USER PERSPECTIVE OF DITIS: VIRTUAL COLLABORATIVE TEAMS FOR HOME-HEALTHCARE

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Abstract: DITIS supports home-care by offering wireless health care services for chronic illnesses. The main service is the dynamic creation, management and co-ordination of virtual collaborative healthcare teams for the continuous treatment of the patient at home, independently of the physical location of the team’s members (or the patient). For each patient a flexible (dynamic) virtual medical team is provided, made up from visiting home-care nurses, doctors, and other health care professionals, responsible for each case. This virtual team is able to provide dedicated, personalized and private service to the home residing patient on a need based and timely fashion, under the direction of the treating specialist, without the necessity to move the patient from his home, thus making better use of the scarce and expensive medical professionals and scarce hospital beds, irrespective of geographic or organisational barriers. DITIS uses a number of state of the art technologies which are seamlessly put together, such as collaboration and personalization via mobile agents, access to medical data from anywhere and any time via a variety of mobile devices and a variety of protocols (i.e., WAP, HTML) and continuous connectivity via new communication technologies such as ADSL and GPRS, and soon UMTS. All the technologies are selected for platform independence.

1. Introduction

Recent trends in the provision of health care services are toward a more results-oriented, integrated and accountable health system that delivers the right services, to the right people, at the most appropriate time, in the most cost-effective manner. The shift from facility-based care to home-based care is pressing, as well as the shift to evidence based medicine. Furthermore, technological advances are enabling a greater shift from institutional services to community-based services, such as home-care.

Given the paradigm shift described above, the DITIS project was initiated in 1999, to support the activities of the home healthcare service of the Cyprus Association of Cancer Patients and Friends (PASYKAF). DITIS goal is to deliver a product that can improve the quality of the citizen’s life. Contrary to today’s health processing structure which is, in all
practical terms facility-based care, this project aims to shift the focus onto home-based care, where everything is moving around the patient, supported by a team of healthcare professionals. Given that the team cannot be by the side of the patient at all times, DITIS developed a collaborative software system to support dynamic virtual health care teams, customised for the differing needs of each patient, at different times. The virtual healthcare team is supported in its provision of dedicated, personalized and private service to the home residing patient on a need based and timely fashion, under the direction of the treating specialist. Thus it is expected that chronic and severe patients, such as cancer patients, can enjoy ‘optimum’ health service in the comfort of their home (i.e. a focus on wellness), feeling safe and secure that in case of a change in their condition the health care team will be (virtually) present to support them. The present users of the system include the Health-Care professionals treating cancer patients (Home-Care nurse, Oncologist, Treating doctor, Psychologist, Physiotherapist, Social worker etc…), and the PASYKAF administration. It is expected that the system will be extended to other paramedical professionals, as for example the Pharmacist and the Cancer Registry, currently located at the Ministry of Health. Furthermore, the system can be adapted to cater for other home health care needs, as for example cardiac, renal or diabetic patients.

DITIS deploys a novel networked system for Tele-collaboration in the area of patient care at the home by a virtual team of medical and paramedical professionals, implemented using existing networking and computing components. (The novelty of the system and competing approaches are briefly discussed in [1].) It was originally developed with a view to address the difficulties of communication and continuity of care between the home health care multidisciplinary team (PASYKAF) and between the team and the oncologist often over 100km away. DITIS has through its database and possibility of access via mobile or wire line computers offered much more than improved communication. Its flexibility of communication and access to the patient's history and daily record at all times, anywhere (home, outpatients or in the event of an emergency hospital admission), has offered the team an overall assessment and history of each symptom. DITIS has thus offered improved quality of life to the patient, for example by offering the nurse's the possibility of immediate authorisation to change prescription via mobile devices and the oncologist the possibility of assessment and symptom control without having to see the patient. It has also offered the home care service the opportunity to plan future services and lobby for funding by offering audit, statistics, and performance evaluation and with these in place, the possibility for research.

The DITIS system was initially deployed in the district of Larnaca, with over 350 home visits recorded in August 2003 for 63 patients. The initial results indicated the usefulness of the system, as well as highlighted practical, at times frustrating, problems. DITIS is currently being extended to island-wide implementation to support the PASYKAF home-care service.

2. Justification of needs and aims of DITIS

The current context of health and health care is characterized by change and transition associated with health care system reform and restructuring [2, 3]. Restructuring initiatives are intended to develop a more results-oriented, integrated and accountable health system that delivers the right services, to the right people, at the most appropriate time, in the right place, in the most cost-effective manner. The aim is to enhance the health quality of populations, by better balancing health promotion and disease prevention, community-based and institutional
Further technological advances potentially enable a greater shift from institutional services to community-based services due to improved communication and efficiency.

