. Our analysis has revealed that medical care is often administrated with a delay, and unfortunately even for critical cases, what can be sometimes dangerous for patients' life. These coordination breakdowns, can lead to delays, what leads to more work hours and additional costs what reduces profits. Also, trying to coordinate every time between team members; can generate stress and workload. Sometimes delays can oblige patients to come back another day, what disturbs their personal plans.

Our study, reveals us that putting artefacts in some specific positions inside the maternity ward can increase awareness, improve the collaboration process, reduce the costs of sharing and gathering information and decrease coordination problems.

The planning process should take into account for any task the availability of the associated medical team members (such as gynaecologist-obstetrician, anaesthetist, midwife, and nurse), the location, the period of time, etc. The collaborative planning tool shows immediately the old scheduled tasks and easily allows planning new ones while visualization provides for specific periods information on availability of current working staff as well as locations (labour and operating rooms).

2.2 Work analysis

Designing group work support features requires first a better work in situ analysis, and particularly identifying the implied participants, their roles, prerogatives as well as the used artefacts. Such way will without doubt enable us to understand how to satisfy both individual and group requirements within a shared environment.

Our design approach is intended to enable medical staff members to cooperate and share responsibility of a patient. We insist here on the necessity for an effective groupware tool to take into account the procedural, intellectual and social complexity of the cooperative care process planning. Indeed the diversity of opinions inside the staff, often generate a great intellectual activity that should be gathered and made available to the community rather than neglected until it becomes a source of conflicts or misunderstandings.

In addition to the obstetricians-gynaecologists, anaesthesiologist, paediatrician, etc., the genecology unit functioning is mainly based on the chief midwife, who is in charge of the care organization, of their quality and their ongoing as well as the motherhood monitoring and her staff management (usually other midwives and assistant nurses). Among the other professionals involved in the service we also distinguish the anaesthetist nurse (a specialized nurse) who assists the anaesthesiologist and supervises the postoperative recovery room. Finally, the staff also involves a social assistant who mediates between patients meeting personal problems and administrative agencies, a psychologist who offers listening, support and advice to patients and families, a physiotherapist for functional rehabilitation and massage therapy, and a nutritionist who tailors the appropriate diet to health problems.

2.3 Used Artefacts

During patients' management, the involved team usually resorts for scheduling to a classical plan board or paper sheets to specify who does what, and when? As well as to coordinate the work with people who are not available, it is usual to use the telephone, email and short messages. Such way to achieve work promotes creativity and information sharing that suitably works and allows the group to get at an on-time objective. Thus, the whole process requires from the team members to take part to the planning process and do nothing else at this moment. Because the planning process works well when under a face to face way, while the detailed tasks are discussed with

the whole team. However, because of their Ad-hoc nature and emergencies the medical activities require not only continuous availability but also a high level of vigilance from the medical staff which should constantly be focused on the evolution of patients' conditions. Therefore, these meetings which are necessary to ensure coordination should be minimized as much as possible. Just as it would be necessary to constantly maintain mutual awareness on the occurring events, even for the busy group members while dealing with emergencies. That is how coordination problems arise and lead to the disruption of the balance within the group leading to tension, nervousness, tiredness, anxiety, etc.

The most used artefact as we said above is the paper medical record. It contains much information about the patient (observations, plan of the day, and dosage of drugs). There is a new paper each day that is placed on the top of the old ones. With time, the consultant need more time to consult a patient state because of the big number of papers added every day. The use of papers has to be reduced to minimum, to avoid some problems such as lose of papers, the need to move to the patient's room to consult its state,... The use of electronic medical records (EMRs) can improve awareness among the group members, and improve collaboration process [1]. The use of EMRs, must be coupled with the correct display device [3]. Because a poor development of the ergonomic design can lead to a difficulty using [7].

Likewise, the strategy used by these institutions has often emphasized on a management that attempts to deal with the massive affluence of patients rather than the quality of their care. Furthermore, we currently see in the emergency service the admission of more and more complex health cases, whose take-in-charge remains an extremely hard task.

