I-CARE
A Health Promotion System for Active Ageing

Maria Lúcia Kroeff Barbosa[1], Valter Roesler[2], Alexandro Bordignon[2],
Johannes Doll[1] and Eliseo Berni Reategui[1]
[1]*PPGEDU, UFRGS, Av. Paulo Gama, 110, Porto Alegre - RS, Brazil*
[2]*PPGC, UFRGS, Av. Bento Gonçalves, 9500, Porto Alegre - RS, Brazil*

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Abstract: I-Care is a health promotion system designed to: a) monitor vital signs of patients in real time; b) improve the patients' knowledge of the disease, aiming to increase their motivation to develop healthy habits; c) motivate the patients through their interaction with doctors, friends and other patients with the same disease. The system works through the web, being suitable for many platforms. A group of three people was monitored during four weeks, generating some interesting conclusions about different ways to motivate people to get older in a more active and healthy way. The test subjects were from 56 to 67 years, both male and female, with hypertension, overweight and diabetes. The adopted methodology was both quantitative and qualitative. Results showed that the proposed system can improve significantly the health of the monitored patients, developing in the participants a better understanding about their health situation.

1 INTRODUCTION

This paper presents i-Care, a web-based system which aims to provide autonomy to active elder people through three basic approaches: **Monitoring** of their health through the use of vital sign sensors and communication with a Health Center; **Awareness** of their health state and physical and nourishment re-education; **More social interaction** with doctors, friends, family and people with the same disease, in order to exchange information.

One difference between i-Care and other health monitoring systems is that i-Care aims to re-educate the patients besides monitoring them.

The ageing of the world population brings more and more attention to new health care tools and technologies enabling an approximation between elder people and the environment around them, aiming to keep them in the center of the process. This extra attention creates involvement and motivation in the pursuit of health promotion and disease prevention, enabling a re-education for healthy lifestyles and better life quality.

The World Health Organization states that a big share of the supervision or care that people actually need may be provided by themselves (WHO, 1986). Nakatani (2009) also emphasizes that most elders are able to take care of themselves in their homes. This is a much more comfortable solution, which may also be more economic and a good alternative for their health care. To make the treatment of chronic conditions more effective and efficient, it is important to envolve the patients and to educate them to participate in the decision making process. Motivating the elderly in the development of an active attitude and making them more aware about their health can lead to a path in which knowledge contributes to the improvement of their lives. It is important to reinforce that, to keep a good quality of life, it is necessary to control chronic-degenerative diseases such as hypertension, diabetes, arthritis, osteoporosis, dementia, among others (Pavarini, 2005). One way to minimize age effects is to have a healthy nutrition and regular exercise habits.

All of the above aspects were taken into consideration when developing the i-Care interface and an investigation was carried out with 11 elders in order to validate it (Jantsch, 2011).

This paper is organized as follows: section 2 presents other works related to this research. Section 3 presents the system details, while section 4 presents the experiment methodology. Section 5 presents the results, and section 6 the conclusions.

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2 RELATED WORKS

The IAMSPE (Institute of Medical Assistance for the Public Server, 2011) created a monitoring system for diabetics. Nowadays they are monitoring about 300 patients, and they have resources to reach 800 people. They provide insulin, test strips and a glucometer with memory to perform 3 exams each day at home. Each 7 or 15 days, the patients upload their data to a health center, and the doctors analyze the data to decide if the patient needs orientation. In that case, there is a team of instructors giving the patients the necessary orientation.

I-Care has many differences in relation to IAMSPE's system. First of all, in i-Care the exams are sent in real time, using an internet or a 3G connection, through computers or mobile devices. Another difference is that i-Care has many sensors, and not only the glucometer. Another one is that the system provides a lot of educational material in order to improve the patients' understanding about their health issues.