In the context of home care, home care professionals visit patients at home. Traditionally, the team of professionals was (loosely) coordinated by weekly meetings, or in case of some urgent event information was exchanged by telephone calls, or face-to-face meetings. Often the same information is requested from the patient, so as each professional can build their own medical and psychosocial history and treatment notes (handwritten). These handwritten notes were filed at the PASYKAF offices, once the health-care professional returned to the office. On a scheduled visit, the file had to be removed from the office and taken with the health-care professional to the patients home. This was inflexible, as there was no possibility of access by another health-care professional at the same time. After hours on call professionals had to make a special visit to the office to collect the patient file (even if there was no other business with the office). For a patient visit to the hospital, especially in emergency, there was no possibility of immediate access to the patient file from the attending home care nurse. Therefore there was limited possibility for continuity of care from home based to institutional care.

As with every manual system, there was limited possibility for audits and statistics, research was difficult, evidence-based medicine was not supported, dynamic coordination of the team was almost impossible, and communication overheads were very high and extremely costly in human and monetary terms. DITIS is aimed to address these problems in the provision of home-care services by a team of professionals.

Generally, given the limitations of the existing home-care delivery models, the need for improved ICT supported practices emerged. Even though the context of health reform may vary across countries, major objectives are similar and include:

- a move towards people-centred services;
- a commitment to healthy public policy and a desire to improve the health status and quality of life of individuals and communities;
- increased emphasis on knowledge/evidence-based decision making and efficiency and effectiveness in service delivery;
- a shift from facility-based health services and a focus on illness, to community-based health services and a focus on wellness;
- the integration of agencies, programs and services to achieve a seamless continuum of health and health-related services; and
- greater community involvement in priority setting and decision-making.

DITIS aims to support the above healthcare reform objectives. We focus our analysis on home health care of cancer patients, but expect our results to be applicable to home healthcare in general as well as cross cultural and cross border interoperability. Thus through DITIS we expect to assist in the delivery of better home-care, by offering the health-care team services that are aimed in achieving a seamless continuum of health and health-related services, despite the structural problems of home-care, as compared to facility based care.

3. Identification of the healthcare team, their roles and collaboration scenarios

The healthcare team includes oncologists who are based in the oncology centre, treating doctors who are usually located in the community, specialist home care nurses who visit the patient regularly at home, and a number of other professionals called in as the demand arises, typically physiotherapists, psychologists, and social workers (see Figure 1). The home care
nurses spend most of the time with the patient, and thus the analysis has focused on them and their interactions with the rest of the healthcare team. Furthermore, nurses are the ones who form the teams as and when they are needed. Such virtual health care teams promise flexibility, responsiveness and new levels of collaboration. The nurse plays a central role in the home-care environment. The nurse will judge whether there is a need for a doctor or any other member of the caring team to visit the patient or whether to provide teleconsultation at the point of care. Clearly, the size of the team may vary depending on the nature of the enquiry. The nurse may have a virtual meeting with other nurses to check on routine enquiries such as keeping appointments. On another instance, the nurse may simply need to call the psychologist for consultation on the emotional state of the patient. For more complex situations, such as a sudden deterioration of a patient’s health the nurse may decide to have a more interactive teleconsultation with text messages, emails and telephone conversations with different medical experts.

Co-operative model of the caring team

As the discussion above indicates, e-health teams may consist of a diverse group of people. These teams are project or task-based, and need to be able to reorganise, dissolve, and select individuals with specific competencies according to need. In such virtual teams, where timely, effective and quality patient management care are the expected outcomes, high levels of interactivity often need to be developed quickly and it is important that they last throughout the short duration of the task life-cycle. Since these teams are often set up at the point of care, they are seen to have a fluid character as a result of the constant emergence of contingencies that require ad hoc and pragmatic responses [4]. Even though interactivity is often presented as a key characteristic of a computer-mediated communication system, the emphasis is often on the computer-human interaction rather than on human-to-human computer-mediated interaction and trust [5]. The latter is particularly important since virtual teams are effective not only because of technological advancements but also and most importantly because individuals are able to interact and thus constructively engage in knowledge sharing and creation in the increasingly emergent virtual work environments. In particular, we focus on interactivity among the key actors in medical virtual teams. In such virtual teams, where effective and quality patient management care are the expected outcomes, high levels of interactivity often need to be developed quickly and it is important that they last throughout the short duration of the interaction. During the last few years there is an increasing volume of literature on virtual
organisations and virtual teams [5], [6], [7], [8], [9]. This body of research generally agrees that virtual teams consist of a collection of geographically dispersed individuals who work on a joint project or common tasks and communicate electronically.

