

SUPPORTING COLLABORATIVE WORK THROUGH WIRELESS TECHNOLOGIES SUPPORT IN PATIENT CENTRIC VIRTUAL ORGANIZATIONS (PCVOS)

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The paper presents a Virtual Organization (VO) framework which incorporates wireless technologies support at the point of care in the clinical healthcare environment. It reflects the move to patient-centric healthcare given by multi-disciplinary care team collaborating in the patient's treatment. The work sheds light into how VOs incorporating wireless technologies can meet the needs of the care team. It describes technical factors of Virtual Organizations and discusses their role in a clinical environment. It identifies how existing virtual infrastructures in the healthcare literature relate to the development of Patient Centric Virtual Organizations (PCVOs). It addresses the issues and results determined by a case study. These results inform the design, development and evaluation strategy of the pilot project to achieve sustainable collaborative working of care teams for possible improvements in patient care infrastructure.

1 INTRODUCTION

In this paper we present a Virtual Organization (VO) framework as a Patient Centric Virtual Organization (PCVO) incorporating wireless technology support at the point of care. A PCVO provides support for collaborative working of care team members involved in a patient's care. It incorporates a Wireless Point of Care System (WPoCS) to address some of the point of care issues. The pilot project is a case study at Velindre Hospital, the South East Wales Cancer Centre. The pilot involved the secondary and tertiary care level in the cancer domain and was carried out using anonymized data in the Clinical Information Unit. It identified the communication and coordination functional requirements of multi-disciplinary care team members for patient care. A PCVO is based on a patient and supports multi-disciplinary care team members having varied skills involved in the care of that patient. It provides sustainable collaborative working to these care team members with the aim of improved patient treatment and care. In our study, the stakeholders are clinicians, nurses and therapists who play a key role in the patient care process. They need to access information from a variety of patient information resources and work together to achieve the common goal of improved patient care.

An analysis of current patient information resources and working practices of the care team members determined the issues which affect the patient care process. It

suggested how to organize patient information at the point of care and support enhanced integrated working of the care team members. A PCVO harmonizes well with the clinical settings and utilizes existing decentralized and distributed information resources in a structured development. This paper presents the technical aspects of VOs which make the base for the PCVOs in the clinical environment and presents an overview of the pilot project which identified the care team's point of care tasks and looked at their suitability for the WPoCS. This showed that a better organization of the care team's daily routine work can be achieved by performing suitable tasks using handheld devices. It can facilitate the understanding of the role of other members and improve collaboration as tasks become more visible.

2 NEED OF VO DEVELOPMENT IN THE CLINICAL ENVIRONMENT

Several survey, exploratory and technical studies have been conducted which analyze the current problems in the healthcare sector. Some of the major issues identified by McKnight (McKnight et al. 2002), Coiera (Coiera & Tombs 1998), Wickramasinghe (Wickramasinghe & Goldberg 2004), Imhoff (Imhoff et al. 2001), and Embi (Embi 2001) include medication errors; insufficient information structure for patient information management; inconsistent and delayed communication patterns among team members; lack of feedback for patient care; interruptions in the internal communication process; poor provision of information support for team based communication; inappropriate use of communication facilities; and unavailability of required information from decentralized and distributed data resources.

Availability of patient information at the right time and right place is a basic requirement for patient care team members. Thus patient information management at the point of care is important for the smooth running of the technical infrastructure of the hospitals/health institutions (Imhoff et al. 2001). For rapid patient information access, quick and relevant information resources and IT based solutions are required in hospitals McKnight (McKnight et al. 2002). Incorporation of wireless technology applications into existing information resources can meet this need of information provision at the point of care and on the move (Mohyuddin et al. 2006). These technologies utilize previous experience of computerized information systems and harmonize well with mobile workflow of care team in the clinical environment (Grasso 2004).

