

Refereed paper

Get moving: the practice nurse is watching you!

A case study of the user-centred design process and testing of a web-based coaching system to stimulate the physical activity of chronically ill patients in primary care

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ABSTRACT

Background The system informs the nurse about levels of physical activity in the daily living of patients who are using the *It's LiFe!* tool. The tool consists of an accelerometer that transfers data to a smartphone, which is subsequently connected to a server. Nurses can monitor patients' physical activity via a secured website. Physical activity levels are measured in minutes per day compared with pre-set activity goals, which are set in dialogue with the patient.

Objective To examine user requirements and to evaluate the usability of the secured website, in order to increase the probability of effective use by nurses.

Method The needs and preferences of nurses towards the system were determined through qualitative research. The usability of the system was evaluated in a laboratory situation and during a three-month pilot study.

Results A monitoring and feedback system to support patients in their intention to be more active

was developed in a systematic way. Automatically generated feedback messages were defined based on the requirements of nurses. The results from the usability tests gave insights into how to improve the structure and quality of the information provided. Nurses were positive about the features and ease of use of the system, but made critical remarks about the time that its use entails.

Conclusion The system supports nurses when performing physical activity counselling in a structured and profound way. The opportunity to support self-management of patients in between regular consultations needs further investigation, and adaptation into the clinical workflow of the nurses.

Keywords: physical activity, primary care nursing, remote sensing technology, self-management support, user-centred design

What is known about the subject

- Although the health benefits of physical activity are well established, evidence regarding the long-term effectiveness of physical activity counselling by primary care providers is limited.
- Usability tests are essential for improving usability and workflow integration, and they are widely recognised as critical to the success of interactive healthcare applications.
- Agile software development tightens the nature of the software lifecycle; this approach is characterised by many iterative cycles and an ongoing process to capture user requirements.

What this paper adds

- A description of the user-centred design process of a coaching system to stimulate physical activity, in which the user requirements of practice nurses were carefully taken into account.
- The development of the system in an iterative way made it possible to constantly improve the system and to adapt its use into the care process.

Introduction

According to guidelines and care standards, stimulating physical activity (PA) should be an important element in the treatment of people with a chronic disease such as chronic obstructive pulmonary disease (COPD) or type II diabetes (DM).^{1,2} In the Netherlands, the majority of chronically ill patients are treated in primary care. They visit the family practice regularly to monitor their condition and it is the task of the practice nurse to provide lifestyle counselling during these consultations.^{3,4} The use of technology for long-term monitoring and feedback could support patients in achieving a more active lifestyle and could also help nurses to coach patients in establishing this behavioural change.

An example of a technological lifestyle intervention is the self-monitoring of PA using a pedometer/accelerometer. Although this has been identified as an effective approach towards behaviour change, it is not often used in practice.^{5,6} In the project *It's LiFe!* (an acronym for Interactive Tool for Self-management through Lifestyle Feedback!) we therefore developed and tested an innovative monitoring and personalised feedback tool (Figure 1) and a PA counselling protocol for nurses. The tool aims to support patients in achieving an active lifestyle as part of their self-management. The system consists of three elements: (1) a 3D accelerometer worn on the hip together with (2) an application (app) on a smartphone (*It's LiFe!* tool) and (3) the coaching system – a server and a website (*It's LiFe!* monitor).

The patient receives three types of feedback on the mobile phone concerning the amount of activity, the amount of activity in relation to an activity goal and the response of a nurse based on the measured activity. In this paper, the emphasis is on the third element – the development and testing of the server and the web-based coaching system used by nurses in primary care.

The involvement of users in the development and testing of technologies is associated with significant benefits such as: the generation of ideas by users; an improvement in system designs and user interfaces; considerable improvement in the functionality, usability and quality of the system; and access to and knowledge about user perspectives.⁸ Usability testing should be incorporated into routine development to avoid the pitfalls of developing applications which cannot be readily integrated into clinical workflow.⁹ Therefore, the aim of this study was to examine the user requirements of nurses working in family practices for the *It's LiFe!* monitor and to test the extent to which nurses were satisfied with the system.

Methods

We followed a user-centred design process for the development and testing of the tool, the coaching



Figure 1 The *It's LiFe!* tool: accelerometer and app on a smartphone⁷

system and the Self-management Support Programme (SSP), the behaviour change counselling protocol for nurses. This strategy was based on several existing models for the design of medical devices (Figure 2).¹⁰⁻¹²

From November 2010 to September 2012 we conducted three substudies: (A) a user requirements study, (B) a usability test of the system in a laboratory situation and (C) a pilot study in two practices.

