WEB-WAP Based Telecare


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Abstract

We have developed two telecare applications based on mobile telephony (WAP) and WEB. The first can be used to request Basic Life Support (BLS) guidelines any time by using a WAP device and to teach people and non-professionals involved in health care emergency situations. The second is a WEB-WAP based tool for medical data retrieval and at-home health care monitoring of chronically ill patients with congestive heart failure (CHF) or diabetes. Medical education content related to these diseases is available on the WEB and on the WAP device. The WAP application uses the features found in the last generation of mobile phones such as better multimedia information presentations, better interactivity capabilities, and enhanced ease of use. Based on these two applications, a promising platform is offered for developing applications in health care, home care, medical monitoring and health education ensuring continuity of care. In the paper we present the preliminary results of a pilot test at Thessaloniki University (Greece) where the WEB-WAP based tool is used to monitor patients with diabetes or CHF.

Introduction

Telematics merges computers and wireless telecommunications to transmit data and information over high-speed networks. In telecommunications over the past few years services have evolved from basic telephone-based data offerings to advanced integrated services, wireless networks, and the Internet. Combining the capabilities of computer with telecommunications leads to a very powerful tool with endless application possibilities.

Today in the United States, chronic disease is the major cause of disability and 70 percent of all healthcare dollars are spent on services for chronic diseases [1]. Diabetes and CHF are two common chronic diseases that affect millions of people in both developed and developing countries. At present throughout the world, approximately 100 million people have diabetes mellitus and by the year 2010, it has been estimated that there will be over 200 million people with diabetes [2]. CHF is a chronic medical condition that is emerging as a serious public health problem in the world. Heart failure afflicts 4.6 million people in the United States where 550,000 new cases are diagnosed every year [3].

Chronic health conditions require constant monitoring and therapy adjustment to avoid complications and disability. The use of telematics has opened up opportunities to improve the quality of care for people requiring regular monitoring. Telematics in the healthcare domain has been found to lead to significant improvement in health care services [4]. Distance monitoring technologies in medicine enable better continuity of care by improving access and supporting the coordination of activities by a clinician [5]. The use of remote video technology in home health care demonstrates the health quality increase, ease of use, patient satisfaction, and cost savings [6]. A system that enabled patients with diabetes to record home monitoring data to a central database and receive feedback summaries was developed and used successfully [7].

In the article, we present a WEB and WAP system for monitoring of patients with diabetes or CHF intending to significantly reduce the costs of health delivery without compromising the quality of care and patient satisfaction. Our WAP tool to access BLS guidelines also will be described.

Design Objectives

The target objectives of the proposed systems are: 1) to provide monitoring of vital parameters and signals of patients with CHF or diabetes at home, with new capabilities in order to increase their quality of life and to guarantee continuity of care, 2) to provide BLS guidelines available any time and
everywhere on a WAP device, 3) to encourage the dissemination of a common knowledge body on health care emergency and CHF and diabetic diseases. A diagram of the system is presented in Figure 1. A WEB and WAP system is the carrier of information between hospital and patients/citizens.

![Diagram of system technologies](image)

**WEB-WAP Technologies: State of the Art**

With the introduction of the WAP standard, a manufacturer independent platform for the development and distribution of applications for WAP devices (principally mobile phones and personal digital assistants) is given [8]. WAP can be developed and implemented on any operating system. WAP applications are written in Wireless Markup Language (WML) and are comprised of one or more decks consisting of one or more cards. The Internet enables mobile users with WAP phones to connect, not to a Web server but to a WAP gateway, often operated by the mobile phone carrier that serves as an intermediary between HyperText Transfer Protocol (HTTP) servers serving WML files and the WAP device. The WAP gateway compiles WML into a byte representation and uses its exchange of information. WAP devices have a variety of interfaces; output can be displayed as text, formatted text or graphics. Touch screen or buttons can be used to provide input [9]. Although a web server can be easily implemented, security and privacy issues, especially encryption mechanisms, have to be investigated above all when medical data have to pass through and be stored.

**System Description**

We used a NOKIA 7110 WAP device for our system. Scrolling up and down is supported very well on a NOKIA 7110 whereas often the display width is fixed and no left right scrolling is provided. Text input is difficult and time consuming on most phone-sized devices and we decided to use list boxes in order to make the interface more user friendly.

