

Personal Health Assistance Service Expert System (PHASES)

Chakkrit Snae, and Michael Brueckner

Abstract—In this paper the authors present the framework of a system for assisting users through counseling on personal health, the Personal Health Assistance Service Expert System (PHASES). Personal health assistance systems need Personal Health Records (PHR), which support wellness activities, improve the understanding of personal health issues, enable access to data from providers of health services, strengthen health promotion, and in the end improve the health of the population. This is especially important in societies where the health costs increase at a higher rate than the overall economy. The most important elements of a healthy lifestyle are related to food (such as balanced nutrition and diets), activities for body fitness (such as walking, sports, fitness programs), and other medical treatments (such as massage, prescriptions of drugs). The PHASES framework uses an ontology of food, which includes nutritional facts, an expert system keeping track of personal health data that are matched with medical treatments, and a comprehensive data transfer between patients and the system.

Keywords—Personal health assistance service, expert system, ontologies, knowledge management, information technology.

I. INTRODUCTION

THE much talked about “paradigm shift” from the traditional hospital-centered to citizen-centered care necessitates greater involvement of citizens in the delivery of healthcare. One of the key elements fostering this is implementation of the eHealth IT infrastructure [1]. The EU has launched ambitious initiatives in an effort to create a Europe-wide health information network and has fostered a collaborative approach to e-health by its member states [2].

This shift provides promise for coping with the forthcoming challenges and for meeting the requirements mentioned above. Information and Communication Technologies (ICT) will play a decisive role in promoting the concept of citizen-centered care, given appropriate R&D support in the coming years. In combination with proper organizational changes and skills, new tools and services based on ICT will become the key enablers of shared and continuous care. This will be achieved through eHealth solutions that (a) provide the necessary connectivity between various distributed points of care and electronic patient health records; and (b) enable the development and implementation of Personal Health Systems.

Manuscript received November 7, 2006.

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A personal health record (PHR) is medical information that is in the possession of an individual patient (or patient's non-professional caregiver). The format may be either paper (or similar types of) documents, electronic media, or a combination of both. Any of the types of data listed above may be included. It may also include information that a doctor may not have, such as exercise routines, dietary habits, herbal or nonprescription medications, or results of home testing (such as home blood pressure or blood sugar readings).

The term has been applied to both paper-based and computerized systems; however, current usage usually implies an electronic resource, which is sometimes called electronic health record (EHR). In recent years, several formal definitions of the term have been proposed by various organizations [3] [4] [5]. Although each definition is unique, most of the definitions agree that the PHR is a computerized application that stores an individual's personal health information and is not limited to a single enterprise or hospital.

It is important to note that PHRs are not the same as EHRs (electronic health records). The latter are software systems designed for use by health care providers. Like the data recorded in paper-based medical records, the data in EHRs are legally mandated notes on the care provided by doctors or hospitals to patients. There is no legal mandate that compels a consumer or patient to store her personal health information in a PHR.

PHRs can contain a diverse range of data but usually include information about:

- allergies and adverse drug reactions,
- medications (including dose and how often taken) including over the counter medications and herbal remedies,
- illnesses and hospitalizations,
- surgeries and other procedures,
- vaccinations,
- laboratory test results,
- and family history.

This paper is organized as follows: after the introduction we give a short account of the relevant literature on systems for personal health assistance and their prerequisites. Section 3 covers the basic requirements for PHASES, followed by an overview of the system framework. Finally, conclusions are drawn and further work is outlined.

II. LITERATURE REVIEW

Currently, there are many initiatives to stimulate and to initiate the personal health awareness of people regarding their health and fitness [2], [6]. On the other hand, it seems to be clear that societies cannot provide a health system that works automatically. One of the important factors is the readiness and capability of the people to make use of the initiatives' work and programs and observe a healthy lifestyle. The most important ways for this are healthy food and an active lifestyle.

As these initiatives reach the individual citizens, they must be thoroughly assisted by an environment that is able to keep track of personal medical data, e.g. [7]. This can be done with the help of databases, which store the personal health data and retrieve the data on request of the patient. There are several knowledge sources on the nutrition domain, which can be checked for their adequacy. Of these sources: the USDA National Nutrient Database for Standard Reference is a database published by the United States Department of Agriculture. It comprises thousands of food items with many food components [8].

To minimize medical errors Active Semantic Documents (ASD) are used, which make use of Semantic Web technologies, such as ontologies [9]. Ontologies, especially, are used in many special applications [10], [11]. Villarias [12] describes an ontology of culinary recipes, developed to be used in a semantic querying system for the Web. Expert systems (or rule-based systems) have also been used for a long time in health care (e.g. [13]).