All studies were approved by the ethical committee of azM/UM. The studies were successive in time, but user-centred design requires iteration, which is why some results of the final study revealed new user requirements additional to the results of the first study. The optimisation of the system is therefore an ongoing process which started with a general project idea. This project idea was developed together with several experts and business partners. It was based on a literature review of studies on coaching patients to achieve a more active lifestyle.^{13,14} The project focused on patients with COPD or DM and their care providers in primary care. Subsequently, we wrote a ‘use case’, a description of the use of the system by a nurse coaching a patient who started using the tool.¹⁵ A use case is a narrative scenario comprising a description of four main elements (PACT): the people involved (P), their activities (A), the context (C) and the technology used (T).¹⁶

User requirements analysis (A)

We chose a qualitative study design using semi-structured, audiotaped interviews in two iterative cycles to determine the user requirements of the system. We conducted 16 interviews with primary care providers, directly involved in the care of patients with COPD or DM, to ask their opinions of the use case, different aspects of the system and using it in daily practice. We transcribed the interviews verbatim and analysed the data, using the QSR NVivo 2 software package, following a directed content analysis method.^{17,18} General themes emerged and these were input for the user requirements document. Based on this document, we built the system in collaboration with two companies: Sananet Ltd developed the web-based system and IDEE/Maastricht Instruments Ltd provided the accelerometer, the app on the smartphone and the upload of the data to the server.

Usability study (B)

Five nurses tested the system in a laboratory setting at Maastricht University to discover its usability.¹⁹ First, we asked them to perform six predefined tasks. The tasks were: registering new patients, viewing individual client charts, setting daily targets, viewing progress reports, changing thresholds, sending new usernames and passwords. We asked the nurses to give comments while performing these tasks (think-aloud method)