Another related work is Angius's research which has the goal of developing of a low-cost system for telemedicine based on the DVB-T (Digital Video Broadcasting – Terrestrial) technology (Angius et al, 2008). The diffusion of DVB-T standard and the low cost of DVB-T set-top boxes bring the vision of a broad distribution of tele homecare monitoring systems with an easy-to-use patient's interface. The proposed system, based on a currently widespread infrastructure, enables patients to monitor their health from home, without the need of any installation procedure. Even untrained people (or the elderly) can easily use such system due to their familiarity with basic DVB-T home-entertainment equipment.

The problem with a digital TV health care is that a broadcaster must send the application through its Transport Stream (TS). However, a health application rarely is a priority for a broadcaster. Besides, the user must have a conventional return channel for sending the results. In practice, what happens is that the patient, having the application in a pendrive, runs it through a set-top box USB port.

The application presented in this paper was initially implemented in NCL (Nested Context Language) and Lua, which are digital TV middleware standards (ITU, 2001). However, evolved to the use of other languages and platforms because of the need to create videoconferencing and social network facilities, among others. Such functionalities are very difficult to implement using digital TV middleware languages.

The platform selected for this version of i-Care is web based, as we observe a convergence towards web. Today handhelds, tablets, connected televisions and computers are all "talking" web.

3 SYSTEM DETAILS

The general idea of the system proposed here is depicted in Figure 1. The patients stay at home, and update their vital signs in a rate defined in their profile (e.g. daily, weekly). According to their chronic diseases, they receive a number of sensors to monitor their data. The most common are Glucometer (for diabetes), Blood pressure (for hypertension) and Scale (for weight control). All of them receive a Pedometer, which is a step meter, used to monitor the amount of physical exercises that they have been doing.

The system interface is projected to work also on a television (as a monitor) connected to a computer, because it is the most friendly equipment for the target public. Some of the interface screens are presented in Figure 1, and will be detailed hereafter. The system has also an interface for mobile devices, as it will be discussed later.

The system runs through a web browser, eliminating the need of installing any software in the patients' home. The patient vital signs are sent to a web server, and the data is immediately available to anyone with access rights and the server's URL.

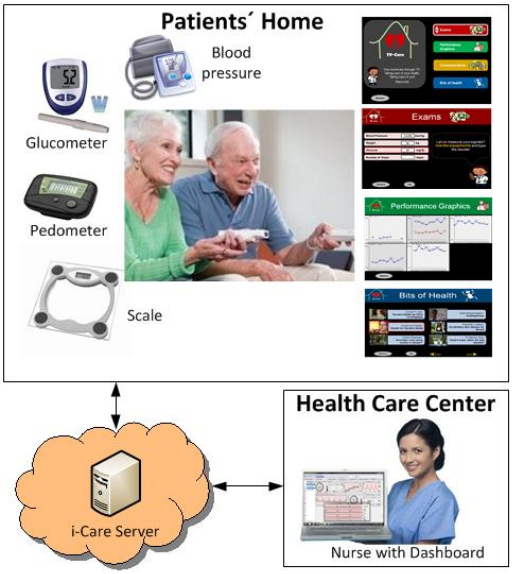

Figure 1: System overview.

The system is composed of two main entities: "*User Portal*" and "*Health Care Center*", described

in the next sections. Besides, the system has the *patients' configuration* module, enabling the setting up of their profile, the recording of the medicines which they are taking, the registration of contact persons, telephones, Body Mass Index (BMI), body fat percentage, Waist to Hip Ratio (WHR), among other information.

3.1 User Portal

The user portal is the interface where the patients interact. The first screen is presented in Figure 2, showing their possible choices, which are:

Figure 2: User portal.

a. **Exams**: allows the insertion of vital signs data;
b. **Performance Graphics**: allows the visualization of the vital signs throughout time;
c. **Communication**: interactive functions related to social networks and videoconferencing;
d. **Bits of Health**: educational videos about diseases and benefits of physical exercises and healthy eating.

