Chapter 14
An Integrated Patient-Centric Approach for Situated Research on Total Hip Replacement: ESTHER

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14.1 Introduction

In the last decade, we have observed several technical innovations and societal transformation processes that have had direct impact in the design of pervasive healthcare systems [52]. In the context of hospital post-surgery care, the growing demand of hospital resources and the advances in surgery technology have led to a reduction of in-patient care and shorter hospitalization times [11]. In response the healthcare system is adopting e-health solutions leading to new approaches in care practices. These solutions embrace a variety of online communities and health services with the aim to facilitate connectivity between patient and medical staff. In addition, the rapid developing applications based on wearable sensor-monitoring devices and context-aware systems aim to improve the access of personal health data to the patients and health professionals. With the increasing amount of personal data offered by these solutions, patients are gradually changing from passive health consumers to pro-active choice-makers [42]. Health practices are therefore experiencing a paradigm shift from being solely delivered by professionals in hospitals to considering the home as a self-care environment and the patient as an active responsible receiver of care.

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Total Hip Replacement (THR) is a highly demanded surgery, therefore subject to the aforementioned paradigm. THR is an effective and conventional solution for moderate or severe osteoarthritis, the prevalence of joint disorders that affect the older population [1]. This procedure improves the quality of life of people that suffer from this condition enabling them to return to their daily life [49]. Due to the high demand for this surgery and the scarcity of medical resources, Total Hip Replacement procedure has adopted an early discharge strategy resulting in a quick transition from surgery to post-operatory home recovery. Wong et al. [49] state that in early discharge, hospital staff limits their effort to support the functional recovery, with little attention to the psychological needs of patients living with a new hip. This situation creates an environment of fear and uncertainty for the patients by not getting adequate educational preparation to manage their recovery [10, 11]. The existing educational programs and the physiotherapist's verbal instructions that patients get before discharge are reported as insufficient in helping them and their families to make adequate decisions about recovery at home [48]. Patients might forget or misunderstand spoken information, or they might not get all their questions answered. As a consequence they do not know the rules they have to follow during rehabilitation [43] and make uninformed decisions [29]. Once at home, the recovery is monitored on the basis of sporadic weekly or biweekly check ups between the professional and the patient, which take place at home or in the hospital. In between these meetings the patient is left with a list of home assignments, which she should perform daily without supervision. This creates a communicational gap between health professional and patient, leading to insufficient information on the progress of recovery. A reduction in the frequency of monitoring and feedback during the recovery may severely aggravate the emotional state of the patient when emotional and psychological problems have a direct effect on the recovery process [21]. Homecare technologies may open an opportunity to provide more frequent guidance and to extend the support beyond the functional.

For surgeries like THR, current technology developments aim to primarily assist homecare practices with the possibility to automatically and even remotely monitor patients' functional performance. The focus on assistance implies a passive role of the patient since all the responsibility lies on the judgments and advises processed by the system. Relying entirely on the system, current developments are primarily focused on the technical challenges to capture functional aspects such as foot pressure, balance and movement in an accurate and efficient way. As pointed by Grönvall and Lundberg [14] the challenges of implementing pervasive healthcare solutions go beyond functional-related aspects. Despite its relevance, these innovations are not considering in their approach an understanding of the complexity of patients' home, their lifestyle, attitudes and preferences. Let's imagine the following scenario: Lia is in her second day at home after surgery and the homecare system detects that she has done too little physical activity today and sends her a reminder to perform the prescribed exercises for today. She does not understand why she gets a reminder as she considers that she has moved enough today and feels very tired and even with some pain. But the system only persists with reminders making Lia feel only more anxious and stressed. What should the system present to Lia so she can be better informed of what is best to do at that moment? How can the system incorporate Lia's feelings and emotional state to better support her? Supportive homecare technologies adopt a reflective approach by providing users with relevant information they can reflect upon to become self-managers of their own care [18] whereas assistive technologies assume a more persuasive approach, where the system takes a prominent role by nudging people towards a goal [32]. The shift from assistive to supportive technology is considered a relevant research direction to avoid scenarios like the one presented above.