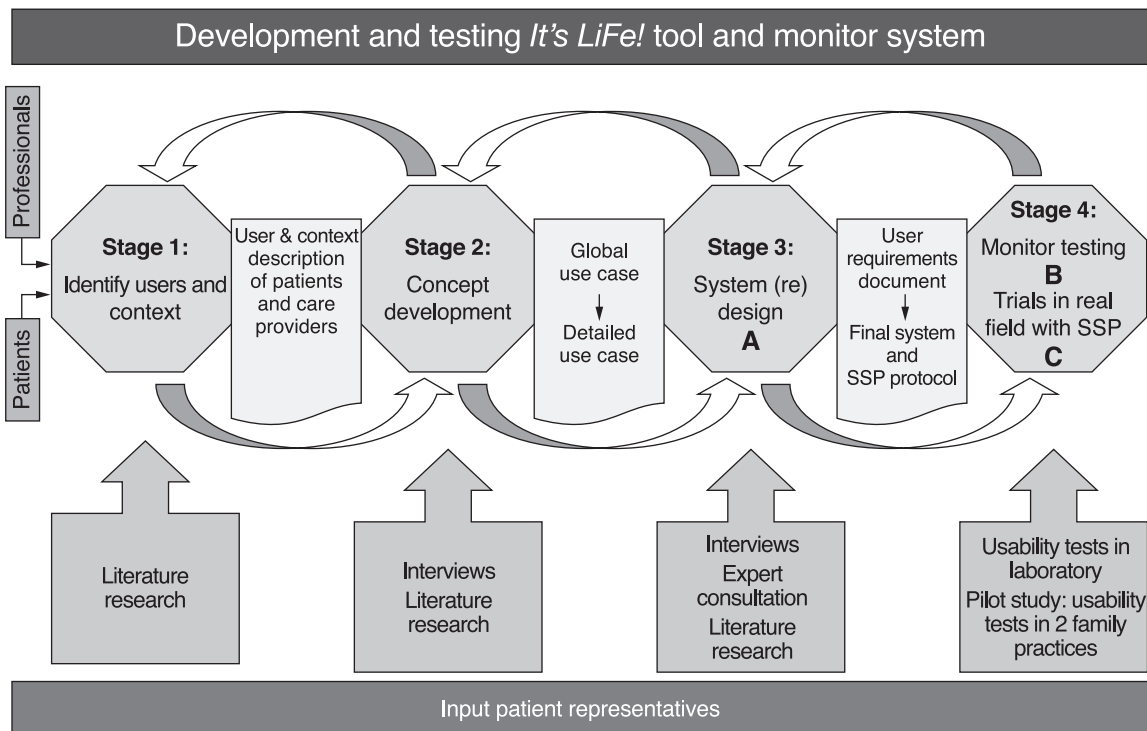


Figure 2 The *It's LiFe!* user-centred design process

and afterwards to provide their feedback for each task and to indicate the difficulty of each task on a scale from 1 (*very difficult*) to 7 (*very easy*). The sessions lasted approximately 1–1.5 hours, and were directly observed and videotaped by the researcher. We used two laptops with the Morae usability assessment software (TechSmith, Inc., Okemos, MI, USA) to record the sessions (Figure 3).

Second, we asked the nurses to complete the 19-item Post-Study System Usability Questionnaire (PSSUQ).²⁰ Finally, to obtain an impression of the desirability of the system, we asked them to mark 5 words from a list of 118 (product reaction charts) that in their view best characterised the system.²¹ We used descriptive statistics and simple content analysis to organise the data into categories that reflected the emerging usability themes. We tagged frequently occurring errors while analysing the video tapes. Based on the results of the usability tests, we improved the system.

Pilot study (C)

As a next step, a pilot study took place with 20 patients and three nurses at two general practices. In each practice, 10 patients with COPD or DM used the tool. The patients visited the practice three times: in the first week, after 2 weeks and after 8–12 weeks for PA counselling.^{22–24} During the first consultation, the nurse supplied the tool, registered the patient in the coaching system and instructed the patient on how to use the tool. During the second consultation, a daily activity goal was set in minutes a day, based on the results of a pre-measurement, and in mutual agreement with the patient. During the third consultation the patient received feedback from the nurse, based on the results of PA performance, which were represented

on the monitor. For patients, those results were also visible on the app of the smartphone. Before the start of the pilot study, nurses received a personal account for the system and were instructed how to use the tool and the coaching system by the researchers. We advised them to use the tool and to sign up as a patient in the system beforehand to get familiar with it.

During the pilot study, we interviewed the nurses three times. We asked questions concerning their experience with the monitor and whether technical problems occurred. We audiotaped the interviews and made field notes. At the end of the pilot study, a focus group interview took place to discuss and complement the analysed interview results.

Results

User requirements analysis (A)

We interviewed 16 primary care providers (11 nurses, 3 GPs and 2 physiotherapists), of which 4 were male and 12 female. Their mean age was 42 years, with a range between 26 and 58 years. The following themes emerged.

The opinion of the use case

Most interviewees liked the idea that using the tool would give both patient and nurse the ability to monitor PA levels. They confirmed the added value compared with self-reported activity because patients often overestimate their level of activity. Interviewees stressed the importance of goal-setting being part of supporting self-management. Furthermore, they indicated that the goals should be flexible, tailored to the

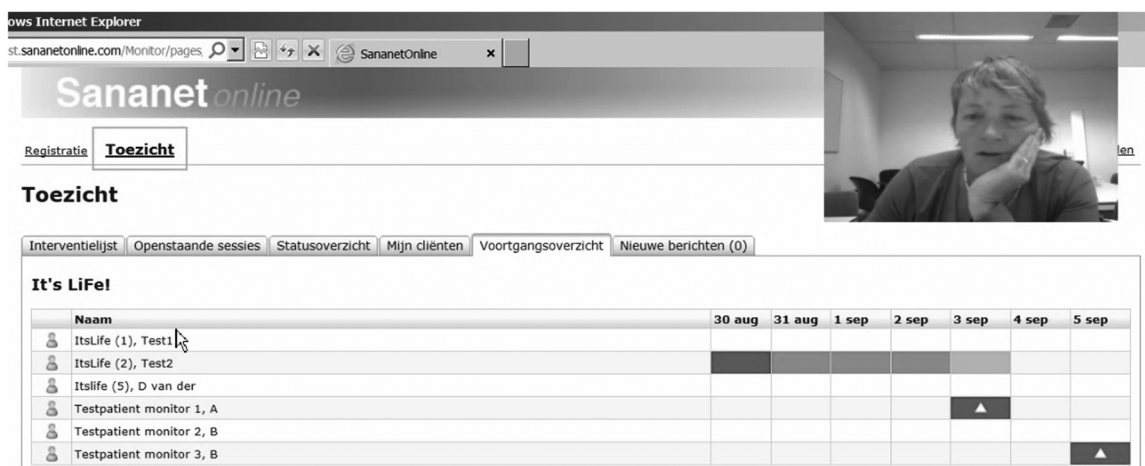


Figure 3 Screenshot of the evaluation of the *It's LiFe!* monitor using Morae

individual situation of the patient, and that comorbidities of patients should be taken into account when setting a goal.

