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Ontology-based Medical Decision Support System to Enhance Chronic Patients' Lifestyle within E-care Telemonitoring Platform

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Abstract. The aim of this paper is to describe an original approach which consists of designing ontology based Medical Decision Support System (MDSS) to enhance the patients' lifestyle. This system is composed of two main parts: data collector which collects relevant lifestyle-related patient data by prompting the only significant questions in connection with the patient's medical background, and advices provider which provides personalized lifestyle advices to the patients regarding their lifestyle changes. The proposed MDSS is integrated within E-care home health monitoring platform in order to: (i) improve the patient's healthy lifestyle; (ii) educate the patients towards their disease; (iii) increase the early detection of risky situation.

Keywords. Medical Decision Support System, Ontology, Lifestyle, Monitoring

Introduction

Poor lifestyle choices, such as smoking, overuse of alcohol, poor diet, and lack of physical activity are factors contributors in the development and progression of chronic diseases including hypertension, heart failure, obesity, diabetes, etc. [7].

Home telemonitoring is a branch of telemedicine which aims to provide a way to monitor patients and their needs within the comfort of their own homes [8]. Often the monitoring of patients requires tools such as Medical Decision Support Systems to warn clinicians of potential anomalies in patients' health status, and to provide recommendations to enhance patients' health status.

In this paper, we present an original approach for designing Ontology based Medical Decision Support System. The proposed system gathers the most relevant information related to the patient and his lifestyle and then provides individual

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advices for patients to enhance their lifestyle. Our MDSS is based on the use of ontologies that offer an easy way for the representation of patient data and domain knowledge.

The proposed MDSS is integrated within E-care home health monitoring platform [1], [5] in order to educate the patients towards their disease and to improve their lifestyle.

The remainder of this paper is structured as follows. In the next section we present E-care platform. Section 2 describes our approach within E-care health monitoring platform and we conclude our paper with the section 3.

1. E-care platform

E-care is a home health monitoring platform for patients with chronic diseases such as diabetes, heart failure, high blood pressure, etc. [1], [5]. The aim is to educate patients to maintain a healthy lifestyle, and reduce emergency by ensuring an early detection of any anomalies in patient health status.

For this purpose, the patient is invited daily to collect his physiological data (heart rate, blood pressure, pulse, weight, etc.) using medical sensors (Blood Pressure Monitor, Pulse Oximeter, Weighing Scale, etc.) and to answer on lifestyle questionnaires for gathering his lifestyle data (tobacco-use, eating habits, physical activity, sleep, stress, etc.).

The collected data (lifestyle data and physiological data) is retrieved through a mobile device (tablet or smart-phone) and then sent via the Internet to the medical server. The medical server processes the collected data using an inference engine by taking into account the patient profile and then triggers alerts to notify physicians if dangerous situations are detected. Moreover, the collected data is also used to provide customized advices that the patient should follow to improve his lifestyle and his medical conditions.

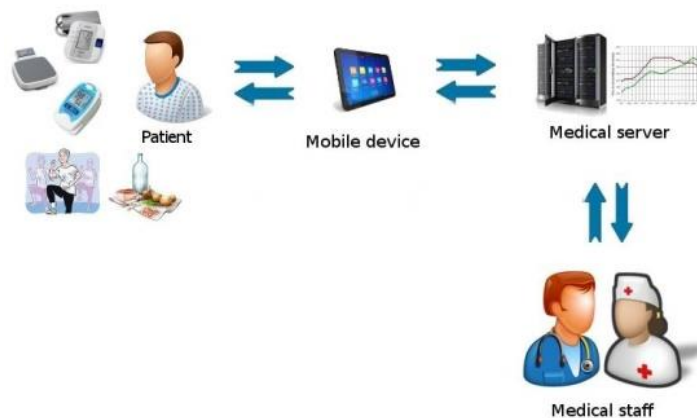


Figure 1. E-care platform

2. Methodology

The proposed approach consists of designing a knowledge based MDSS to educate the monitored patient towards his disease by providing useful advices. To achieve this goal, the proposed MDSS collects relevant information about the lifestyle of the patient. The collected information is treated by the advices provider and then provides customized lifestyle advices. These advices are inferred from medical guidelines using an inference engine and adapted to the patient profile.

The proposed MDSS is based on the use of ontologies and is composed of three main parts:

2.1. Knowledge Base

Considering the advantages of using ontologies as mentioned in [6], the knowledge base is structured in an ontological format using the Web Ontology Language (OWL). It is composed of four ontologies as follows:

2.1.1. Patient Profile Ontology (PPO)

PPO is used to represent data that accurately captures the state of the patient at all time. It is crucial in E-care platform as it contains relevant information about the patient including general information (age, sex, job, ethnic group, etc.), medical information (pathologies, allergies, treatments, surgical history, etc.), medical measurements (blood pressure, weight, heart pulse, etc.) and lifestyle information (physical activity, eating habits, smoking, sleep, etc.).

2.1.2. Questionnaire Ontology (QO)

QO introduces concepts representing generic components of a questionnaire (sub-questionnaires, questions, potential answers, etc.) and relations between them. It was designed based on works done in [2, 3, 4].

2.1.3. Lifestyle Ontology (LSO)

LSO is a domain ontology which is designed to drive the creation of the questionnaires by offering sense for each question. The lifestyle ontology contains a generic representation of lifestyle concepts and relation between them. It is created based on the recommendations proposed by Haute Autorité de Santé (HAS).

2.1.4. Guidelines Ontology (GO)

GO is designed to model the medical guidelines which are used to derive the lifestyle advices. The guidelines ontology is created based on the guidelines document proposed by accredited organizations such as European Society of Cardiology (ESC) for cardiovascular diseases.

2.2. Data Collector

The data collector is used to collect lifestyle-related patient data. The Data Collector employs the Questionnaire Ontology to provide daily questions. These questions aim

to gather relevant information about the lifestyle changes (tobacco-use, lack of physical activity, poor eating habits, etc.). The data collector adapts the posed questions to the patient profile by taking into account the medical conditions (Medical history, treatments, etc.) and the answers given by the patient.

2.3. Advices Provider

The advices provider used to provide personalized lifestyle advices to patients for healthy lifestyle. Basing on the collected data and the patient profile, the advices are inferred from the Guidelines Ontology using the inference engine. These advices are then sent to the patient through his mobile device.

3. Conclusion

In this paper, we presented a novel approach, which consists of designing ontology based Medical Decision Support System to enhance patients' lifestyle. This system permits gathering the most relevant information by providing personalized questionnaires regarding to the patient profile and then provides customized advices depending on the information collected and the medical background of the patient.

The proposed system is integrated within E-care health monitoring platform in order to: (i) improve the patient's healthy lifestyle; (ii) educate the patients towards their disease; (iii) increase the early detection of risky.

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