Design research on Human Computer Interaction (HCI) provides methods and tools to investigate and design technologies driven by people's needs and desires [16]. In particular the field of User Experience considers people's feelings in relation to their daily practices as an important focus for the design of technologies that aim to have a positive impact on people's life [17]. The goal to support patient's reflective process of their physical and emotional state during the recovery requires a holistic understanding of people's momentary experiences. These experiences relate to individuals' moment-to-moment changes of feelings regarding a specific situation (Roto et al. 2010) therefore the use of traditional methods like interviews and questionnaires are considered insufficient to capture the rich and lively aspects that can be extracted from them. Relying primarily on participants' ability to recall past memories, shortcomings of these methods result in obtaining an inaccurate view of past experiences based on guesses and estimations.

This chapter reflects on the authors' experience in developing and implementing a research tool that aims to capture the recovery process from the perspective of the patient, contextualized to when and where this process takes place, with the goal to inform the design of technology innovations that will be accepted and adopted as part of the daily life practices of patients. The chapter bases on research and field studies done around the design and development of a novel research tool that considers User Experience as a key element in understanding acceptance and long-term adoption. The purpose of this chapter goes beyond describing and evaluating the tool and potential home care applications, which have been reported elsewhere, but aims to reflect on the challenges and opportunities this approach opens for HCI in the design of home care innovations. It ultimately aims to contribute to the existing research approaches, discussing why and how innovations should address patients' experience early in their design process to guarantee the acceptance and adoption of innovations that are designed to support home care.

First, the state of the art as related to HCI research on homecare technologies in the context of THR is presented. Next, Experience Sampling Method (ESM) and Stage-based model of Personal Informatics are briefly introduced to report on existing developments of in-situ tools as well as applications to support self-reflection. Third, ESTHER, an in-situ and ecological research tool in the context of THR is introduced describing the experiences in implementing the tool in different interventions. The chapter closes with a discussion on the opportunities and challenges that a patient-centric, in-situ and ecological tool creates when used in health related life settings.

14.2 Glossary

Total Hip Replacement (THR) Total Hip Replacement (THR) is an effective and common surgery for moderate or severe osteoarthritis. This medical intervention reduces considerably pain and returns patients to function [49].

Experience Sampling Method (ESM) An ecological, in-situ data collection method in which participants respond to repeated prompts that are triggered at random or specific moments over the course of a day. The reports are related to emotional aspects that people experience around living activities in their natural life settings [19].

Personal Informatics (PI) An emerging area in the field of Human Computer Interaction that facilitates people to collect personal relevant information for the main purpose to support self-reflection and gaining self-knowledge regarding their emotional and physical state as well as behavioral practices [26].

Outcome measurement methods in Total Hip Replacement Standardized tools and techniques to establish the baseline status of a patient at different stages of the THR intervention. It provides a means to quantify progress in the patient's functional recovery. They mainly used at the early stages of recovery (1–8 weeks) providing a common language with which to evaluate the success of physical therapy interventions [35]. Examples of these techniques are Western Ontario and McMaster Universities (WOMAC), Short-Form 36 (SF-36) and Oxford Hip Score.

Pictorial Mood Reporting Instrument (PMRI) PMRI is a cartoon-based pictorial instrument for self-reporting and expressing moods. The use of cartoon characters enables people to unambiguously and visually express or report their mood in a rich and easy-to-use way [47].

Experience Sampling for Total Hip Replacement (ESTHER) ESTHER is a research and design tool initially developed to study THR patients' experiences after surgery and to evaluate design interventions to support patients in the complexity of home recovery. This tool is based on Experience Sampling Methods to capture patients' self-report on their recovery process and to support self-reflection processes in relation to daily life practices.