The role of the nurse in stimulating physical activity

Although nurses often see a sedentary lifestyle with COPD or DM patients, most nurses indicated that normally they do not spend much time on the assessment of the level of PA. Therefore, the use of this tool by patients to assess PA levels objectively was considered valuable. Furthermore, interviewees suggested that if a diary were part of the system, this would give more insights into the normal activity patterns of the patients.

How the information generated by the system should be presented

The activity data should be clearly presented and embedded in the information system or they should be linked with this system. Several nurses complained about using two or more systems and they wanted to avoid 'double registration'. Furthermore, the system should present a summary of all information about all their patient's performance and goal attainment at a single glance, presented in numbers and graphs.

Integration of the system into the workflow

The majority of the nurses were not enthusiastic about giving feedback on the PA levels of patients in between regular consultations. Only a few mentioned that they would probably monitor activity levels to find out whether the patient was actually using the tool. They did not, by any means, want to receive push information, such as notifications from the system.

After the interviews it was clear that providing feedback in between consultations was too much to ask of the nurses and therefore it was decided to provide patients with automatically generated feedback messages, directly from the coaching system. Furthermore, dialogue sessions were developed and automatically provided, to support the nurse and the patient in preparing for a consultation.

The coaching system

Based on the user requirements elicited, the *It's LiFe!* monitor was developed. The system consists of a server with two portals, one for care providers and one for patients. The nurse signs the patient into the system. The login name and password are sent to the patient by email. At home, the patient has to complete an additional questionnaire online (a session) con-

cerning PA preferences. At 6 a.m. the smartphone automatically connects to the *It's LiFe!* server to store the PA data from the previous day on the server. There is a pre-measurement period of 14 days. In the second week, patients receive short sessions every day to keep a diary. These can be accessed both on the smartphone and on the website. Furthermore, patients receive two sessions concerning goals and activity planning based on the PACE.²⁵ The nurse can see the answers given by patients in the system on the individual chart of the patient (Figure 4).

After two weeks a daily goal in minutes per day is set in the system by the nurse in dialogue with the patient. Based on the PA data related to this goal, patients receive feedback messages. There are several types of message (tips, encouragement, positive trends, rewards, barriers, facilitators and adjusting goals). Patients get such messages when they reach or do not reach their goal after 3, 5 and 14 days. All messages are written in a positive tone, e.g. 'Good that you still try to be more active. We can see that it is hard to reach your daily target. If you want to adjust your goal, contact your nurse or click here.'

Usability study (B)

All five nurses who were invited took part in the test sessions. They were female and their mean age was 45 years with a range of 31–54 years.

Task performances and feedback on the manual

Although it was the first time nurses had used the system, they were mainly positive about the ease of use. Scores on task performance ranged from 5.5 to 6.6 on a scale from 1 to 7 (Table 1).

Observed problems

When registering a new patient in the system, three nurses used the back button of the web browser instead of the back button of the application itself. This caused an error with the connection to the server. Furthermore, the 'more ▼' button in the individual charts with information about the preferences of patients was overlooked by four of the five participants. Finally, sometimes the system was slow due to Internet connectivity problems.

Participants' remarks

Most remarks made by the nurses related to the structure and the quality of the information.

Beweging in beeld

Beweegrapport

Het beweegrapport is een overzicht van de activiteiten die u heeft gedaan en de antwoorden die u heeft gegeven tijdens de eerste 2 weken waarin u uw bewegingsmeter heeft gedragen.

[Toon informatie voor consult 2](#)

Mijn activiteit in de afgelopen maand

In onderstaande grafiek kunt u per maand zien hoe actief u bent geweest. Gebruik de pijltjes om een andere periode te zien.

