ICT ARCHITECTURE FOR A COMMUNITY MEDICINE NURSE PROJECT

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Abstract: In the Federal State of Mecklenburg-West Pomerania 35-40% of the general practitioners (GPs) will retire within the next 5-7 years. In rural regions, it is difficult to find successors for the vacant practices. Thus a problem of supplying primary health care to the elderly population in rural regions is foreseeable. An efficient way to lower the workload for the remaining GPs is the implementation of a special trained community medicine nurse (cm-nurse). The cm-nurses are supported by telemedical devices, a video conference system and a mobile data management system. In this paper we report on the information and communication technology (ICT) architecture of the project.

1 INTRODUCTION

Society's demographic change and structural changes in the German health-care system are nationwide challenges. In the Federal State of Mecklenburg-West Pomerania, demographic changes are developing more dynamically than in many other regions in Germany. At the end of 2005, 25.4% of the population was more than 60 years old - a percentage which will climb to 34.8% by the year 2020. One of the consequences of an ageing population is the increase of age-specific diseases.
On the other hand, 35-40% of the general practitioners (GPs) will retire within the next 5-7 years.
In rural regions, it is difficult to find successors for the vacant practices. Thus a problem of supplying primary health care to the elderly population in rural regions is foreseeable. The Institute of Community Medicine of the University of Greifswald and the Institute of Computer Science of the University of Rostock have started an interdisciplinary research project between the faculties of medicine, health economics, pharmaceutics and informatics to develop a model project for a cm-nurse that supports GPs in the primary health care for elderly patients in rural areas (Terschüren, 2007). One of the main goals of the project is to develop a model that disburdens the GPs in rural areas in the task of serving an ever increasing area and therefore spending a lot of time travelling from the patients for home visits. The idea is that a part of the home visits can be carried out by a special trained cm-nurse, supported by telecare equipment. Modern mobile technologies, a carefully designed information flow between the cm-nurse, GP and the participating pharmacists as well as a central data store for epidemiological and health economic evaluation are the prerequisites for the development of a new model that is unprecedented in the German health care system.
A key role for the success of a project of this kind plays the underlying ICT infrastructure. While the different devices and techniques needed already exist,

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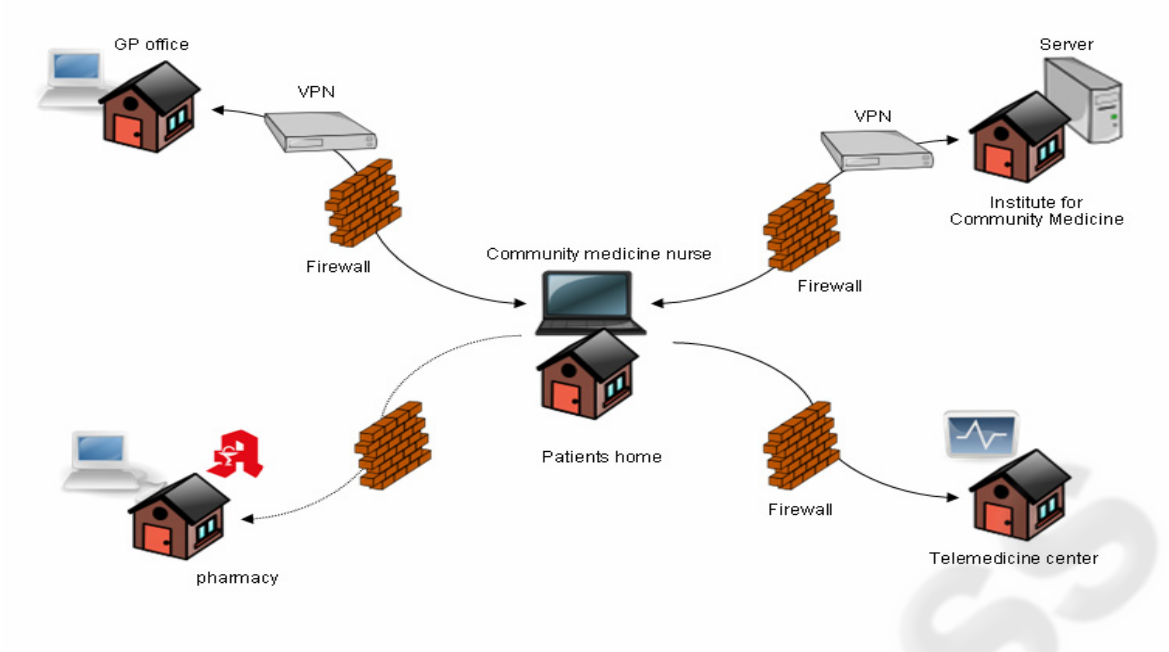

Figure 1: System Architecture.

the integration of these into a working system is still a challenge. In this paper we focus on the technological aspects and challenges for the ICT infrastructure needed to allow the project to work.