Several scenarios were identified and analysed in order to implement the collaboration system. The UML (Unified Modeling Language) has been used to identify roles and analyse and formalise collaboration scenario and tasks between virtual healthcare team members. Using results of the analysis the collaborative system software was developed. Some Common Scenarios include: Referrals, e.g. of a new patient to home-care, to other professionals, and for First home-care visit; Management of Home-care virtual team, e.g. creation/addition of members and communication with virtual team members; Community based tasks, such as change of prescription, bloods taken, and Chemotherapy; and Continuity of care, e.g. in outpatients, for patients admitted to a hospital, and for staff members on call. Due to space limitations the interested reader is referred to [10] for details.

4. System design

DITIS is an Internet (web) based Group Collaboration system with fixed and GSM/GPRS mobile connectivity. In the context of DITIS, a number of research and development issues were addressed [1], including: Requirements analysis, Infrastructure development, Design of EMR, Design of collaborative platform and collaborative software agents, Design of wireless e-services, Design and implementation of prototypes, Design of user interface, and Studies of system functionality. A brief overview of some of the design issues follows.

The development of DITIS was based on the HL7, ICD-0 and ICD-10 standards [11], [12], with a view toward an open Healthcare Information Infrastructure [13]. Note that continuous monitoring of international standards is necessary. In particular, in the light of the high priority for EMR, messaging (e-prescriptions), protecting personal information (PKI and health cards) [14] the use of the following standards is reviewed: the EMR, e.g CEN standard EN 13606, ISO PKI Technical Spec., multipart ISO standard on health cards, CEN standard for e-prescriptions, and for messaging HL7 Version 3 and XML.

The development team adopted the use of persistent mobile agents. Each user is assigned explicitly one mobile agent who is personalized to suit his needs, and ensure his/her continuous presence as a member of the virtual team (see Figure 2). Several features of mobile agents are currently being investigated [Error! Bookmark not defined.] and planned for implementation. DITIS users are busy health care professionals. Such users need fast access to medical information, e.g. side effects of a drug or of the combination of two drugs may lead to an unfortunate situation for the patient. This is classified as a standard human error, but the built in intelligence of agents can minimise this problem. The agent can retrieve information about the two drugs which are about to be combined from the database and deliver it to the user when it “feels” there is a need to do so. An additional equally important feature is the ability of the user agent to adapt its interfaces to any format the user device supports. In this case the agent can work as a proxy for transforming the output into the appropriate desired format. For example, in the case of mobile devices with small screen, the agent will reformat the output to ‘fit’ the small screen size, whereas for a desktop PC the agent will reformat the output for the ‘big’ screen. In this way, it is expected that the system will handle multi-modal devices and provide a better experience to the busy user.
Mobile devices were a necessity since most team members are mobile workers, visiting the patients at home, or needing to be accessible from anywhere at anytime. At the time of development high power mobile devices such as Pocket PC 2002 or Tablet PC were not available. Therefore the team turned to existing mobile devices such as the Smart-Phones, Pocket PC, Palm PC and Handheld PC. As a result, DITIS interface was built as simple as possible to support such devices. WAP and HTML technologies were used to address the problems of platform independence and portability. If the device supported a WML or HTML browser then it was supported as a candidate host for the application.

![Diagram](image)

**Figure 2.** The Client / Agent / Server application model used in DITIS, showing every user represented by a mobile agent.

An example interface is shown in **Figure 3** for two commonly available mobile devices, which show a number of menu selections for the home-nurses.
The design and development of DITIS, is based on commonly available technology, and includes and integrates: Flexible networking infrastructure, (GSM and GPRS cellular networks and ADSL for always-on high speed access to the Internet); Mobile Computing Units (e.g. Tablet PC, Pocket PC 2002, Handheld PCs, Smart Phones, PDAs), Mobile Agents running on the Voyager platform, for the implementation of flexible communication infrastructure for the support of mobile users; Relational Database with Java Database Connectivity (JDBC) for information storage and processing of Electronic Medical Records and Agents; Tele-cooperation system for sharing of information, team communication, coordination of team activities; Adaptive intelligent interface for database access from a variety of access units, such as devices with GSM/GPRS Internet connectivity, and Fixed units with Internet Access supporting Tele-cooperation; GSM Short Message Service (SMS) to enable push and pull of data and alerts, for example, whenever an agent updates information that affects the virtual medical team. MMS the emerging messaging system is under review. As all the technologies are Internet, GSM/GPRS, and JAVA based there is platform independence. The components collaborate seamlessly to implement the system.