The system compares the vital signs filled by the patient with his/hers profile to see if there is any that is out of the normal range. If so, it presents an alert to the user, and suggests him/her to watch some educational videos specifically about the problem. For example, Figure 3 shows two parameters out of range: Glucose and number of steps. The system will suggest some videos with information on diabetes, healthy food for patients with diabetes, and the importance of physical activity.

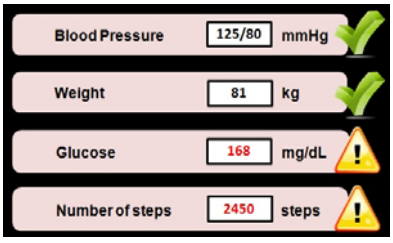

Figure 3: Vital signs out of range.

At the same time, these data are sent to the Health Care Center and, as there are vital signs out of range, there will be an alarm also in the central. This can be used for decision making, as for example to call the patient and offer help. In extreme cases, it is possible to use these data to send immediately an ambulance to the patients' home.

Related to the "Communication" option, the interface allows the patient to access a social network and interact with other people with similar diseases, aiming to minimize the elderly isolation and to be a forum for the exchange of ideas.

3.2 Health Care Center

The Health Care Center Module is responsible for the monitoring of patients. If there is an alarm on a patient, his/her data appear in the beginning of the list, and a sound is generated, followed by a yellow message.

The Health Care Center has also all the information about the patients, as their performance bar charts, telephone, name and telephone of close people, name of doctors, medicines that the person is taking, visit records, measurements, among other.

4 METODOLOGY OF TESTING

An experiment with i-Care has been carried out for the period of 4 weeks, involving a group of 3 people:

- **Patient 1**: 56 years old, male, overweight and acquired diabetes type 2.
- **Patient 2**: 67 years old, male, overweight and Parkinson.
- **Patient 3**: 60 years old, female, overweight and hypertension.

The test subjects were registered in the system, and they were asked to fill out a web form informing their vital signs on a daily basis. They were advised to take these measurements at the same time every day to avoid pressure or glucose levels variation.
Three profiles were created:

- **Hypertension**: for subjects with high pressure levels. The system asks for daily exams of *Pressure* (systolic and diastolic) and *Resting heart rate*. Besides that, the system asks for the *Number of steps* performed during the day. Weekly, the system asks for the *weight* of the subject.
- **Diabetes**: for subjects with diabetes mellitus. The vital signs are exactly the same as Hypertension profile, with an additional exam, which is the measurement of *glucose levels*.

- **Obesity**: it is exactly the same as Hypertension profile, with the difference that the *weight* is asked daily, and not weekly.

During the first visit to the patient, a care taker explained the system and also took some measurements. This allowed the professional to get some indexes of the patients, like Body Mass Index (BMI), body fat percentage, Waist to Hip Ratio (WHR), and so on.

During the first visit, we also made an interview about their eating habits and physical activities during the last 4 weeks, in order to better understand how much the system could influence them.

During the experiment, we contacted the subjects through some phone calls when needed due to the exam results.

The patients were informed that, if they did not fill the forms one day or if one of their vital signs were out of the accepted range, an alarm would be sent to the health center. They were also informed that all their vital signs would be monitored daily by a professional.

From an educational perspective, besides participating in the process of making the users more aware about their conditions, the system has about 160 videos related to each one of their profiles. The users can watch the videos freely navigating through the interface, or they can be directed to a specific ones in the case one of their vital signs is out of the accepted range. In that case, an alarm is also generated to the health center dashboard.

After 4 weeks, the initial measurements were repeated, and a final interview was made.

5 RESULTS

The experiment was performed during the month of October, 2011. During the initial interview, we discovered that two patients were trying to lose weight and were fairly active, walking around 6 km twice a week during the previous month. One of them was not so active, and did not perform activities at all.