2 DESIGN OF THE SYSTEM

Several requirements had to be fulfilled and influenced the design of the system. The main requirement was that the system should work in rural areas with no guarantee of internet access. Further, the system should be open for different clients and operating systems. Another requirement was the usability of the system. The software should be designed in a way that reflects the workflow that the nurse is accustomed to.

Figure 1 gives an overview of the system. The central part is a tablet-PC that is used by the cm-nurse during the home visits. The Institute for Community Medicine has developed standardised questionnaires to support the cm-nurse in the daily work and to collect data for research. At the end of a working day the cm-nurse transmits the data to the central database. To support the research in the project, a central database with pseudonymized patient data was installed in the Institute of Community Medicine. The database consists of a MySQL database currently running on a Windows 2003 server behind the university firewall. The cm-nurses use a VPN client to log into the university network to access this central database. Several other interfaces exist in the system. To support the drug anamnesis module data is exchanged between cooperating pharmacies the GP and the cm-nurse. The data that the nurse collects can be sent to the electronic patient record (EPR) system in the GP office. Several telecare devices are also used in the system. This interface is currently not integrated into the system and is not considered here.

3 IMPLEMENTATION

Whenever possible we used open source software for the system. The system was implemented as a client server system. We used the model-view-controller (MVC) design pattern for the development of the system. This allows for easy implementation of different clients. Figure 2 illustrates the software design. Currently the only clients used are tablet PCs. But it is also possible to use PDAs or UMPCs. Apache Struts is used as the framework. Tomcat 5.5 is used as servlet container. The recorded data is stored in a local object database (DB4O) on the tablet PC. At the end of a working day the cm-nurse transmits the data to the server in the Institute for Community Medicine using a VPN connection. On the server the data is inserted in a MySQL database. This is done using Hibernate for the

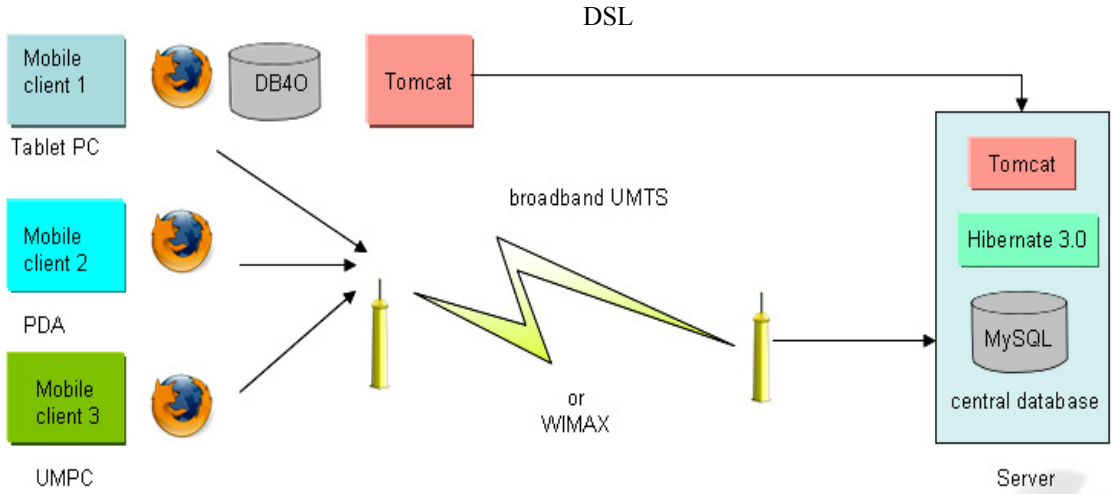

Figure 2: Software Design.

object-relational mapping. The software was designed in a way that it is possible to add other mobile clients in a later phase of the project.

4 DISCUSSION

The constraint with the highest impact on system design was the requirement for the system to work in rural areas. This is a contradiction to the need of a broadband wireless infrastructure. In the first pilot project we experimented with WIMAX but it was not possible to serve the area needed. An alternative is GSM/GPRS or broadband UMTS. Both system were not available in all of our test regions. We also noticed problems with unstable connections. Therefore we decided to implement a system that allows the nurse to work offline. The nurse selects the patients she wants to visit. All the data is copied to a local database on the tablet-PC. Once the nurse is back in her office, she connects the tablet-PC to the internet and transmits the data to the central server.