Although clinical information systems are considered a major information source for patient information, they are not the only way of meeting this need. Currently most patient information is still recorded in patient notes, manual charts, observation charts and other paper based records during the treatment process (Fitzpatrick 2004, Bardram & Bossen 2005). Often care team members have a limited and superficial understanding of each other's work and close coordination is not possible (Bossen 2002). The task repetition and overlapping occurs due to lack of mutual coordination and communication among these care team workers which consumes their effort and time, and results in data redundancy.

Thus there is a need for a better information communication and coordination infrastructure for care team members. This infrastructure must be capable of providing an integrated work pattern and centralizing care team activities in a single platform where they can access and share work information in a better way. These requirements also emphasize the need to incorporate wireless technologies at the point of care

to provide the required information to care team members when needed. These issues are addressed by the proposed PCVO framework, which is based on a patient centric approach and harnesses the power of wireless technologies at the point of care.

3 VO BASICS AND ROLE OF WIRELESS TECHNOLOGIES

In the literature, VOs are used in varied ways according to their features; but VOs can certainly be distinguished from traditional organizations because of their functionality and characteristics. Some of the features which are basic for VOs can be described as: 'working for certain organizational objectives together; formation of teams for accessing and sharing resources; usage of computer and communication technologies; trust, collaboration and cooperation among team members' (Rittenbruch et al. 1998). The functionality of a VO is very much linked with the working of organizations and applications in which they are used. The VO team members may be dispersed by time (temporally) or space (physically), but they use communication and information technologies to share and access information resources. In the clinical environment, care team members collaborating with a common objective of caring for a patient may form a VO. Looking at the nature of clinical environments in a VO context, we find a synergy of aim as the work practices in the clinical environment can be diverse; healthcare professionals with different skills might be caring for the same patient while working from different locations and at different times; and patient resources may be heterogeneous and dispersed (Bossen 2002).

Usage of technology is one of the important pillars in the VO development. Advanced information and communication technologies have played an active role in changing the organizational structures and processes along with evolution of VOs. In order to determine whether a VO approach is suitable, organizations need to know how to expand their technology infrastructure to support the VO environment. They need to consider collaborative technology tools like personal communication tools, laptops and PDAs (Becker et al. 1999). Suitable technology support is a prerequisite for VO team members who are separated by time, space and culture. Wireless technologies can play a major role within a VO as an information and communication technology factor. These technologies provide a range of value added services to the members of a VO including coordination and collaboration; information access and retrieval; content access and delivery (Camarinha-Matos et al. 2004). Due to the mobility and portability of wireless devices, VO team members can access and share information and updates when working at different physical locations or in different time shifts.

4 VIRTUAL INFRASTRUCTURES IN HEALTHCARE

A concept of dynamic virtual collaborative healthcare teams dealing with home healthcare utilizing fixed computers, mobile phones, PDAs and internet telephones is presented in enterprise project DITIS (Pitsillides et al. 2004). An idea of virtual patient communities which aim to direct and support the chronic patients having long term disease is presented in (Winkelman & Choo 2003). Grootveld (Grootveld et al. 2004) discussed a VO and ad-hoc virtual team formation approach in a telecare

project. It describes a VO for the stroke service which is a regional network of healthcare professionals who access patient records in the emergency room for diagnosis. A project for the integration of Cuban healthcare service market discusses a virtual institutional infrastructure which includes different healthcare services and a linked structure of national networks (C. Seror 2003). In a case study of a prison telemedicine program, a VO and virtual clinic creation strategy for distributed clinical consultations which connects an academic medical centre to a prison hospital is discussed (Turner 1998). A new generation of web-based tools like Wikis, blogs and podcasts collectively called collaborationware, are discussed in (Boulos et al. 2006) for virtual collaborative clinical practice.

