A Monitoring and Feedback Tool to Support Patients in Achieving a more Active Lifestyle

The development of portable technology embedded in primary care

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***Abstract*—The paper describes the process of development of an innovative monitoring and feedback tool to improve the level of physical activity of chronically ill patients. The tool aims to support chronic obstructive pulmonary disease and diabetic patients' self-management in achieving an active lifestyle. The tool consists of a sensor that transfers data to a Smartphone; subsequently the Smartphone is connected to a server. Patients wearing the sensors will receive feedback on their Smartphones based on pre-set activity goals. Use of the tool will be embedded in a healthcare model to be executed by practice nurses in primary care. Both the tool and the healthcare model are developed in an iterative way based on user requirements research. An intensive cooperation has been set up between the research team, two enterprises that produce the technology, healthcare professionals, and patient representatives. From the very first phase onwards, patients, professionals, and technology developers are actively involved in the project in order to increase the probability of effective use of the tool in practice. The tool will be validated and tested in pilot studies. Eventually a randomized controlled trial will be set up to measure the effects of embedding the tool in primary care.**

Keywords—physical activity; accelerometer; persuasive technology; self-management support; primary care.

I. INTRODUCTION

A quarter of all people in the Netherlands suffer from a chronic disease such as chronic obstructive pulmonary disease (COPD) or diabetes. The number of people with diabetes is increasing most of all. It is estimated that in 2025, seven percent of the total Dutch population will have a diagnosis of diabetes [1]. For a lot of people with COPD or diabetes it is very hard to be sufficiently active. People with COPD suffer from shortness of breath and people with diabetes are often overweight. This makes exercise more difficult. Nevertheless, physical activity is very important for COPD and diabetic patients because it improves their quality of life and long term prognosis.

Most patients with COPD or diabetes are treated in primary care by general practitioners and practice nurses. According to guidelines and care standards, stimulating physical activity should be a central element in the treatment of people with COPD or diabetes [2][3]. The level of success regarding this element of the care process depends for the greater part on the degree to which patients succeed in executing their self-management role. Therefore, healthcare providers should involve the patient in decisions on self-management, and together with the patient should seek lifestyle interventions that fit with the motivation, needs, and capabilities of the patient [4][5].

An example of a lifestyle intervention is self-monitoring of physical activity using a pedometer or an accelerometer. This is often identified as an effective approach towards behaviour change [6][7]. Use of technology for long term monitoring and feedback could support patients in achieving a more active lifestyle and could also help care providers to coach patients in establishing this behavioural change more easily. In the project **It's LiFe!** (an acronym for **I**nteractive **T**ool for **S**elf-management through **Li**festyle **Fe**edback**!**) an innovative monitoring and personalized feedback tool will be developed and tested. The tool aims to support COPD and diabetic patients in achieving an active lifestyle as part of their self-management. The project started in September 2010 and will last four years.

Nowadays there are tools on the market that try to improve people's level of activity, such as the Fitbit®, but those tools do not give continuous feedback on people's mobile phones [8]. In 2009 Klasnja et al. reported on the UbiFit. This tool (the flower phone) does contain similar features [9]. In this project we analyse such exercise tools with the aim of identifying the underlying principles of persuasive technology [10]. During the development, as far as possible, effective principles will be merged into the It's LiFe! tool. Furthermore, one of the most basic assumptions about the combination of technology and lifestyle interventions is that it will only succeed when the technology is actually part of care services in which healthcare professionals see patients' levels of activity as a "vital sign" and are aware of the need to promote exercise [11]. This is the reason why a healthcare model (HCM) will be developed on the basis of which practice nurses will simultaneously support patients' self-management to achieve a more active lifestyle.

During the first stage of the project the following research questions were answered:

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- What feedback and information do patients need to optimally support them in their self-management role and how should the feedback to the patient be presented in order to promote optimal use of the tool and optimal patient compliance?
- What information do professional caregivers need to optimally support patients in their self-management role and how should the information generated by the system be presented in order to stimulate use of the tool and patient compliance?
- How can the use of the monitoring and feedback tool to support patients in maintaining a healthy lifestyle be integrated in an HCM that is based on the principles of patient involvement, shared decision making, and current insights into disease management and the chronic care model?

In this work-in-progress paper the methods and some preliminary results of the first year will be described and plans for the upcoming years will be explained.

II. METHODS

To design useful technology that meets the needs of patients and healthcare professionals, it is important to involve both parties in a very early stage of the development process. A user centred design strategy was used during the first phase of the project in which the tool and an HCM were developed. Several strategies for designing medical devices were combined into a specific model tailored to this project [12]. This model is depicted in Figure 1. The model was used to specify the steps to be taken to define the user requirements.