Our systems are developed on a Windows 2000 environment with an Internet Information Server as Web server and an Active Server Pages service (ASP). ASP is a viable technology for developing dynamic web content. Because ASP is a server-side technology, it is well suited to creating dynamic WAP and WEB applications, especially in the area of database access. By using ASP it is possible to generate dynamically WML and WMLScript (a WML scripting language) decks.

The WEB and WAP connection with the system involves a web server that uses an authentication module in order to authenticate and identify the user into the system and consequently assign specific privileges. We implemented the system by using a personal firewall product, a strong anti-virus product with automatic updates, physical integrity such as power failures and data mirroring and an access control, so that a user is allowed to access only authorized data and so that different users can be restricted to different modes of access. Files and folders of the stored data in the database are encrypted and all connections between the mobile host and the corporate network are designed to take place over a Virtual Private Network (VPN). This ensures that the communication channel remains secure. The security policies adopted are thought to be stringent enough to protect the system, yet flexible not to disrupt the user and negatively affect the productivity. Logs about who has accessed or modified the elements in the database are stored on the system.

**Methods**

**BLS Guidelines**

Previously, the only way to get first aid guidelines was via a telephone call or by reading instructional material in medical books. The medical information available from the system follows Resuscitation Council guidelines.

![BLS guidelines through WAP device](image)
The Resuscitation Council (UK), formed in August 1981 by a group of medical practitioners, provides education and reference materials to healthcare professionals and the general public in the most effective methods of resuscitation. The objective of the system is to facilitate education of both lay and healthcare professional members of the population in the most effective methods of resuscitation appropriate to their needs (Figure 2).

The ability to acquire BLS skills by using new technologies that are different from the standard BLS course has been demonstrated [10]. However, our system should be used only after calling the health care emergency center that can organize, as fast as possible, a better medical intervention operated by specialized personnel in first aid. The medical content is organized in an XML file and distributed in different formats in accordance with the technology of the user’s device: Web, WAP, WEB-CD. XML permits easy maintenance of the data: the changing of data is made only one time on the XML file and not on each application.

Educational Content

Clinical evidence indicates that patients’ education can improve the quality of medical care [11]. Patients’ education contributes to behavior change for the primary prevention of diseases. In order to have efficient patient educational services both the content of the education as well as the means of providing it have to be properly developed (Figure 3).

![Figure 3: Educational Content WEB Site](image)

Language and layout have to be presented as simply as possible in order to avoid misunderstanding and loss of time [12]. The educational material has been restructured so that it can be offered via WEB and WAP platforms. The structure is hierarchical: all material is initially divided in subject groups, each of them containing up to ten messages and in some cases each message has up to four subtopics. The educational material has been selected according to the needs of two target groups: 1) patients with diabetes and 2) patients with CHF. It covers various aspects of diabetes and chronic heart failure management, such as common mistakes and emergencies. The main categories of educational content for patients with diabetes are: knowledge and prevention, glucose level, diet and activity, management and coping. The main educational content categories for patients with CHF are: knowledge and prevention, therapeutic treatment, exercise, salt reduction, fat, cholesterol and weight, fluids and alcohol. From the main page of the Web site (http://lipid.med.auth.gr/chs/eng/default.htm) the user can choose “Educational Pages” and then select the CHF or diabetes topics. For example, after selecting diabetes, the user is prompted to select one of the four main categories. By selecting “Knowledge and Prevention”, the user gets a list of all the text messages in this group. With a further selection, the user can choose the category of interest (risk factors for instance) and read the respective text messages. The user can in this way easily navigate in the different subject categories and read the respective text messages. Additionally, a site map is available and can be accessed from any page. The CHF educational content can be accessed in a similar manner. By using WAP device the user can access the same medical content.

Study on Monitoring and System Evaluation

Patients with diabetes were recruited for the study from the diabetic and obesity outpatient clinic of Department of Endocrinology, Hippocratic General Hospital, Thessaloniki Greece. The Department has a vast experience in the management of endocrine and metabolic patients, including diabetes mellitus, with more than 14,000 outpatient visits annually. Patients with CHF were recruited from recently hospitalized patients, patients with a known diagnosis of CHF irrespective of prior hospitalizations, and outpatients of the heart failure clinic in the Department of Cardiology, Aristotle University (AHEPA Hospital of Thessaloniki). All the examinations and laboratory tests were conducted in the AHEPA Hospital of Thessaloniki.