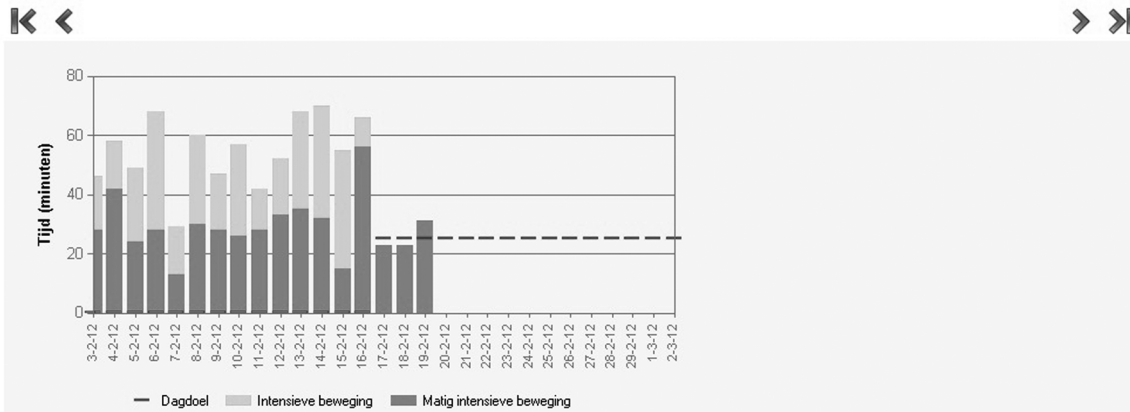


Figure 4 Screenshot of an individual patient chart

Table 1 Task performance

Tasks	N	Mean (SD) scores ^a
Register a new patient	5	6.6 (0.5)
View an individual client chart	5	5.8 (0.8)
Set a daily target	5	5.6 (1.5)
View the progress report	4	5.5 (1.0)
Change the threshold	4	5.5 (1.9)
Send new username and password	4	6.3 (1.0)

^a Scores range from 1 (*very difficult*) to 7 (*very easy*).

Structure of information:

- The system is organised in four different layers (subpages). Many participants commented on the complexity of navigation.
- Participants asked whether it was possible to remove subpages which were not necessary for the coaching of PA (e.g. medication charts).
- Remarks regarding the individual charts: the most important information should be presented at the top of the page and this page was too long (users had to scroll to view all the information).

Quality of information:

- Participants liked the use of the graph indicating the level of activity over the past months and they were satisfied with the content of the individual charts. They said that it was useful information and that this could support them when talking to the patients during consultations.

Questionnaire

The results of the PSSUQ (Table 2) were positive and in line with the positive remarks of the respondents concerning the information provided by the system. The overall score of the PSSUQ was 2.6 on a scale from 1 to 7. Scores on the subscales were 2.4 for System Usefulness, 2.7 for Information Quality and 2.3 for Interface Quality.

The product reaction word list

From the 118 words that the respondents could choose to characterise the system, the following five words were chosen twice: 'professional', 'motivating', 'valuable', 'customisable' and 'innovative'. Most words selected were positive. Only two negative words were chosen: 'slow' and 'time-consuming'. An overview of all the words is represented in Table 3.

Pilot study (C)

The following comments on using the system in daily practice were given in the interviews and the focus group:

- All nurses found it helpful to try out the tool and the coaching system first by themselves.
- They thought the system was valuable and easy to use, and instructing the nurses to use the system was done in a few minutes.
- They all agreed on the usefulness of obtaining objective PA data via the system, because they indicated that it is difficult to assess this level otherwise.
- Owing to some connection problems nurses were not always able to see the data, but during the consultations this was partly solved by looking on the app of the smartphone.
- On the one hand, all nurses indicated that when looking at the data together with the patient, it was much easier to talk about barriers and facilitators for becoming more active. But, on the other hand, this often resulted in a longer consultation time.
- These nurses differed in their opinion about monitoring results and giving personal feedback in between consultations, compared to the nurses we interviewed during the user requirements study. They would probably do this if they would receive a notification when patients did not reach their goals and if an option would be part of the system to create feedback messages.

Discussion

Principal findings

The *It's LiFe!* monitor was built for nurses to support self-management of PA of chronically ill patients in primary care. Different components of the system were based on the user requirements, such as the development of automatically generated feedback messages. The iterative approach resulted in a system which was appreciated by the nurses. The results of the usability tests gave insights into how to improve the structure and the quality of the information provided. When used in practice, nurses were positive about the features and ease of use of the system, but they made critical remarks about the time that its use entails.

