Biomed Tech 2013; 58 (Suppl. 1) © 2013 by Walter de Gruyter · Berlin · Boston. DOI 10.1515/bmt-2013-4313

DEVELOPMENT OF A COMMUNICATION SERVER FOR LONG-TERM TELEMONITORING OF PATIENTS WITH COPD

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Abstract: *The COPD is one of the most chronic diseases in the world. To reach an integrated accommodation of these patients it is necessary to deploy a telemedicine monitoring. Basically the vital signs of the patients need to be captured with medical device technology. Then the data is send to different actors in healthcare. Data security and interfaces to different systems must be noted in this case. Within the scope of the infrastructure there is a need of a communication server which can transfer the data to different systems.*
The goal is that the server is developed preferably open, expandable, maintenance-friendly and economic.

Keywords: *COPD, telemonitoring, communication server, web service, service-oriented architecture*

Introduction

The demographic change and the advance of the age are very important. These factors have a big impact of healthcare. That means that the costs will increase more and more [1]. With this change the rate of chronic diseases will increase [2]. Especially chronic airway diseases are playing an important role, especially the COPD which is the 4th cause of death in the world.

Meanwhile the telemedicine has a big meaning in the accommodation of chronic diseases. The goal of telemedicine accommodation is defined as comprehensive information processing which can optimize the patient accommodation and care. Through these factors the quality of living should be increase [1]. Some studies are proving that longer and more exact studies are needed for evaluating the quality of living from COPD patients [3, 4].
Currently we are developing in a project a platform that documents telemonitoring continuous device parameters and safety aspects [1].
Within this project, a platform is been created that adjusts the different communication systems and their interfaces to each other. This platform will enable long-term studies in the field of telemedicine monitoring of COPD patients. To perform a perfect monitoring, it requires a patient selection. At this point, patients with gold stage 3 or 4 should be selected.

First the vital signs are recorded, using medical-technical devices in the home environment of the patient. Then, the data is transmitted to relevant institutions to provide integrated care. That includes doctors, treating hospitals, emergency services and medical service providers. The data collection of the vital signs of the patients should be done with a Smartphone. For example, oxygen saturation, blood pressure and respiration values are documented.
Subsequently, the collected data is transferred out of the home environment of the patient. To ensure this, all newly collected medical data needs to be sent from the Smartphone to the communication server. This essential hub for transfer provides the server. The transmission to the communication is via a mobile internet network. These data has to provide to other systems.

As particularly important is a mechanism seen which may detect a life-threatening condition of a patient. This data must be send via SMS.

Methods

The development of the communication server as part of the project requires on the one hand software engineering methods but also the variety of software systems that are needed for developing and operating the server.
The development was based on the software life circle within the context of the requirements engineering, functional and non-functional requirements were defined, which should be placed on the created system. Furthermore, the design of the server, which was divided in coarse and fine design, has been defined. In the rough draft the global software architecture and subsystems were modeled. In the detailed design the classes and components for technical programming were created. This was followed by the implementation of the functionality of the server and adequate software testing.

Results

In the requirements analysis, the most important functional und not-functional requirements were defined. Here the most important requirement was an encrypted data transfer between phone and server to allow communication. The communication server checks if the transferred data is correct and gives feedback whether the data were correct or incorrect.
Subsequently, the successfully transmitted and checked data are stored persistently in the database. After this process a check to critical monitoring parameters is made.
This procedure checks whether these values where exceeded or deceeded.

If critical data is recognized, there must be a possibility of sending an SMS with this information. Furthermore, the possibility of communicating with other medical information systems, was defined.

The decision fell on the open-source software, Mirth Connect, which enables a unified and standardized information exchange with the communication standard HL7 in healthcare. Recently, the possibility of message exchange between doctors and patients can be guaranteed.
The demand for platform independence led to the use of SOA-based web services. As seen in Figure 1, the communication between the individual components is only via the central SOA component that is implemented with web services possible.

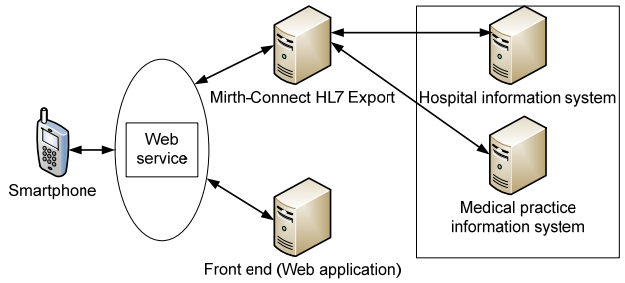

Figure 1: Service-oriented architecture of the Servers

The implementation was done in the .NET Framework based on the Windows Communication Foundation and the C# programming language. The essential basis of the communication server is the server operating system Windows Server 2008 R2 on which the instances were installed, which were necessary for the use of the communication server.
This includes a Microsoft SQL Server 2008 R2 that provides the database and Internet Information Service (IIS) that hosts the web server. Finally, the actual program code for the web service was developed in the programming language C#.
With help of white-box testing, the inner function of each software component has been tested.

Discussion

With the platform a telemedicine infrastructure is created which provides an integrated and improved care of patients with COPD. At this point we will see whether increasing the quality of life of the patients and reducing health costs with respect to the disease is possible.

Based to the determination of a certain group of patients, and other essential parameters, such a lung sounds, heart rate or oxygen saturation, the study can establish from the previous scientific studies to make more accurate and prolonged investigation.
The required communication infrastructure must prove stability, extensibility, maintainability and an ideal information exchange between all involved components.
The communication server provides with its service-oriented architecture as a web service and independent and bundled component in the communication infrastructure.
The decision to use a service-oriented architecture was especially important to carry out extensions and changes easily.

Acknowledgement

We thank the Hessian Ministry for Science and Art for financial assistance under the state program LOEWE.

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