Mobile phones as user interface in the management of chronic diseases

A. Kollmann, D. Hayn, P. Kastner, G. Schreier

This paper presents and compares mobile phone-based solutions for assisting chronically ill patients in the self managing process by establishing an active cooperation and connection between patients and physicians. The article focuses on the patient terminal, i.e. how to provide the patient with a method to enter the measured data into the system, which is still one of the most challenging tasks.

Keywords: home monitoring; mobile phone; usability; information- and communication technologies; chronic diseases

Das Mobiltelefon als Benutzerschnittstelle im Management von chronischen Krankheiten.

Diese Arbeit zeigt Möglichkeiten auf, wie das Mobiltelefon als Benutzerschnittstelle im Management von chronischen Krankheiten zur erweiterten Kommunikation zwischen Arzt und Patient eingesetzt werden kann. Der Artikel konzentriert sich auf das Benutzerterminal, das den Patienten bei der Eingabe der gemessenen Gesundheitsdaten unterstützt und das nach wie vor die Haupt-Herausforderung darstellt.

Schlüsselwörter: Home Monitoring; Mobiltelefon; Usability; Informations- und Kommunikationstechnologie; chronische Krankheiten

1. Introduction

Home monitoring using information and communication technologies is particularly suitable for managing chronic diseases since it permits observing patient's health parameters in regular intervals using standard measuring devices like blood glucose meters, blood pressure meters or scales. The basic idea is to track the patient's personal health status using a patient terminal and to send the data to a remote monitoring centre (Fig. 1). An automated monitoring process checks the values and gives feedback in order to guide the patient through the self managing process and to turn the doctor's or other caregivers' attention to the patient when necessary by means of notifications and alerts. A number of clinical trials have indicated the value of this concept to optimize therapy in hypertension, diabetes, asthma as well as to reduce hospitalization in heart failure (*Meystre, 2005*).

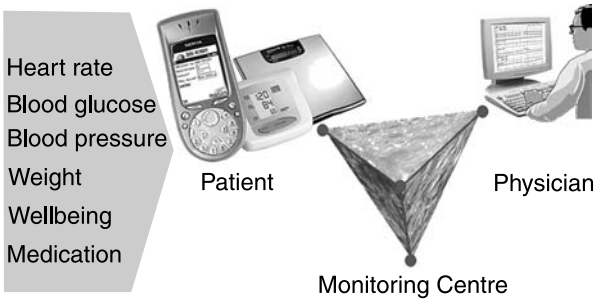


Fig. 1. Overview of the health data management system facilitating an additional way of communication between patients and physicians by means of a monitoring centre

However, the most challenging part still is the patient terminal, i.e. to provide the user with a method to interact with the system with good usability in terms of learnability, efficiency, memorability, low error rate, and user satisfaction (*Holzinger, 2005*). Because of widespread usage and ubiquitous availability of mobile phones these devices may be the patient terminal of choice.

2. Methods

The authors developed a person-centred health data management concept for regular and home-based measurement and transmission of health parameters using standard mobile phones. The objective of this paper is to present several mobile phone-based human computer interface concepts, which have been developed at the laboratory of the eHealth systems department, for the broad usage as patient terminal.

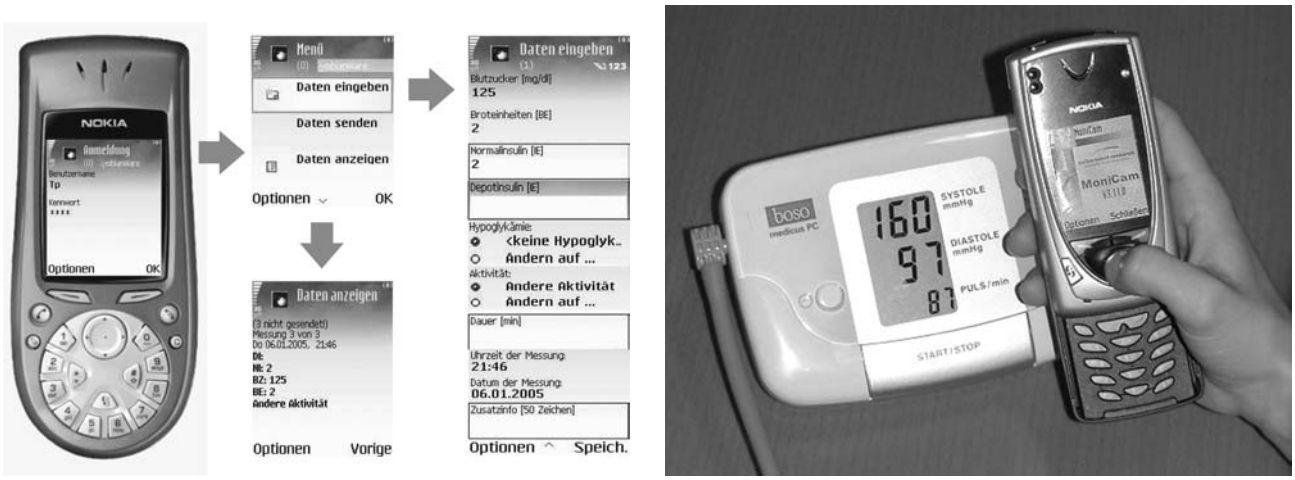
2.1 Short message service (SMS)

Using SMS enables users to send and receive text messages up to 160 characters. The user has to enter his values following predefined syntax. Thereafter the SMS is sent to the monitoring centre, where the message is received, decoded, and the values are stored into the database automatically. On the other hand SMS could be used for patient reminders and alerts or to give the user feedback of his current health status in terms of statistics and trends.