Implications of the findings

On the basis of the studies presented in this article, the system was improved in several areas. The results are promising with respect to usability, providing a sufficient basis for a large-scale effectiveness study. After such a study the system might be further improved and could be linked with existing medical record systems.

Comparison with the literature

We developed the system in an iterative way, not neglecting usability and following agile principles.^{9,26}

The concept of a user's smartphone connected to a sensor device, and providing patients with phone-based feedback together with nurse support was previously applied in the telemedicine system to support young adults with type I diabetes.²⁷ In this system, PA monitoring was based on self-reported performance. In addition to this, *It's LiFe!* informs patients and practice nurses about more objective PA results through the use of an accelerometer.

Different opinions were expressed about monitoring PA results in between planned consultations. Unfortunately, lifestyle counselling for chronically ill patients in the Netherlands is organised and reimbursed based on regular scheduled consultations, not yet on supporting self-management by continuous monitoring conditions in collaboration with patients.^{28,29}

Limitations of the method

The user-centred design takes into account the requirements of all users, both care providers and patients. Requirements of patients were not reported

Table 2 PSSUQ

PSSUQ questions	N	Mean (SD) scores ^a
1 Overall, I am satisfied with how easy it is to use this system.	5	3.4 (0.9)
2 It was simple to use this system.	5	2.6 (1.5)
3 I could effectively complete the tasks and scenarios using this system.	5	2.0 (0.7)
4 I was able to complete the tasks and scenarios quickly using this system.	5	3.6 (1.8)
5 I was able to efficiently complete the tasks and scenarios using this system.	5	2.0 (0.7)
6 I felt comfortable using this system.	5	1.4 (0.9)
7 It was easy to learn to use this system.	5	1.8 (0.8)
8 I believe I could become productive quickly using this system.	5	2.6 (1.8)
9 The system gave error messages that clearly told me how to fix problems.	4	3.0 (2.8)
10 Whenever I made a mistake using the system, I could recover easily and quickly.	4	3.3 (2.6)
11 The information (such as online help, on-screen messages and other documentation) provided with this system was clear.	5	1.8 (0.4)
12 It was easy to find the information I needed.	5	2.4 (1.7)
13 The information provided by the system was easy to understand.	5	2.6 (1.8)
14 The information was effective in helping me complete the tasks and scenarios.	5	3.2 (1.5)
15 The organisation of information on the system screens was clear.	5	3.6 (2.0)
16 The interface of this system was pleasant.	5	2.0 (0.7)
17 I liked using the interface of this system.	5	2.0 (0.7)
18 This system has all the functions and capabilities I expect it to have.	5	3.0 (1.6)
19 Overall, I am satisfied with this system.	5	2.8 (1.3)
Overall PSSUQ	5	2.6 (0.8)
System usefulness	5	2.4 (0.8)
Information quality	4	2.7 (1.2)
Interface quality	5	2.3 (0.8)

^a Scores range from 1 (*strongly agree*) to 7 (*strongly disagree*).

Table 3 Product reaction word list^a

Respondent			Chosen words		
1	Enthusiastic	Novel	Professional	Stimulating	Interesting
2	Confident	Convenient	Familiar	Motivating	Valuable
3	Approachable	Customisable	Innovative	Relevant	Slow
4	Innovative	Motivating	Personal	Professional	Valuable
5	Clean	Controllable	Customisable	Essential	Time-consuming

^a Words given in bold were chosen twice.

in this paper, but all development steps were carefully commented upon by two patient representatives, from the Netherlands Asthma Foundation and the Dutch Diabetes Association.

Maastricht Instruments Ltd. Oxfordlaan 70, 6229 EV Maastricht, the Netherlands, www.maastrichtinstruments.nl; Sananet Care Ltd. Rijksweg Zuid 22A, 6131 AP Sittard, the Netherlands, www.sananet.nl

Call for further research

The tool is equipped with an option for patients to get automated feedback based on their PA goals. Further investigation should reveal information about the best balance between this form of feedback and the feedback given during consultations. An RCT will be set up to measure the effects of the tool and the coaching system embedded in the Self-management Support Programme.

Conclusions

A monitoring and feedback system to support patients in their intention to be more active was developed in a systematic and iterative way. The system allows the daily PA levels of patients to be monitored, and supports nurses when performing PA counselling in a structured and profound way. The option of supporting self-management of patients in between regular consultations needs further investigation and adaptation into the clinical workflow of the nurses.

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