5. Evaluation and Cost Benefit Analysis

5.1 Evaluation

A continuous evaluation of DITIS from a user perspective has been undertaken (longitudinal assessment) since the early phases of the project; full details will be reported at a future date. An overview of the initial results based on the internal report [15], follows. In this section, we present the key findings of the evaluations that has taken place so far on users’ views and expectation regarding Ditis and its implementation process.
The fieldwork has taken place in various district sites of PASYKAF. Each site is served by a number of palliative care nurses who visit patients regularly in their house offering care. Data on DITIS implementation were collected on different stages of the implementation process:

**Phase 1:** The preliminary part of the research has studied the use of mobile telephones by a group of palliative care nurses during the period August to September 2000. Interviews with three nurses and one doctor in the Larnaca site have provided useful insights on users' level of awareness about DITIS and its potential use in palliative care prior to system implementation. The data collected have also enabled a better understanding of nurses-to-nurses interactions and nurses and doctors/other specialists interactions. At the time of this study, the mobile phones were a popular communication device among nurses and doctors.

**Phase 2:** This part of the study took place in May 2001. By this time, some initial pilot implementation had taken place. This phase involved the use of a structured questionnaire that was sent to DITIS developers and potential users. It aimed to explore stakeholders' expectations regarding DITIS.

**Phase 3:** The third phase of data collection took place in April 2003. By this time DITIS has been implemented in four district sites and most of the nurses and some doctors had been given access to the system. During this phase, current users of the system in three district offices of Pasykaf were interviewed: 1 psychologist and 3 nurses. The main issues explored during interviews included participants’ actual use of DITIS, their own explanation of why they use DITIS the way they do, and their understanding of what users' and others stakeholders' role should be for achieving effective DITIS use.

*Perceived Benefits from evaluation study*

Overall, the data reveal that DITIS offers innumerable opportunities for palliative care nurses and other cancer-care practitioners. Nurses, psychologists and doctors acknowledge that DITIS has numerous advantages and that they are willing to incorporate it in their work activities. DITIS can improve communication, coordination and collaboration among members. Due to the huge amount of data regarding new and old patient records that need to be handled on a daily basis DITIS enables users to access data quickly either from their office or remotely. Furthermore, it can be used as a statistical tool, for producing internal reports for the district offices and the head office as well as external reports required by the Ministry of Health and other government departments.

"Pasykaf will be able to extract more information and statistics about cancer symptoms. Information about cancers and their occurrence by region will help to detect possible reasons that may be responsible about cancer (e.g. factories in the areas, etc)" (Developer, Phase 2).

Interestingly, even though technology phobia was identified in Phase 1 as a potential problem in the effective implementation of the system, it was later expressed by nurses in all districts that participated in Phase 3 that users have welcomed the implementation of DITIS in their workplace and were generally willing to adapt the system in their day to day work because they have experienced tasks to be executed faster and easier, saving time and effort:

"...Life will be so much easier with DITIS to fill in the gaps from unknown to known" (Limassol Nurse, Phase 3).
All participants agreed that the system was a novel one and a radical departure from the paper-based system that existed previously. It was also acknowledged that the system was at the core of Pasykaï’s activities (i.e. in the provision of health care to home-based cancer patients). Boddy et al [17] suggest that projects of this kind (novel and core) represent the most risky types of change and are likely to give managers major implementation problems, both technical and organizational. Indeed, the findings of the study identify several problems that hindered effective implementation including discontinuities in funding and consequently in staffing which led to delays, frustrations and inconsistencies. Based on the results of the longitudinal assessment corrective measures are continuously being taken. For example, over the last year, a more stable team has been developed due to the commitment of all relevant stakeholders and availability of funding.

5.2 Cost Benefits

DITIS allows the specialist nurse and the patient to become the assessment tool. The technology has allowed this assessment to be accessed remotely from anywhere, anytime, via mobile devices. The results of an initial assessment on the cost benefits indicate the usefulness of the system to all the stakeholders. A continuous assessment plan is currently in place and benefits are expected to increase as the users become aware of the systems capabilities.