Loojie et al. [14] talk about the incorporation of a personal health assistance system into an intelligent social robot. A social robot exhibits humanlike social characteristics; some important elements of human-robot interaction are [15]

- Express and/or perceive emotions
- Communicate with high-level dialogue
- Learn/recognize models of other agents
- Use natural cues (gaze, gestures, etc.)
- Exhibit distinctive personality and character
- If possible, learn/develop social competencies

Not all activities regarding public healthcare information systems succeed. Heeks, Mundy and Salazar state some of the reasons behind success and failure of such systems in [16].

III. REQUIREMENTS FOR PERSONAL HEALTH ASSISTANCE SYSTEMS

A careful analysis of the literature has led us to the following overview of the topics involved in the PHASE framework (Fig. 1). Data input can be performed by the users (patients) themselves, by doctors and nurses or by using a data transfer from hospitals and clinics. Data used for assisting the patient are paper-based or in various forms computer-based, including Bluetooth devices for the measurement of health parameters on mobile platforms. Using exchange standards, such as ISO/TC 15 based standards, facilitates the data transfer between different medical institutions and PHASES. The patients must be assisted within the medical history, the

diagnosis, and the treatment, which can cover advice on healthy food, diets, exercise, and drugs.

In order to exchange medical data between heterogeneous systems it is necessary to share common concepts of data, information, and higher order concepts. This calls for semantic data, usually implemented or generated as ontologies [9]. For PHASES we have to create and share concepts of health represented by healthy food and nutrition, lifestyle, appropriate prescription of drugs according to symptoms and general health data based on individual record of the medical history. For the time being the system uses an ontology of food and nutrition accompanied by an expert system on healthy lifestyle that uses an appropriate rule base.

Some of the basic questions that have to be answered by the ontology are:

- If users have entered a specific disease (or taken from PHR), such as diabetes, in the user interface, what is the suitable kind of food?
- Which are good alternatives for ingredients of a meal the user has chosen?

With the help of the expert system in PHASES more complicated questions can be answered. Examples of such questions are:

- How much intake of vitamin K do I need regarding my constitution, gender, and body-mass-index?
- What kinds of exercises suit the patient best?
- What kind of foods might be appropriate for the patient?
- What general treatments do patients need?
- Which drugs have mutual influence and should not be prescribed simultaneously?

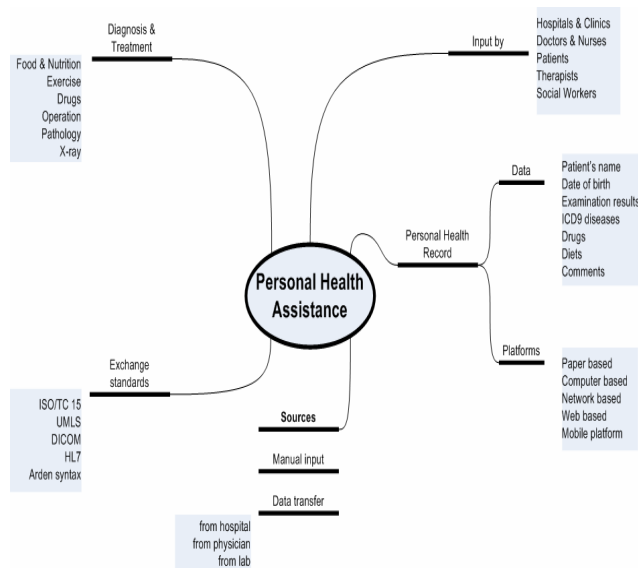


Fig. 1 Mind map on personal health assistance systems

The basic categories of food and nutrition as they are developed for the PHASES system are shown in Fig. 2. This ontology is actually a further development of a project the authors carried out for a pure food ontology [17].

The PHASES ontology makes use of food specifics, such as animal-based or plant-based food, flavors, added by nutritional facts, such as vitamins, proteins, fats, carbohydrates, and so on. These data can then be used by the expert system and other facilities to generate assisting advice and more shared data if necessary.