Defining the user requirements was an iterative process that started with identifying the users and their context. The general project idea was developed together with several experts and business partners. Subsequently general use cases were written from the perspectives of a COPD patient, a diabetic patient, and a practice nurse. They were narrative stories of the use of the tool embedded in daily living and in daily practice. During interviews with patients and healthcare professionals, end users were asked to give their opinions about the use cases.

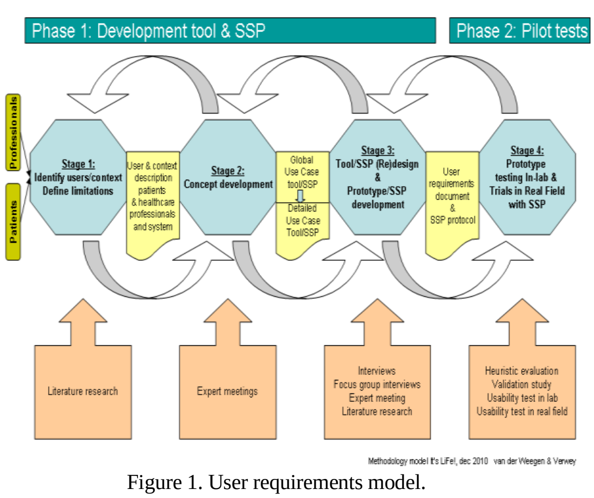

Figure 1. User requirements model.

Semi-structured interviews were conducted with 15 people with COPD or diabetes. After analysing the interviews the use cases were modified and specified. The results of all interviews were verified and explored in two focus groups, in which the interviewees participated. The data were supplemented by interviews with 15 healthcare professionals. After analysing the data using NVivo and open coding, general themes emerged and these results were input for the user requirements document.

Furthermore, two members of the research team are patient representatives who gave feedback on every step in the process. In addition two expert meetings took place, in which project plans and progress were presented to people with a broad range of expertise in COPD and diabetes care, sensor technology, general practice, human movement, and health promotion and implementation science. All experts provided their feedback on the course of the project.

The technological development of the tool is an ongoing process taking place in collaboration with two companies: Maastricht Instruments BV and Sananet Care BV. There are in fact two parallel paths in the project: the research team of Maastricht University conducts research and "feeds" the technical team with information about user requirements for the tool so that gradually the elements of the technology evolve. This continuous interaction between the two teams is a unique aspect of this project.

Simultaneously with the technological development, the HCM is being developed (the Self-management Support Programme). This was done by conducting a literature study and furthermore through 15 semi-structured interviews with general practitioners, physiotherapists, nurse specialists in diabetic and pulmonary care, and practice nurses.

III. PRELIMINARY RESULTS

A. *Technology*

The original project idea was that the tool should consist of three parts: a sensor with a 3D accelerometer, a mobile phone, and a server/website for both patients and care providers. The patient would receive three types of feedback on the mobile phone concerning:

1. the amount of activity;
2. the amount of activity in relation to an activity goal;
3. the response of a practice nurse based on the measured activity.

The user requirements study provided the details for this framework.

Patients have indicated that the sensor should be small, discreet, and shockproof and that it should measure accurately. The mobile phone should have a large screen so that patients can read information easily. Furthermore patients opted for a mobile phone with a touch screen. Personal activity goals will be set in minutes per day in consultation with the practice nurse. Patients would like to set goals that are achievable and adapted to their abilities. The immediate feedback patients want to see is the percentage of minutes that they have been active during the day compared to their activity goal, presented as an image and in colour. In their opinion it is not necessary to see the

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data on the level of intensity and history of activities directly. They appreciated an option in the system in which they can fill in details themselves so that they can give reasons why they did not succeed in achieving their goals. They preferred to receive mostly positive feedback and limited negative feedback. Patients said that they want to receive a neutral response from the system when they achieve their goals. Negative feedback is not necessary; when negative results occur, they said they would probably already feel guilty and would not want to be further stressed by the system.

Based on the requirements the following tool was developed. The sensor has the same dimensions as a match-box and contains a 3D accelerometer. The patient wears the sensor somewhere around the hip (clipped on a belt or in the pocket). The sensor is wirelessly connected to an Android Smartphone with a touch screen. An application called It's LiFe! will be installed on the Smartphone. The application consists of a widget which fills the home screen of the Smartphone. The widget shows a bar that continually fills as the participant moves closer to his or her activity goal of that particular day.