3 Software architecture

The developed system is a synchronous web-based groupware accessible through a browser that enables real-time collaboration among collocated or geographically separated group members. The proposed architecture is illustrated on Figure 1. It is developed under AJAX Push also known as Server Push or Comet [2].

The first layer contains the system database which is mainly characterized by its capacity to provide reliable data for long time, concurrency control management, data storage, and security capabilities.

The second layer contains all the defined software components. In the case of a real-time groupware, sharing data and events constitutes the most important aspect. Thus enabling data sharing requires that any event or data generated by one user has to be immediately notified and delivered to all the other users (in real- time). For better workspace awareness, fault tolerance, responsiveness, and replication of shared data, objects are often used together with other operations on them like creation, updating, deletion and reading.

Some web 2.0 technologies such as AJAX and Comet, allow creation of rich internet applications (RIAs). In an Ajax application, servers respond to each request in sequence, just as in classical web, but in the browser only a part of the user interface

is updated, rather than updating the whole page and refresh the whole display. However, the user must send a request to the server to see the updates.

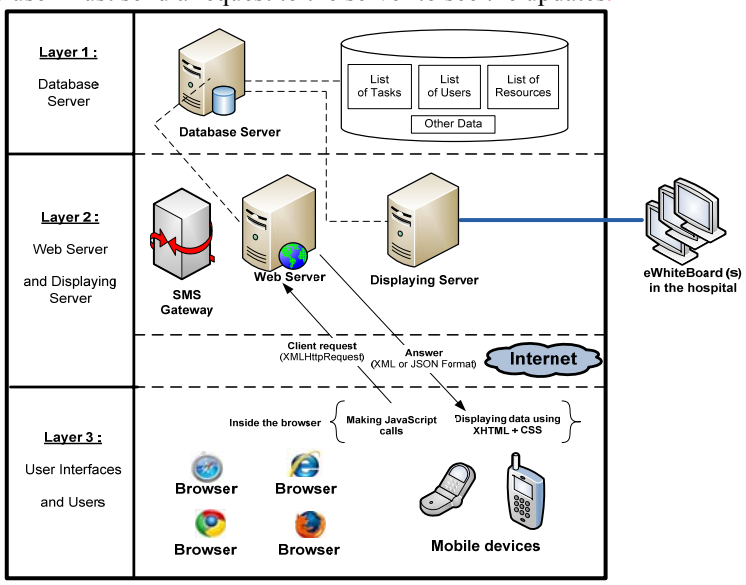

Fig. 1. Software architecture.

The problem of AJAX which is the absence of two-way communication that is needed for synchronous groupware implementation is partially solved with a set of technologies commonly called Comet. They allow a server to push data to the browser ('server push') without requiring a new connection for each update. This capability allows a server to notify data to clients at any moment. Comet is ideal for collaborative and real time applications, because of its abilities for improving responsiveness of collaborative systems, without causing any throughput problems [2].

In [12], authors carried out a study on groupware-based framework requirements to assess the performance of different networking approaches including Comet. They found that web-based networking approaches perform well and can support the communication requirements of many types of real-time groupware. The results suggest that web technologies can support a wide variety of network requirements, including highly interactive shared workspaces and systems for large groups.

The second layer defines two servers: Web-Server and Displaying-Server [5] [6]. The web server contains rich web pages that may be loaded on users' browsers. The Displaying Server is intended to display the schedule on eWhiteBoards (screens disposed on the appropriate locations in the hospital). After every modification of the schedule, all the eWhiteBoards are automatically updated. Also to significantly reduce users' cognitive overload such as nurses, surgeons…, the eWhiteBoard(s) can be configured to restrict the display only for pertinent information needed by each group [19] and decrease the amount of data on screens.

Finally, the third part consists of the client machines, which may be a laptop or a desktop. However, recent years have seen a wide variety of computer devices includ-

ing mobile telephones, smartphones and tablets that can be considered as an alternative for traditional computers.