14.3 State-of-the-Art

14.3.1 Research Developments of THR Post-operatory Home Recovery Technologies

Clinicians are constantly seeking better ways to coordinate care, and ensure that people undergoing THR receive a personal and tailored therapy [43]. Therefore, measuring both patients' health perceptions in surgical recovery and how their experiences change during recovery is becoming an important element in the evaluation of THR after surgery, to predict short-term outcomes [41, 49]. Currently, medical teams are using standardized techniques in stages of the recovery to measure functional progress. For example, the Western Ontario and McMaster Universities osteoarthritis index (WOMAC) and the multi-purpose health survey questionnaire (SF 36), in combination with several physical performance measurements (e.g. 6 Min Walk Test, Time Up and Go) are widely used prior and several months after surgery [9, 30, 44]. These standardized clinical methods have a strong cross-sectional ability that provides useful information from a wide population in a particular time. Although several studies suggest their high validity and reliability, physical performance measurements focus only on a single isolated functional status resulting in a low correlation in their results [44]. THR recovery is strongly related to the individual experiences of the patient, which are left unobserved by these methods. Woolhead et al. [50] reported that only after complementary in-depth interviews it was possible to get a more global reflection on the recovery process, where patients admitted that they still perceived limitations during their process. Additionally, [13] emphasize the importance to consider the evolution of patients' needs, however these methods capture snapshots situations overlooking meaningful changes overtime [4]. Finally, these questionnaires often fail to elicit more constructive critical responses from the patients' points of view overlooking their emotional responses [10].

Few studies have explored aspects of recovery beyond the functional rehabilitation. Fielden et al. [10] and Grant et al. [13] used in-depth interviews to investigate patient's perspectives about surgery service and their satisfaction after discharge. These studies opened new insights about the psychosocial determinants involved in THR though the information is based only on two pre-defined periods, one just after discharge and another several weeks later. Van den Akker-Scheek et al. [45] and Fortina et al. [11] identified the importance to educate patients and assist in their recovery process after discharge involving both physical and psychological aspects. One example was a tailored made guidebook to support patients' physical function and satisfaction after surgery [11]. The guidebook provides information to the patient and family about the physical implications of the surgical intervention. It also collects patients' satisfaction rates post-surgery. Stevens et al. [43] developed a strategy using a home-based program that aims at supporting the rehabilitation at home. The strategy consists of an exit-video (practice session of patients' home exercises, including instructions and explanations, which are video taped and given to the patient for later reference), newsletters and telephone follow-up appointments to support the transition from hospital to home recovery and the process of rehabilitation at home for a period of 6 months. Both examples provided valuable information about the use and effectiveness of the proposed material to support patient during recovery. Customized guides were well accepted, and perceived as satisfactory in providing valuable information, but a low effect of the intervention was observed possibly due to a lack of moment-to-moment feedback. Since these methods are designed to document experiences in a snapshot format with high demands on patients' recalling

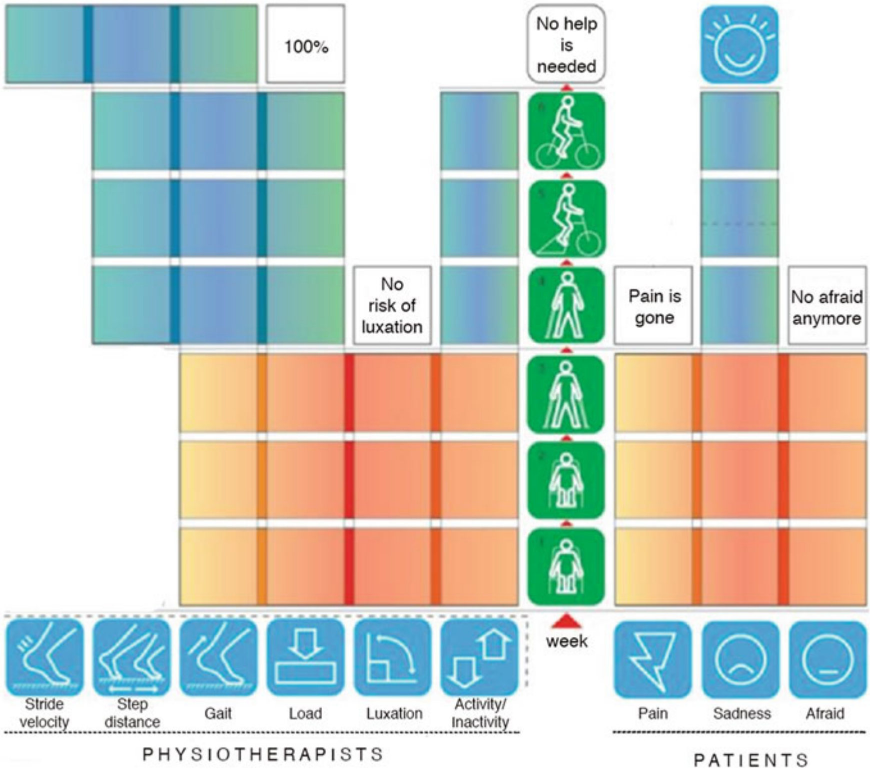

Fig. 14.1 THR recovery process. Physiotherapist and patient's main concerns during the 7 initial weeks of rehabilitation and their relevance through time. It was identified that during these weeks of recovery, physiotherapists are more concerned about the functional outcomes of the recovery while patients are more focused on their emotions and experiences

skills, it is argued that these questionnaires are limited to understand how patients experience their recovery process, and how changes affect their state of progress.