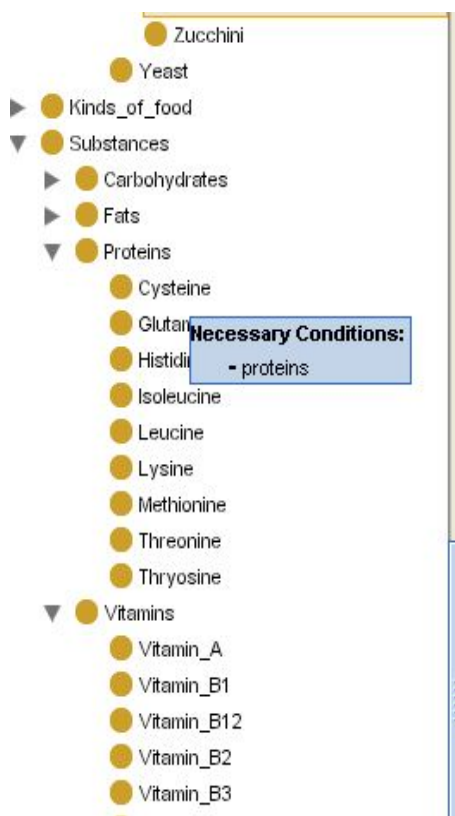


Fig. 2 Basic categories of nutrition

IV. SYSTEM FRAMEWORK OF PHASES

In this section an overview of framework of PHASES is provided (Fig. 3). The framework comprises (1) a database on personal health data that are necessary for processing assisting advice consistently; (2) a data transfer mechanism, which is open to different technologies and standards; (3) an expert system with decision support, which uses the personal health data and a medical inference engine; (4) an ontology of food and nutrition; and (5) a user interface, which is easy to use. In the following these components are described in more detail and outlined according to the intended use in PHASES.

(1) The database or Personal Health Record (PHR) is feeded by the patient manually or by the hospital/clinic that is responsible for the patient via data transfer. The PHR consists of individual data about the patient, such as full name, date of birth, height, weight and medical history (examination results, diseases, and drugs).

(2) The data transfer mechanism in health care systems is important in many environments, e.g. for nomadic patients [18]. It needs a secure and reliable connection over potentially wide ranges. The transfer of data can be processed by many

different protocols, such as HTTP, SHTTP, Firewire, Infrared Connection, and Bluetooth.

(3) The core expert system of PHASES uses a medical inference engine with forward chaining that uses the data of the PHR as a feed to generate appropriate advice and suggestions.

(4) The ontology of food and nutrition consists of concepts for ingredients, nutrients, substances, and so on, defining the semantics of nutritional facts, and makes these data available in other systems. This ontology extracts and gathers nutrient data reliably. Generally, ontologies emanate from the idea of the Semantic Web and are used more and more for automated data exchange, collection, and manipulation in the Internet.

(5) The user interface plays a crucial role in fostering the awareness of a patient's healthy lifestyle and assisting a sustained interest in health topics related to individual needs. Besides an ergonomic and easy-to-use approach, there is also the need for a user-centered explanation level to make sure that patients perceive - and maybe internalize - the matter of facts presented through the various levels of abstraction, which are held and expressed by the system.

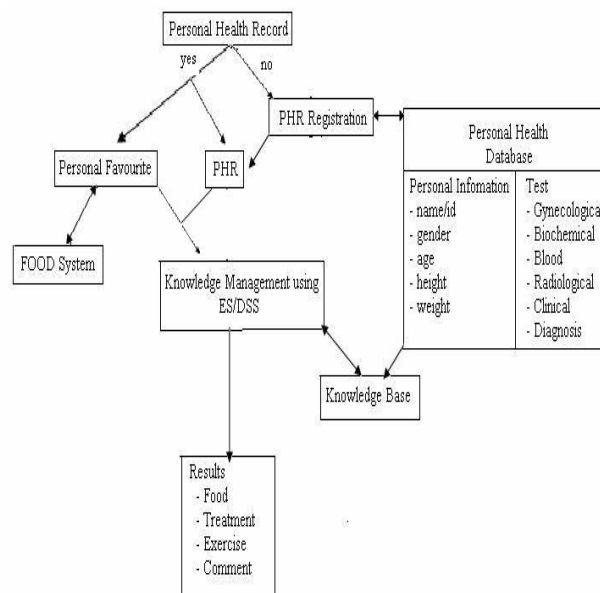


Fig. 3 PHASES Framework

The user framework is designed to serve different user needs (Fig. 3), depending on the existence of a personal health record. Users are requested personal health record (PHR) if they do not have one they will be asked to fill in the registration form and then all necessary information is saved into the database for future use. In this case, the users are forced to enter some more information about themselves, regarding age, height and weight (leading to a computation of the body mass index [19]), known diseases, along with tests under the supervision of hospital care, e.g. gynecological, biochemical, blood, radiological and diagnosis tests. With the personal health record the individual favorites (e.g., what kind of food, ingredients, and flavor) can be entered as important information. This is then used by the expert system to find

appropriate ingredients, meals, treatments, exercises and comments for specific diets and their effects on the users' health, or to deny the explicitly expressed request of the patient for specific meals because of inappropriateness (or out-of-stock reasons).

V. CONCLUSION AND FURTHER WORK

This paper has shown an expert system for advice on healthy food and activities, such as exercise. This system is able to assist people in being aware of good practices for fitness and good health.

Further work has to be done for implementing the system and test it with real patients in Thailand. A further extension of the system could be to provide a solution for the complete upload of the patients' data to the patients' hospital. This would ensure that the hospital gets an up-to-date basis for diagnosis in rural areas of Thailand.

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