The monitored tests proceeded for four weeks beginning the day after the interview. It was clear that only the fact of being participating in a health program motivated the subjects. They now had to walk at least 5,000 steps daily and they had to fill the web form, otherwise the system would show an alarm to the user and to the health center.

Figure 4 presents the 4 week result for one of the patients. It is clear the motivation increase due to the program. He began to walk about 10,000 steps every day, without having anyone asking him to do so.

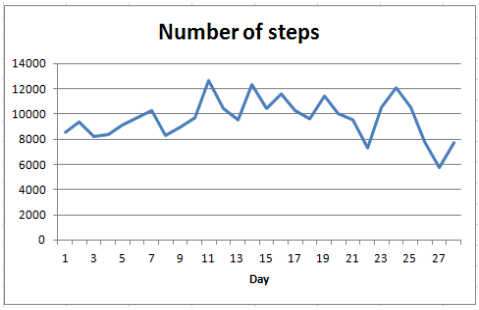

Figure 4: Patient 1 – number of steps when monitored.

Patient 2 presented similar results. Patient 3 increased slightly the number of steps at the beginning but, when she discovered that she was losing weight, the daily number of steps increased impressively.

Figure 5 presents the number of steps for all test subjects during the monitoring period. It is clear that all of them tried to fulfil their duties with the system, and were compromised with the program success.

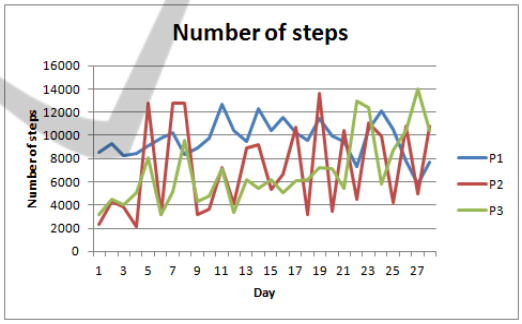

Figure 5: Number of steps during the monitoring phase.

Figure 6 depicts the glucose and pressure variation of patient 1. The glucose levels were high at the beginning of the experiments, and decreased to normal levels, while the pressure, which was normal, continued normal.

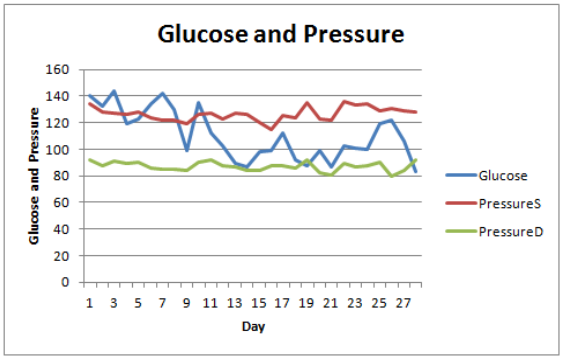

Figure 6: Glucose levels of patient 1.

With the end of the experiment, the set of measurements was repeated, and the results for the patients' weight are presented in Table 1.

All patients reduced the total weight (first column), and additionally some of them increased the lean weight (third column), reducing even more their percentage of body fat (fourth column).

Patient 1 reduced 2.3 kg, 1.44 kg of fat and 0.86 kg of lean body mass.

Patient 2 reduced 1.5 kg, **losing 4.29 kg of fat** and increasing 2.79 kg of lean body mass.

Patient 3 reduced 2 kg, **losing 3.98 kg of fat** and increasing 1.98 kg of lean body mass.

The fat weight and lean weight are valuable information because they showed that the system was producing significant results for the patients. Many times a person wants to lose weight and enters a diet; however, often diets result in loss of lean body tissue and water, which is not beneficial for the person's health.

Table 1: Weight results.