The related work has shown the benefits of virtual infrastructures and VO formation in different telecare and homecare projects, but no work has been done to analyze the potential benefits of VO development to support a Patient Centric approach at the clinical level, in particular at the point of care. It can be used to manage and classify the tasks of the care team and can play an important role in their mutual cooperation by improving the understanding of other team member's work. Within this domain even less study has been conducted to find out the benefits of VOs with wireless technologies support. The development of PCVOs harnessing the benefits of WPoCS for patient care task management to provide a collaborative working environment for care team members is the novel aspect discussed in this paper and this area needs to be explored further.

5 PROPOSED APPROACH AND FRAMEWORK

PCVOs are built on the VO approach. They use wireless technology support and are based on the functionality and tasks needed by care team members at the point of care in a clinical environment where these members work together in an integrated way to achieve a common goal, i.e. improved patient care. The Patient Centric approach has patient information as the central entity of the paradigm and the PCVO enables each patient's data to be used in different and improved ways in their care. The framework (Figure 1) shows how different decentralized resources such as patient information databases and patient notes in hospital; and distributed resources available on the internet such as medical, pharmacy and evidence based medicine repositories are incorporated in the PCVO. The PCVO works on top of the existing patient information resources to identify and organize patient information with respect to suitable interface for the care team at the point of care. It incorporates WPoCS in the current setup which enables information gaps to be filled and provide missing functionality thereby giving a more complete support facility. The proposed PCVO framework in Figure 1 shows the categorized tasks as 'existing tasks', 'transferable tasks', 'added tasks' and 'automated tasks'. These tasks are classified with the aim of appropriate information provision at the point of care with respect to patient information resources for care team members discussed in the results section.

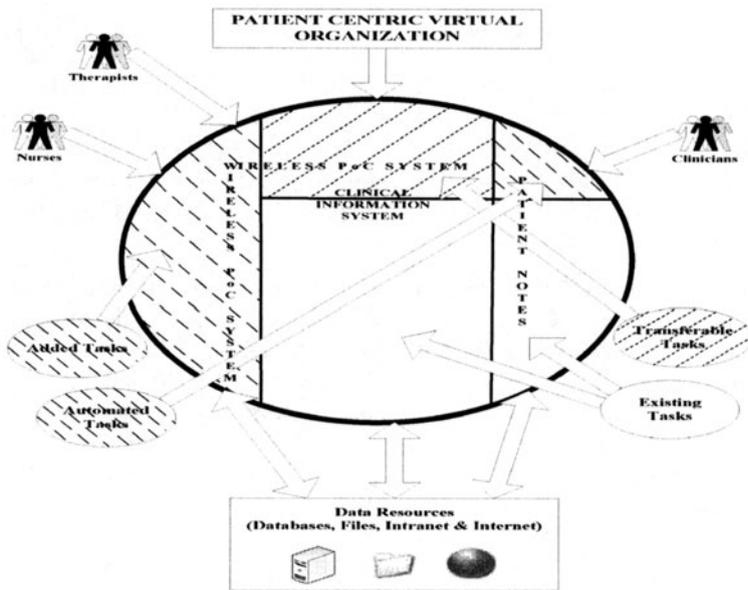


Figure 1 - Patient Centric Virtual Organization Framework

Every PCVO is based on a single patient's information, so different care team members treating that patient become a part of that particular PCVO. Care team members might be working in different time slots and at different physical locations but will always work in a coordinated way for patient treatment under the PCVO platform because patient information structure remains the same.

Because of the distributed nature of clinical work, including the heterogeneity of information resources, and diverse time zones and locations of care team members; we emphasize that wireless technology is a key technology factor for PCVOs. It provides the required communication and coordination among care team for patient care. The steps of a VO roadmap presented in (Camarinha-Matos & Afsarmanesh 2004) show that in general, PCVOs with wireless technologies will provide a roadmap leading to sustainable collaborative care team working for the patient care.