The Benefit to the Patient is an Improved Quality of life

- Patients able to choose their place of care, trusting that their medical needs will be met.
- Protected prescription via secure access, by specialist Dr. (depending on legislation, including e-signature). Telephone prescribing is in question in many countries and requires two registered nurses to be present. This is almost impossible in remote areas of the community. If telephone prescribing ceases this would affect many people as they may need to opt for hospital/hospice or an old age facility away from the support of extended family networks.
- Symptom control attended remotely by specialist Dr. in charge of the case in consultation with specialist nurse or general practitioner, rather than these professionals working alone. For difficult cases this consultation could include an overseas based expert. This offers immediate, efficient and safe control of symptoms. Improved symptom control improves quality of life.
- Enhanced communication within an extended virtual team as the same record is shared. Patient does not have to repeat the same information to different team members. Improved co-ordination of care especially if there is new staff member or staff on call at nights or weekend.
- Improved co-ordination of care from different services, e.g home care to hospital. The full history and record from the home care is accessible avoiding misinterpretations from a history taken from a distressed patient or family, for example in casualty.
- Improved health practices by using validated tools and evidenced based practice to monitor patients

Benefits to the health care professional
- Prescription via secure access, gives nurses the opportunity to work in the community safely and legally.

- If patients symptoms are managed well, there is less job stress and burnout within the health care team (Evaluation in place, still continuing)

- Shared record means time saved handing over patients to different on call staff each day and different members of the team, e.g nurse to physio etc.

- If a full record is accessible to nurse on call she can often avoid a visit and manage symptoms remotely.

- If telephone prescribing ceases Dr’s will need to remain on the premises of smaller community hospitals and hospices to allow for alteration in prescription, working longer hours and increased job stress. Remote prescription avoids the problems of telephone prescription.

- The possibility of staff to work remotely not having to meet daily in the office to discuss patients; a saving in time. A team meeting required only once a week to discuss difficult cases.

Benefits for the organisation -The Cyprus Association of Cancer Patients and Friends

- Organisation can audit their work effectively

- Organisation can use the audit for evaluation of their service

- From this evaluation planning of new staff, future services and educational needs can be justified

- Offers the possibility to research in home care. After an effective evaluation, areas that are lacking will become more obvious and research can be attended that will hopefully offer evidence based protocols of care.

- Improved management of stock for example equipment loaned in the home.

- Accurate management of staffing hours and travel costs to visit patients

Benefit to Community/Government

- A more cost effective health service utilising the home as a medically safe and comfortable place of care

- The possibility to effectively monitor and audit money contributed to the health sector at any time.

- Effectively use specialist nurses with enhanced cost effectiveness

- Flexible collection of statistical data that could be linked to national statistics.

- Cost effective if telephone prescription becomes illegal as e-prescription will reduce manpower required, (recall, as an example, the current debate in England due to the Shipman inquiry).
The investment in new technology, development costs, initial deployment costs, and finally running costs are offset by the gains indicated above. As a crude estimate the development costs were around 250 KEuro. These were contributed by an initial research grant of 50000 Euro, in-kind contributions by the partners and some small donations for the purchase of devices. The running costs are not expected to exceed ten thousand Euros for managing the basic infrastructure, plus around 200 Euro per healthcare professional per year, mainly for telecommunication costs for accessing data (based on today’s high costs for accessing data through mobile devices).

It is worth pointing out that the cost of setting up such an infrastructure and supporting it, versus the benefits such as Quality of Life, time saved, and job stress are difficult to justify in purely monetary terms.

6. Conclusion

Today, some 8 years after the initial idea of DITIS [16], the face of cancer care and telecommunications in Cyprus has transformed. The Bank of Cyprus Oncology Centre was recently established, and is working with us on direct referrals through the system and security issues. Also the new technologies of ADSL and GPRS offer easier access by the health care team to current patient information and each other, at all times, and from anywhere. The results of an initial assessment on the cost benefits indicate the usefulness of the system to all stakeholders.

DITIS is offering the possibility for a flexible dynamic virtual health care team for every patient. We expect it will lead to an improved quality of life for both the patient and the health professional. We continually strive to improve user friendliness and responsiveness of system, being aware that the healthcare professional is not always computer literate and always busy.

In conclusion, DITIS delivers a product that can improve the quality of the citizen’s life. Contrary to today’s health processing structure which is, in all practical terms facility-based, this project shifts focus onto home-based care, where everything is moving around the patient. Thus chronic patients, such as the cancer patient, can now enjoy ‘optimum’ health service, with improved quality of life, in the warmth of their own friendly environment, without a degradation in the quality of care provided to them, feeling safe and secure that in case of a change in their condition the health care team will be (virtually) present to support them.

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