In the first fortnight of use, a baseline measurement will take place to give insight into the "normal activity pattern" of the patient. Based on this insight the patient will set an activity goal in minutes per day during a face to face consultation with the practice nurse.

While using the tool the patient gets feedback messages via the application. On the phone the patient can get more information about his or her activity level such as the degree of intensity during a day, a week, and a month. At some specific moments, for example, during the baseline measurement or when goals are reached, the patient can start dialogue sessions on the application to give more information about how activities are experienced. Based on this information the patient gets "intelligent" answers, tips, feedback, and reminders on the phone. The results of participating patients will be sent to the general practice so that practice nurses can respond to this information. The different types of feedback are depicted in Figure 2.

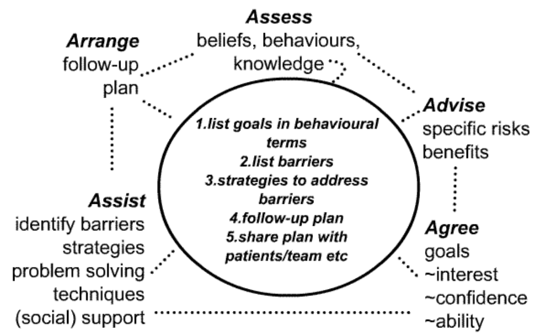

Figure 3. Self-Management Support Model with five A's (Glasgow et al., 2002; Whitlock et al., 2002).

B. *Self-management Support Programme*

Based on a literature study a model was proposed (see Figure 3). The model gives an outline of how the contact between patient and practice nurse proceeds. Practice nurses will use a consultation approach to coach patients in their self-management regarding physical activity based on a "five A's cycle" counselling technique (assess–advise–agree–assist–arrange) [13]–[15]. During the interviews, healthcare professionals were asked to give their opinions about specific aspects of this approach such as using motivational interviewing, risk assessment, and goal setting.

The interviews with professionals gave insight into "care as usual" for COPD and diabetic patients, the opinions of professionals about the Self-management Support Programme (SSP), and their attitudes regarding the use of technology and anticipated barriers and facilitators when implementing the technology in primary care. Most practice nurses reacted positively: "With this tool I can give these patients something tangible to help them improve their daily activity levels."

Both patients and professionals agreed that the sensor should measure accurately. Professionals often stated that patients tend to overestimate their normal physical activity. A remarkable difference between the results of the patients and those of professionals was that, in the opinion of most professionals, elderly patients find it very difficult to use technology, whereas the patients did not mention this

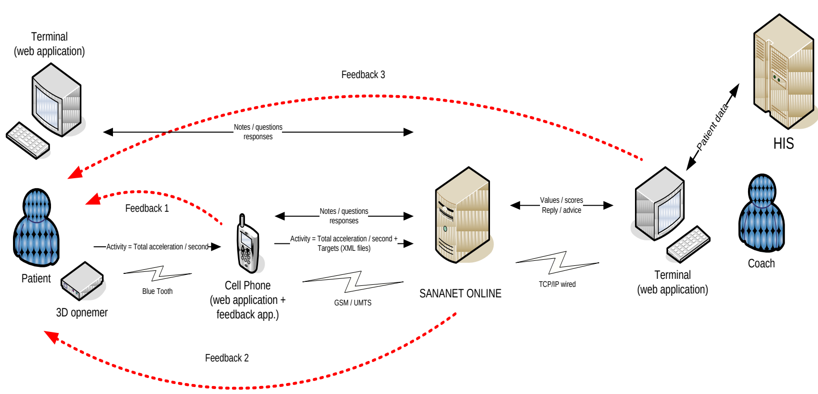

Figure 2. It's LiFe! tool feedback types.

difficulty in such a way. The opinions of the professionals about the potential of the system to give a personal response to patients between consultations varied.

At the time of writing, the latest draft of the Self-management Support Programme has now been presented to a panel of experts.

IV. Conclusion and Future Work

Supporting self-management regarding physical activity is part of the healthcare services of general practices. Both the technology and an HCM are being developed in an iterative way based on user requirements research. Intensive cooperation between the research team, technical team, and patient representatives increases the probability of successful use of the technology. The development is an ongoing process; in the upcoming years the technology will be validated and tested and a randomised controlled trial (RCT) will be set up to measure the effects of embedding the tool in primary care.

During the second year of the project the usability and validity of the prototype will be tested in a lab environment. In addition, the tool and the SSP will be tested in a pilot study of 20 patients from two general practices. At the time of writing, this part of the project is in preparation.