6 STUDY RESULTS

The results of the case study and current work of the pilot project presented in this section were determined by analysis, direct observation, different questionnaires, structured and semi-structured interviews conducted at various levels with different care team members, Information Analysts and IT staff at Velindre Hospital (Burns 1998, Trust 2006). The iterative process of this analysis and design included interviews, discussions and feedback from these stakeholders throughout all the phases of problem discovery, framework approach, suitability and usefulness of task classification, design and modelling of test cases, and continues in the development and

evaluation phases. The study identified approximately sixty tasks and is the basis for the next section (Mohyuddin et al. 2007).

6.1 Point of Care Tasks Classification

For improved provision of patient information, PCVOs can identify and classify the point of care tasks for care team members according to the tasks suitability with reference to patient information resources. These three tasks categories are described below and more detailed explanation of the results in tabular forms for each category and care team member is presented in the study results section of paper (Mohyuddin et al. 2007).

1. Tasks which are better suited to existing computerized clinical information systems, are shown as 'existing tasks' in Figure 1, e.g. patient's details on referrals; search and comparison of best Evidence Based Medicine (EBM) cases, X-Ray and large image analysis; and data entry involving detailed keyboard input.

2. Tasks for transfer from existing clinical information systems to the WPoCS due to suitability of the information, are shown as 'transferable tasks' in Figure 1, e.g. accessing summary of treatment history; checking current disease status; checking clinical summary; and checking the lab results.

3. Tasks that can be added or automated by the WPoCS because the tasks do not exist in the current setup or are still done using manual paper based approaches, are shown as 'added tasks' and 'automated tasks' in Figure 1, e.g. accessing vital signs; checking drug details and timings; consulting reference notes; and accessing treatment protocols.

6.2 Collaborative Working Tasks Modelling

A few important test cases have been selected for design and modelling of the clinical collaborative working aspects. These aspects described below are important to collaborative working in a clinical environment, see (Bardram 1996). For each scenario, the current practice structure is compared with the suggested WPoCS design to show how the approach of a PCVO facilitates the collaborative working of care team. These selected collaborative working test cases described below are modelled using Unified Modelling Language (UML) and their detailed explanation with diagrams is given in the results section of paper (Mohyuddin et al. 2007).

1. Sharing of records and material.
2. Communication among care team members.
3. Collaborative problem solving.
4. Care team's task planning for patient treatment.

6.3 Wireless Point of Care System: The Pilot Prototype

A few point of care test cases for the care team members are selected from the tasks list for the WPoCS pilot prototype development. These test cases are verified from the care team members and positive feedback was received. The results of these test cases are to be presented using a Pocket PC Emulator and PDAs. To evaluate the PCVO platform, we will be comparing the proposed working of care team members using WPoCS with the existing practices performed using current information

resources. Feedback from the care team members will be used to observe the enhanced collaborative working pattern in their work practices.

7 RESEARCH BOUNDARIES

This pilot prototype utilizes the information resources in the hospital domain but it can be extended for distributed information resources as well. Due to the broad spectrum, some other challenges of administration, management, security and other aspects of PCVOs must be considered if this framework is to be adopted in practice. As wireless handheld devices have limited capabilities, they can only be used for limited information access and are not meant for all information capture and view needs. Finally, using a WPOCS for the collaborative activities is useful for suitable tasks, but it is not a substitute and replacement for computerized systems and all paper based artifacts. It can work in conjunction with these other resources to complement the existing functionality in a clinical environment in a novel way.

8 CONCLUSIONS

This paper presented a PCVO development for a clinical care environment and the potential benefits of using WPOCS in the system. It discussed how a VO is an appropriate foundation for the PCVO framework in a clinical environment as a means of enhancing collaborative working of care team members. It presented the lifecycle of the pilot project including analysis, design, development, implementation and evaluation strategies. The results presented suggest the real and tangible benefits that may be achieved with our framework. The positive feedback from care team members received through discussions and interviews shows the suitability of the results in addressing issues faced during routine clinical tasks. The next step is the development and implementation phase which is in progress. We are also working on qualitative assessment methods for the evaluation phase. The ongoing work is likely to provide useful and practical benefits through patient care improvements in secondary and tertiary cancer care.

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