	Total weight	Fat weight	Lean body weight	Body Fat (%)
P1_ini	85.00	16.14	68.86	18,99
P1_final	82.70	14.70	68.00	17.72
P2_ini	83.50	20.79	62.71	24.90
P2_final	82.00	16.50	65.50	20.12
P3_ini	73.10	25.56	47.54	34.96
P3_final	71.10	21.58	49.52	30.35

Other monitored results were the main corporal indexes, shown in Table 2: BMI (Body Mass Index), WHR (Waist to Hip Ratio) and BAI (Body adiposity Index).

The results showed a reduction of all indexes for all patients. However, it is important to note that all participants still need to keep lowering most of their indexes in order to reach the international health standards (WHO, 1995, 2000, 2004, 2008) (Bergman et al, 2011).

Table 2: Main corporal indexes.

Exam	BMI	WHR	BAI
P1_ini	30.11	1.04	27.46
P1_final	29.30	1.01	26.54
P2_ini	29.94	1.00	29.72
P2_final	29.40	0.96	29.63
P3_ini	27.17	0.74	34.37
P3_final	26.43	0.74	33.51

In relation to glucose levels, the only patient with diabetes was patient 1, and his results, shown in Table 3, presented an average reduction of more than 20%, which made him very happy indeed. One comment was "I have never seen my glucose levels so low as they are now".

Table 3: Average glucose levels.

Exam	Average glucose levels
P1_first two weeks	120.64
P1_final two weeks	100.64

Related to the patients' awareness about their own health, the results were just as exciting as the quantitative ones. The patients had a form to fill out with their impressions about the system, and the interviews also clarified their feelings and learning. Some selected statements from this form and from the interviews are presented below:

"*My goal is to reach the ideal weight. I will have to reduce food and increase physical activity to see if I succeed, but it is not easy, because it seems the scale is stuck in 71.1 kg. Oh, God!!!*"

"*Today I watched some videos and I was very pleased. They have a short duration, I can pause them if I want, if I do not like one I can cancel and choose another. Very good. I loved it.*"

"*The use of the Pedometer is very important. If I do not reach the number of steps at the end of the day, I walk around my building as many times as needed to complete the minimum.*"

"*I was having some difficulties with my arms flexibility, and then I saw a video explaining a series of exercises to improve that. I tried and it worked, and I am repeating them regularly since then.*"

There are a lot of other interesting statements, but these ones synthesize most of them. The fact is that the patients are improving their life style, their health, their autonomy and their knowledge about their own condition.

6 CONCLUSIONS

This paper presented a new system for health promotion, called i-Care. The system works on any browser, so, it is suitable to many platforms, like computers, tablets, mobile devices and also television.

The main differences between i-Care and other related health promotion systems are:

- The educational characteristic of i-Care, where the patient has the option to effectively learn about his disease, exercises and nutrition using the videos;
- The indication of exercises (daily number of steps) to set goals to the patients;

- The social component, which was slightly explored in this paper.

The system is composed of three main modules: *patient configuration*; *health center dashboard*; and *user portal*. Each of these was explained in section 3.The interface usability was validated for television, computers, tablets and mobile devices, as also detailed in section 3.

We performed a four week experiment with three real users to validate the system in relation to its ability to increase the patients' autonomy and awareness about their health condition. The users belonged to three different groups: diabetes, hypertension and obesity, and they had to fill out information about their vital signs every day using a web browser. They also had to walk a number of steps daily. They knew that they were being monitored by a health center on a daily basis.

From the first moment it was clear that the motivation of being constantly monitored was much bigger than in a situation where the person only has to count on him/herself to reduce weight without any follow up. The system changed the routine of these people, and they worked out much more when compared to the time without monitoring, mainly because they now had goals to reach, and someone to help with their doubts and questions.

The results showed that a monitoring and educational system can improve the health of the monitored people, creating an "obligation" of exercising and following some healthy rules. Besides that, the results showed a real improvement in the knowledge of the patients about their health situation and what to do in order to grow old in a healthy way.

The system is beginning to be applied to 8 new users only with the diabetes profile, being monitored with an enterprise specialized in homecare, in order to confirm (or not) the data presented in this paper.

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