2.2 Wireless Application Protocol (WAP)

WAP communication is based on client-server architecture. It consists of the mobile phone supporting a WAP browser and the content server, which responds to the users' requests and stores information. After going online with the micro browser, i.e. building up an Internet connection between the mobile phone and the remote server, the menu promptly routes the patients through subsequent entry templates generated by WML (Wireless Markup Language) syntax. Finally, entered data are sent auto-

Kollmann, Alexander, Dipl.-Ing., Hayn, Dieter, Dipl.-Ing., Kastner, Peter, Dipl.-Ing., Schreier, Günter, Dipl.-Ing. Dr., Head of the eHealth systems department, ARC Seibersdorf research GmbH, Biomedical Engineering/eHealth systems, Reininghausstraße 13/1, 8020 Graz, Austria (E-Mail: kollmann@telbiomed.at)



a **b**

Fig. 2. a) ''DiabDiary'' – Java-based software application running on mobile phones supports the user in home-based data acquisition. b) ''MoniCam'' – principle: A special developed software helps the user in taking a photo of the display and sending it to a central monitoring centre via MMS, where the values are extracted and stored into the database

matically to the central database at the remote monitoring centre for further processing.

2.3 Java 2 Platform Micro Edition (J2ME)

J2ME is used for developing stand-alone software applications running on mobile phones or PDAs. Software could be designed using core application functionality – including graphical user interfaces, network connectivity and local data storage.

An example of the developed ''DiabDiary'' application is given in Fig. 2. After login, the user is asked to enter collected data (insulin dose, bread units, sports, etc.), via keypad. A well designed, intuitive graphical user interface supports the user in entering data by the means of predefined lists and drop down menus. Thereafter the record is stored into a local database temporally. From time to time the user starts a synchronization process with the central database using mobile phone-based network connectivity.

2.4 Multimedia Messaging Service (MMS)

Because of the limited usability of textual input via keypad the authors developed a unique approach to the human computer interface challenge which is based on digital camera enabled smart phones and MMS, so called ''MoniCam''. A special software running on the mobile phone guides the user in taking a photo of the display e.g. of the blood pressure meter device as well as to send the photo to the health monitoring centre via MMS with not more than two keystrokes. A character extraction algorithm starts to process the photo in order to extract displayed values automatically, which are finally stored within the central database.

3. Discussion

In recent years a couple of home monitoring applications have been developed successfully in order to support the patient in recording his/her self-measured values by means of a mobile phone using WAP or SMS to transfer data to the monitoring centre (*Kollmann, 2005*). Although the medical benefit of such monitoring programs could still be approved (reduction of emergency cases and hospitalization, increase in patient therapy adherence, etc.), users reported a lack of usability, problems in handling the numeric keypad as well as in reading the display. Moreover, using WAP technology requires a permanent online connection to the network during data input and is also limited due to the lack of designable and intuitive user interfaces. By using JAVA technology, which allows designing much more user friendly graphical user interfaces, we were able to improve usability significantly. JAVA software application is less affected by temporary lack of network availability because the data are stored locally on the mobile phone, and so the data transmission process can take place at times when the mobile communications network is available. Additionally implementation of source data verification by checking the entered data for plausibility and limits is also feasible for software application resulting in a lower error rate.

However, both technologies require basic knowledge in handling a mobile phone and using the numeric keypad which some – in particular elderly – people do not have. Using a mobile phone camera to take a photo of the display and send it to the monitoring centre is actually very intuitive, robust, error resident, and easy-to-use, given that most people are used to take photos (*Schreier, 2004*). On the other hand, home monitoring for daily usage should provide flexibility in terms of adding or removing parameters to the user interface because of changing conditions in the treatment, which could easily be supported by server side scripts like WAP compared to stand-alone software applications (DiabDiary, MoniCam) on client side.

4. Conclusion

Our research activities are mainly focused on developing and testing new ways to utilize mobile phones for home-based health data acquisition. The wide and growing use of mobile phones provides new methods for home monitoring application as well as communication between doctor and patient. The most challenging part of home monitoring concepts still is the patient terminal, i.e. to provide the user with a method to enter the measured data into the system, as well as to receive feedback, reminders or alerts. However, using mobile phones as patient terminal offers advantages like timely delivery of data and supports an additional way in patient – doctor communication. On the other hand limitations like memory size, display size, resolution as well as interaction via keypad are disposed and have to be considered when mobile phone-based software applications are developed.

The aim of this paper was to present and compare mobile phone-based technologies for acquisition and transmission of patients' self-measurements.

However, up to now, there is no method which fulfils all criteria of an ideal patient terminal in terms of user friendliness, adaptability, flexibility, and low-cost. Every method for entering data implies specific advantages and disadvantages. Hence, the home monitoring terminal which fits best into a particular application has to be chosen on an individual basis, depending on the requirements, the user group and the medical demand.

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