With a closer view on patients' individual psychosocial experiences, Hassling et al. [18] used cultural probes as a method for elicitation of requirements for the design of supportive technologies including emotional aspects. They implemented a self-documentary media kit for the collection of data to capture patients' experiences from living with a chronic disease. Although participants were able to capture interesting family and personal activities around the disease, it was still challenging to express emotions and to provide more reflective thoughts on what they reported. The authors suggest that explicit mechanisms need to be developed to motivate emotional reports.

A study based on user centered design methods was conducted to define the functional and non-functional aspects of a THR supportive system [22]. The study showed the value of using workshops, scenarios, and individual interviews with various stakeholders (elderly, physiotherapists, engineers, and researchers) to uncover different aspects of the recovery procedure. One of the main findings describes the recovery process as a journey in which both functional and emotional aspects are dynamic and inter-related. This journey is illustrated in Fig. 14.1 recognizing the several stages of the THR recovery process in which mobility, general health, independency, pain, family, friends, and emotions are involved.

These insights reveal the need for in-situ methods to capture patients' experience during their rehabilitation. The design of such methods requires the development of mechanisms to support people to self-report their experiences and to provide visualizations in ways that are relevant and appropriate to patients in the homecare context. These methods will help to identify the role of experiential aspects in the recovery and gradually investigate how these experiences can provide relevant information to support patients to self-manage their progress.

14.3.2 In-situ and Self-Reflection Methods

Designing for experiences in relation to care and in the context of home poses a major challenge to design technologies that become part of the current practices of patients in their home environment. As pointed out by Rogers [37], new pervasive technologies should address a wider understanding on how people experience daily life, moving from laboratory to more realistic design and testing settings. Intille et al. [20] state that developing meaningful ubiquitous computing applications first requires a global understanding of how people behave in context. Experience Sampling Method (ESM) [19] has been developed with the purpose to capture user experiences in-situ, i.e. in timed and situated, and for extended period of times to elicit people's feelings and emotional change of state. ESM takes advantage of the popularity of mobile devices to ask people for feedback at random times during the day. With ESM participants make a quick record close to the moment of interest, providing instant reports on momentary experiences instead of having to recall what they did in the past. The involvement of context-aware technologies in ESM opens the opportunity to automatize the capturing of context around participants' self-reports [2, 7, 20]. Furthermore, contextual information could help to adapt the timing and content of the prompts minimizing interruptions as well as tailoring the research questions according to what is been observed [46]. The downside of this method is that participants may perceive the prompts as too frequent and/or repetitive, which could result in undesired interruptions, burden and boredom negatively influencing participants' experience. One interesting way to overcome this drawback, is by providing participants visualizations of (part of) their reports which may result in a more positive experience, as they become aware of personal situations that other wise would be difficult to envisage [24, 38].

The Stage-based model of Personal Informatics [26] defines five stages to support behavioral change based on personal data. The first three relates to preparation, collection and integration of data while the last two refers to reflection and action. Whereas the tendency is on automating the first three stages, we question the late involvement of people at only the reflection stage. To support people's reflection and action, the integration stage plays a crucial role in selecting what is relevant. We instead envision the use of self-report methods to link the collection stage with the integration stage by inviting people to add personal insights to the automatic collected data. The opportunity that participants' reflections on the reported data could enrich the information gathered from the self-reports needs to be carefully studied as there is a fine line separating this from influencing participants' actions and their experiences in unexpected ways.

As defined by Li et al. [27] people iterate between two phases of reflection, discovery and maintenance. People in the discovery phase are seeking understanding of what affects their current situation, while in the maintenance phase they look for help to achieve a set goal. In the design of a tool that motivates patients of THR to report their experiences during the recovery weeks, the implementation of an in-situ self-report method should gradually introduce elements that support the integration stage to support discovery but prevent maintenance. In this way possible unwanted influences, such as making participants increasingly worried or overly confident, could be detected on time.