3.1 Software Architecture Components

The following components are loaded in the browser from the Web Server. Our architecture is composed of several modules which are important for the collaborative scheduling task:

- Interface component: this module plays the role of a medium between the user and the system.
- Session Manager: This component is intended to manage users' work sessions, like rights on the schedule list (read/write), users join/leave within the shared workspace, latecomers...
- Collaboration: to allow users to simultaneously work together, we designed several appropriate tools, such as the tasks shared table. Users share the same display which instantly shows any event that may occur in consequence of a user action. Such way provides users with real time awareness capabilities and enhances coordination.
- Communication: CPlan supports both synchronous (instant messaging) and asynchronous (post comments, and give valuable suggestions to their colleagues).
- Scheduling: This is the most important system component; it provides all the necessary tools for managing resources and tasks. The list of the tasks is displayed to the users in a table that showing all related tasks information (starting time, priority, location…). Once a task is created, it will immediately appear on the other participants (users) screens.
- Collaborative diagnostic: This is a component intended for diagnostics elaboration of a given case under a collaborative way.

The server extracts the required information from the database and uses an SMS gateway to send messages to the staff members. There are two kinds of messages: reminders, notifiers to notify new events or a new created task. To allow users to connect to our web interface with their mobile devices, an adapted version of the web application is developed. The developed system allows an authorized physician to access at any location to the electronic patient record data, using a hand held device or a desktop, and can for example remotely access the patient medical images.

3.2 Events notification

Our system uses an event notification mechanism. When any action is executed within the shared workspace [17], the web server notifies the other users to inform them (XML messages) about the different actions in the shared workspace. Such mechanism keeps the whole group member aware of their mutual actions [9].

4 Conclusions and perspectives

To objectively measure the efficiency of CPlan, we have implemented a first prototype of the collaborative tool, and the evaluation of the current version on a local network brings rich ideas on collaboration and coordination opportunities provided.

In this paper, we have discussed basic design concepts of our groupware application CPlan. We have attempted to show that it allows several participants to collaborate within a shared workspace. It allows the execution of individual and collective actions on a common patient case as the elaboration of the planning. The sharing of the planning scheduling has been widely discussed, because its use allows us to concretely inform participants on their mutual actions. At the visual level, the simplified and rich web interface shows explicitly the shared plan phases and significantly reduces participants' cognitive loads and enables them to intuitively understand what is currently going on and get knowledge about their patients' states evolution as well as the next actions that should be achieved.

During a work session, medical staff members may act on the shared plan under specific role, dynamically exchange messages and interact through natural cooperation way. Such flexibility is motivated by the necessity to enable CPlan to support the dynamics implied by the care process.

Being conscious of the great interest of CPlan experimentation in effective context situations, we plan in the next step of our research work to collect information about efficient activities from medical staff. It is of an extreme importance for us and represents a double objective. First, we can validate or forsake some technical choices among those we made for implementation. Second, we will be able to determine with more precisions the appropriated adaptations we should apply to the supports provided in CPlan. To this end such as any software project we designed modular and extendable software architecture, in the sense that it allows design and integration of new modules through an incremental way.

References

1. Craig, E. Kuziemsky., James, B. Williams., Jens, H. Weber-jahnke.: Towards Electronic Health Record Support for Collaborative Processes. SEHC '11 Proceedings of the 3rd Workshop on Software Engineering in Health Care (2011)
2. Russell, A.: Comet: Low Latency Data for the Browser. Continuing Intermittent Incoherency (2006)
3. Cecily Morrison., Geraldine Fitzpatrick., Alan Blackwell.:Multi-disciplinary collaboration during ward rounds: Embodied aspects of electronic medical record usage. International Journal of Medical Informatics Vol. 80, Issue 8, Pages e96-e111 (2011)
4. J. Cummings., S. Kiesler.: Coordination and success in multidisciplinary scientific collaborations. International Conferenceon Information Systems (ICIS), Seattle, WA: Association for Information Systems (2003)
5. Wong, H.J., Caesar, M., Bandali, S., Agnew J., Abrams H.: Electronic inpatient whiteboards: improving multidisciplinary communication and coordination of care. Int J Med Inform.;78(4):239-47 (2009)