The diabetes group consists of 80 patients (40 in the intervention group and 40 in the control group) with diabetes mellitus or impaired glucose tolerance, diagnosed by both WHO (World Health Organization) and ADA (American Diabetes Association) criteria. Inclusion criteria were a diagnosis of diabetes mellitus, increased body mass
Patients with systolic heart failure (HF) irrespective of underlying etiology, NYHA classes II-III, according to the Framingham criteria and with an ejection fraction < 40% (as measured by two-dimensional echocardiography) were eligible for inclusion in the CHF intervention group which consisted of 60 patients (20 in the intervention group and 40 in the control group) in March 2002. Both trials are randomized controlled trials. All patients signed a consent form before being included in the study.

The study was subdivided into two phases. Phase 1 (pre-intervention) lasted three months. During this phase, randomization, epidemiological data collection and education of the intervention group subjects regarding the use of telematics systems microdevices was accomplished. Phase 2 (post-intervention) lasted four months. All the subjects of the intervention group were supplied with a number of electronic devices (e.g. glucometer, blood pressure monitor, ECG device, weight recorder, electronic diary), a WAP telephone, and Internet access.

Outpatient visits of both groups occurred at three-month intervals. Hospital visits included history, basic physical examination, including blood pressure and weight recordings, as well as specific search for development of diabetes or CHF complications.

All intervention group subjects had unrestricted access to the telematics system (contact center) with which they could freely interact. According to their individualized treatment plan, patients were requested to record measurements, to answer questions, and to send responses through the WEB site or WAP phone.

Results

Basic Life Support

BLS guidelines differ in accordance with the age of the patient. When users start the connection to the proposed service by using a WAP device, they must select first aid guidelines for an adult, child or infant. Then the system shows instruction and guides the user to the correct decision. Text is available and it is always possible to display images that clarify better what to do. The system loads cyclically the same file so the user can navigate through the decision algorithm and use the system as a learning tool. An on-line demo of the system proposed is available at http://wap.bio.dist.unige.it.

Monitoring

By using a WAP or a WEB interface the patients with CHF or diabetes can send their medical data acquired through medical devices to the call center. We decided to have two input styles: free text and presentation of structured data in order to combine the most suitable model for data representation with the interface that best fits the patient setting [13]. Patients have to answer to some simple multiple-choice questions (different for the two diseases) or write health measurements (heart rate, blood pressure for example) regarding their health status (Figure 4 and 5). An automated verification system is able to recognize if the patient inserts incorrect medical data (i.e. 8-12 for blood pressure measurements) or if the values are out of the patient’s usual range. In these cases, the system asks the patients to re-enter the values. Each doctor at the contact center has access to the patients’ measurements and answers. The data collected in the first three months of the study demonstrates a high level of acceptance of the system proposed by the target group. Furthermore, the effects on medical economics, quality of life, patients’ satisfaction and social functioning are examined using questionnaires.
**Discussion**

We are currently investigating whether the use of novel technologies based on mobile telephony and the WEB can result in better treatment and increased quality of life in people with chronic diseases. In this paper we examined the feasibility of these two technologies in providing meaningful and just-in-time educational advice to the patients. The fully developed contact center is expected to enable part of diabetes/CHF treatment to take place at the patient's home, thus minimizing the number of hospital visits and increasing the quality of health care delivery and quality of life. The proposed systems are designed to be an aid to, and not a replacement for, physician services. All patients were instructed to contact their doctors directly if they were seriously concerned about their health.

The WAP technology allows visualizing text and low-resolution images on a small screen and it is already available for a large number of users. Flexibility and availability are the main advantages of the proposed system. WAP is positioned at the convergence of two rapidly evolving network technologies, wireless data and the Internet. For this reason, in the future we are likely to see much higher bandwidths available and to have devices with better processing powers, which would enable more client-side processing and an altogether more responsive user's experience. It has been estimated that there will be half a billion WAP-enabled mobile phones in use within the next three years. This means that potential WAP users will outnumber conventional Internet users by far.

The meaning of "home care" is changing to a care that has to be available everywhere and at all times. Patients can feel free to move and to live in any environment undoubtedly helping them to understand and manage their diseases.

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**References**