14.4 Open Problems

There is an existing lack of tools to remotely follow patients at home and to measure beyond the functional aspects of recovery. It gives to the medical team an incomplete assessment of patients' health status and current progress. There is an increasing body of research reporting that many diseases and physical complications are related to psychosocial factors in particular during the recovery phase [33, 41, 51]. However, most of the current methods that are available and commonly used to follow THR recovery focus on functional aspects with few studies exploring other aspects of recovery. There is limited knowledge into how patients experience the recovery process and how they would experience the use of technology that supports their current situation.

Several technical approaches co-exist in the development and implementation of a supportive system for healthcare that consider the home as the main care environment instead of just the clinic (context-aware systems, on-body sensor networks, telemedicine). Developing a tailored system that is able to understand patients' situation and communicate this information to health stakeholders poses several challenges. From the point of view of engineers, the design of systems architecture needs to specify clear requirements for the management of the collected data, reliability, algorithmic design, and interoperability of architectural components. From interaction designers' perspective, user related issues such as trust upon technology, acceptability of usable and attractive technology should be well understood in order to be translated into user requirements.

Existing research efforts focus on combining different information sources for better understanding user activity and context (physical state and situation) [5, 27].

However, few studies have been conducted to understand users' state and context in relation to situated support [15]. Recently, we can see this effort in commercial products such as Nike+ that has started to shift the responsibility on users to record certain activities. FuelBand and Nike+ app (2013), involves self-reporting as a powerful mechanism to engage users and it is read like a major departure from the original design intention of a carefully streamlined user experience [34]. This shows a potential for using different sources of information in a complementary way to provide better detection of user state and context and right motivational feedback.

Although further research is needed to understand self-reporting as a source of meaningful information for the user, these new developments are opening a new channel to investigate how this information can trigger in-situ motivational feedback in relation with the user state and context. It might become a powerful self-reflection tool with a positive impact to the wellbeing of patients, The potential of this can be investigated by means of an integrated patient-centric approach that combines User Centered Design (UCD), Experience Sampling Method (ESM) and Personal Informatics (PI), providing instruments to address the challenges in developing a supportive tool for healthcare.

14.5 ESTHER: Tool to Explore the Context of Total Hip Replacement

THR involves a personal and highly dynamic process where physical and emotional states are affected by unpredicted changes. Experience Sampling for Total Hip Replacement (ESTHER), is a toolkit based on Experience Sampling Method (ESM) [19] developed with the purpose to inform the design of a supportive system for homecare recovery [23]. It goes beyond the architectural components of sensing technologies as such, by aiming to provide a description of the situation of the patient, capturing the changes of determinant factors throughout the recovery period. Special attention is given to understand the influences of issues related to patients' emotional transition in this process.

Four iterations were designed and implemented as situated design interventions. Self-reporting mechanisms and the combination of sensing and subjective data analysis were considered as a patient-centric way to address patients' needs during recovery. ESTHER 1.0 was first introduced as a mean for researchers and developers to get a better understanding of meaningful experiences of THR recovery. ESTHER 1.0 was a step-by-step interactive questionnaire embedded in a touch-screen device (see Fig. 14.2, left). It triggered prompts to patients in a fixed interval asking about their individual physical and emotional daily experiences. An open question "How are you doing?", was followed by an open/close question that asked the patient to position themselves in a diagram of eight moods (see Fig. 14.2, right). The diagram was based on the Pictorial Mood Reporting Instrument (PMRI) the precedent version of Pick-A-Mood (PAM) tool [8]. The tool is specially designed to support in-situ

Fig. 14.2 ESTHER 1.0: *Left*, patient reacting to a prompt, self-reporting; *Right*, the PMRI tool applied in this design iteration