Another process was the selection of the client. We proposed three clients: A tablet-PC, a PDA and a UMPC. PDAs are already in use in different clinical settings and also in home care (Hsu, 2007; Alonso, 2004). Although the PDA is small, light and has a long battery runtime, we opted against the PDA because the display is too small for our application. The modules are designed to guide the cm-nurse through her visit with standardised questionnaires. On a PDA the handling was judged to be too complicated. The UMPC was ruled out due to the low battery runtime. We finally choose the tablet PC as a compromise. It has a good battery runtime, allows a good visualisation of the questionnaires and is easy to handle with the pen.

Table 1 shows the kind of data and the number of measurements in the monitoring module in one of the projects.

Table 1: Type and frequency of data in the monitoring module.

Module	**# of Measurements**
Monitoring	1822
Blood pressure	1696
Pulse	1241
Drink monitoring	1142
Blood sugar	839
Weight	486
Blood sample	364
Nutrition advice	382
Medical advice	273
Conversation	126
Vaccination	125
Wound examination	112
Dressing	101

The decision to use the Apache Struts Framework was partly due to time constraints in the project. We

only had one month to develop the core of the system. The Apache Struts framework with the validation support and the supplied libraries was an ideal starting point for a prototype. Later on it was very easy to add new modules to the software and it was decided to keep the web application instead of developing a native client. A disadvantage of the servlet technology is the response time that the servlet container needs to build the page and the stateless interface. The advantage, however, is the easy to use interface and the maintainability of the software. Currently the software is used in four different field trials by 27 cm-nurses.

To the authors knowledge the model of a community medicine nurse supported by ICT as described here is new. However, the participation of nurses in primary care or the support of GPs by nurses is already considered in several countries. In the systematic review of (Laurant, 2005) the authors come to the conclusion that appropriately trained nurses can produce as high quality care as primary care doctors and achieve as good health outcomes for patients. The report of (Bourgueil, 2005) compares the situation in six European countries as well as in Quebec and Ontario. However, there is few information of the ICT used by nurses to communicate with the GP. Most of the published literature is concerned with telenursing or telehomecare. Telenursing refers to the use of telecommunications technology in nursing where the nurse either does a "virtual visit" using a video conference system or a telephone to provide home care services. Studies in Europe suggest that a large number of patients could benefit from in-home telecommunication services (Valero, 1999). Telehomecare means the delivery of health services over distances into the home care setting where home health nurses use technology to provide services in the home which enhance the efficiency and the quality of care (Milholland, 1995). In these use cases ICT is used to support a home health nurse in providing her service, usually over a distance. Although we also use telemedical devices the primary use case of our software is the standardised communication of a cm-nurse with the GP. The cm-nurse works in delegation of the GP i.e. a task formerly carried out by the GP is now transferred to the cm-nurse. However, the GP needs to have the overview of the health state of the patient and therefore needs the measurements as well as the standardised questionnaires to get an impression of the patients' current health state. Table 2 gives an overview of the currently implemented modules.

Table 2: Overview of implemented modules.

Module	Description
First Interview	General questions. Carried out during first patient contact
Standard monitoring	Module that is carried out during every home visit
Training for telemedical devices	Used to document the training in the use of the telemedical devices
Fall prevention	Standardised questionnaire for the detection of fall risks in the domesticity of the patient
Drug anamnesis	Registration and check of all drugs in the domesticity of the patient (including interaction check in cooperation with local pharmacist)
Geriatric assessment	Test for signs of possible dementia: clock drawing test (Shulman, 1986), DemTect (Kessler, 2000)
Palliative care	Management of pain and provision of psychological and social support
SF-12	Short form of the SF-36 health survey for assessment of the health related quality of life of patients (Bullinger, 1995)

A project that uses very similar technology is from the Luleå University of Technology in Sweden (Andersson, 2007). The project is called SARAH and is run by the Center for Distance spanning healthcare at Luleå University of Technology, Norrbotton County council and the municipalities in Luleå and Boden. In this project a district nurse is supplied with a field rucksack with a laptop facilitating mobile access to the electronic patient record and videoconferencing between the GP and the district nurse, an electronic stethoscope, a digital camera and other telecare equipment.

For future work an interface for the cooperating pharmacies is planned where the pharmacist can

access the questionnaire for the drug anamnesis module.

5 CONCLUSIONS

An ageing population, fewer GPs in rural areas and high costs in the healthcare system challenge the development of new models in home healthcare. ICT offers numerous potential benefits in terms of improvements for patients, professionals and cost savings in the healthcare system. We have implemented a complex ICT infrastructure to support a community medicine nurse that carries out home visits in delegation of a GP. The ICT infrastructure supports the cm-nurses in their daily work as well as providing data for the health-economical and epidemiological evaluation of the project.

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