6. M. Hertzum.: Electronic emergency-department whiteboards*:* A study of clinicians′ expectations and experiences. I. J. Medical Informatics, Vol. 80, No. 9, pp. 618-630 (2011)
7. C. Tang, S. Carpendale., An observational study of information flow during nurses' shift change, Proceedings of CHI 2007 219–228. (2007)
8. K. Schmidt., C. Simone.,: Coordination mechanisms: Towards a conceptual foundation of CSCW systems design. Journal of Computer Supported Cooperative Work: The Journal of Collaborative Computing, 5(2-3), 155-200(1996)
9. Dourish, P.: What we talk about when we talk about context. Personal and Ubiquitous Computing, 8(1), 19–30 (2004)
10. Scupelli, P., Xiao, Y., Fussell, S. R., Kiesler, S., Gross, M.: Supporting coordination in surgical suites: Physical aspects of common information spaces. Proceedings of the Conference on Human Factors in Computing Systems CHI10, NY: ACM Press (2010)
11. Z. Niazkhani., et al.: Evaluating the medication process in the context of CPOE use: The significance of working around the system, Int. J. Med. Inform. (2011).
12. Carl, A. Gutwin, Lippold,M.,: Real-Time Groupware in the Browser: Testing the Performance of Web-Based Networking, T. C. Nicholas Graham March 2011 CSCW '11: Proceedings of the ACM 2011 conference on Computer supported cooperative work (2011)
13. Reddy., M.S., Spence, P.R.: Collaborative information seeking: A field study of a multidisciplinary patient care team. Information Processing and Management;44:242–255(2008)
14. Seffah A, Forbrig P, Javahery H Multi-devices "multiple" user interfaces: development models and research opportunities. J SystSoftw 73(n 2):287–3001 (2004)
15. Kuziemsky, C.E., Varpio, L.: A Model of Awareness to Enhance Our Understanding of Interprofessional Collaborative Care Delivery and Health Information System Design to Support it, International Journal of Medical Informatics, doi:10.1016/j.ijmedinf.2011.01.009, forthcoming (2011)
16. S. R. Barley., W. H. Dutton., S. Kiesler., P. Resnick., R. E. Kraut., J. A. Yates.: Does CSCW Need Organization Theory ?," Proceedings of the 2004 ACM conference on Computer supported cooperative work (CSCW'04), ACM Press, November 6–10, 2004, Chicago, Illinois, USA, pp.122-124 (2004)
17. U. K. Wiil, :Using Events as Support for Data Sharing in collaborative Work," Proceedings of the International Workshop on CSCW, Berlin (1991)
18. M. Zacklad,: Communities of Action: a Cognitive and Social Approach to the Design of CSCW Systems," GROUP'03, November 9–12, 2003, Sanibel Island,Florida, USA, pp.190-197 (2003)
19. Ren, Y., S. Kiesler, S. Fussell, P. Scupelli.: Multiple Group Coordination in Complex and Dynamic Task Environments: Interruptions, Coping Mechanisms, and Technology Recommendations. Journal of Management Information Systems / Summer 2008, Vol. 25, No. 1, pp. 105–130. (2008)
20. Bardram, J.E., Hansen, T.R: Context-based workplace awareness concepts and technologies for supporting distributed awareness in a hospital environment. Computer Supported Cooperative Work. 2010;19:105–138 (2010)
21. Kuziemsky, C.E., Varpio, L.: A Model of Awareness to Enhance Our Understanding of Interprofessional Collaborative Care Delivery and Health Information System Design to Support it, International Journal of Medical Informatics, doi:10.1016/j.ijmedinf.2011.01.009, forthcoming (2011)