In the last two years of the project an RTC will be set up to measure the effects of embedding the tool in primary care. There will be three branches in the trial, each with 80 patients from eight different general practices: one group will receive "care as usual", one group will receive only the care described in the SSP, and one group will receive the complete intervention with both the SSP and the tool. The primary outcome measures will be physical activity and goal attainment. The secondary outcome measures will be quality of life and self-efficacy. Physical activity will be measured objectively by an accelerometer differing from the one developed in this project. Additionally, physical activity will be measured subjectively by a questionnaire as part of the SSP.

This project focuses on patients with COPD or diabetes who are treated in primary care, but if their effectiveness is proven, the tool and the model could also be used by patients with other chronic conditions. Furthermore the tool sensor could be extended by measuring other parameters.

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Oxfordlaan 70, 6229 EV Maastricht, the Netherlands www.maastrichtinstruments.nl

- Sananet Care BV

Rijksweg Zuid 22A, 6131 AP Sittard, the Netherlands www.sananet.nl

References

[1] Hoeymans N. and Melse J.M., Rijksinstituut voor Volksgezondheid en Milieu, Ministerie van Volksgezondheid Welzijn en Sport. "Gezondheid en determinanten: deelrapport van de VTV 2010 van gezond naar beter," ("Health and determinants: report section VTV 2010 from healthy to better,") Houten: Bohn Stafleu Van Loghum, 2010. Retrieved from <http://www.vtv2010.nl/deelrapporten/gezondheid--determinanten/ >23.11.2011.

[2] Long Alliantie, "Zorgstandaard COPD," ("Care standard COPD,") Amersfoort: Long Alliantie Nederland, 2010. Retrieved from < http://www.longalliantie.nl/zorgstandaard-copd >23.11.2011.

[3] "NDF care standard: transparancy and quality of diabetic care for people with diabetes type 2," Amersfoort: Nederlandse Diabetes Federatie, 2007. Retrieved from < http://www.diabetesfederatie.nl/start/zorgstandaard/diabetes-care-standard/download.html > 23.11.2011.

[4] Bodenheimer T., Lorig K., Holman H., and Grumbach K., "Patient self-management of chronic disease in primary care," JAMA, vol. 288, no. 19, 20 Nov. 2002, pp. 2469–2475.

[5] CBO, "Zelfmanagement, samen werken aan zorg die bij de patient past," ("Self-management, working together towards patient centred care,") 2011. Retrieved from <http://www.zelfmanagement.com/ >23.11.2011.

[6] van Achterberg T., Huisman-de Waal G. G., Ketelaar N. A., Oostendorp R. A., Jacobs J. E., and Wollersheim H. C., "How to promote healthy behaviours in patients? An overview of evidence for behaviour change techniques," Health Promot. Int., vol. 26, no. 2, Jun.2010, pp. 148–162.

[7] Tudor-Locke C. and Lutes L., "Why do pedometers work?: a reflection upon the factors related to successfully increasing physical activity," Sports Med., vol. 39, no. 12, 2009, pp. 981–993.

[8] Khan K. M., Weiler R., and Blair S. N., "Prescribing exercise in primary care," BMJ 2011;343:d4141.

[9] "Introducing the new fitbit ultra." Retrieved from <http://www.fitbit.com/product >23.11.2011.

[10] Klasnja P., Consolvo S., McDonald D. W., Landay J. A., and Pratt W., "Using mobile & personal sensing technologies to support health behavior change in everyday life: lessons learned," AMIA Annu. Symp. Proc., 2009, pp. 338–342.

[11] Fogg B. J., Persuasive Technology: Using Computers to Change What We Think and Do. Amsterdam; Boston: Morgan Kaufmann Publishers, 2003.

[12] Shah S. G. and Robinson I. "User involvement in healthcare technology development and assessment: structured literature review," Int. J. Health. Care. Qual. Assur. Inc. Leadersh. Health Serv., vol. 19, no. 6/7, 2006, pp. 500–515.

[13] Whitlock E. P., Orleans C. T., Pender N., and Allan J., "Evaluating primary care behavioral counseling interventions: an evidence-based approach," Am. J. Prev. Med., vol. 22, no. 4, May 2002, pp. 267–284.

[14] Glasgow R. E., Funnell M. M., Bonomi A. E., Davis C., Beckham V., and Wagner E. H., "Self-management aspects of the improving chronic illness care breakthrough series: implementation with diabetes and heart failure teams," Ann. Behav. Med., vol. 24, no. 2, Spring 2002, pp. 80–87.

[15] Glasgow R. E., Emont S., and Miller D. C., "Assessing delivery of the five 'As' for patient-centred counselling," Health Promot. Int., vol. 21, no. 3, 2006, pp. 245–255.