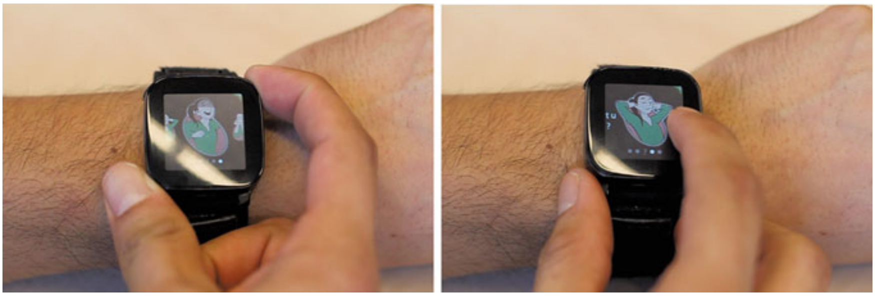

Fig. 14.3 ESTHER 1.1: Mood self-reporting actions; choosing and selecting a mood

reporting of moods. Based on the circumplex model of Russel [40], PAM identifies eight moods to represent arousal and valence dimensions in a circular space. PAM developed a female, male and robot avatars to adjust to different context and target groups. The eight moods are: excited, happy, calm, relaxed, angry, tense, bored and sad (in a clock-wise order). Reporting a mood involves to select one (or more) expressions that identify one's mood state at that moment. This is expected to be a lighter cognitive process than compared to the act of position one's mood in an open two-dimensional circle space or from a list of words. Though not recommended by the authors, we have deliberately added the text to each avatar for ESTHER. The patients must select at least one mood, and maximum two, that they feel represents them at the moment of the prompt, with the option to explain in words their choices. All of the patients' inputs with the system were logged and sent to a web server for later analysis. The server scheduled prompts and stored participants' inputs by a timestamp and type of question.

ESTHER 1.1 was a wearable version of the tool aimed to explore new input mechanisms (see Fig. 14.3). It focused on facilitating in-situ reporting by decreasing the burden of carrying along bulky devices, in particular when patients are dealing with crutches or walker during their recovery. ESTHER 1.1 also modified the prompt-

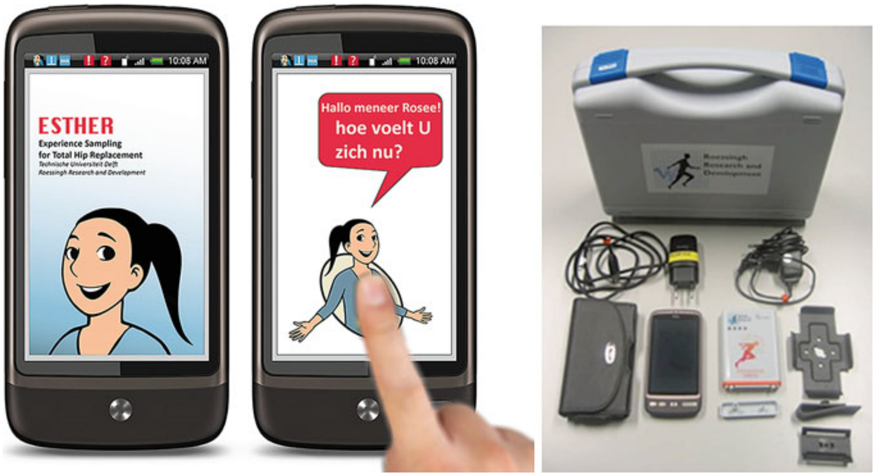

Fig. 14.4 ESTHER 1.2: *Left*, the application running on an Android phone; *Right*, the complete kit including the sensor node, the mobile phone, chargers and belt holders

ing protocol of the version 1.0 by moving the open question at the end of the day. This tool was built on the LiveView^{TM} watch connected wirelessly via Bluetooth to an Android smartphone. The small physical display of 1.3 inch OLED entailed a different interaction showing a small set of four moods from PMRI to select from.

ESTHER 1.2, an application implemented on a mobile phone along with wearable sensors (see Fig. 14.4), aimed to gain more in-depth information on 'critical moments' during recovery. Problems such as being too passive or being too physically active corresponded to 'critical moments' of a day, where, if captured and linked to mood reported could better describe a holistic recovery process of a particular patient. To achieve this, this iteration was designed to use data from on-body sensors to trigger the mood prompts to link changes in physical activity behavior with emotional aspects of recovery. With an inertial sensor placed on the patient's hip, ESTHER 1.2 captured values for physical activity (IMA). Pre-defined thresholds in physical activity were used to prompt patients about their mood when too low or too high physical activity was detected within an hour. This iteration was the first one exploring the technical challenges of monitoring and storing data in the integration of physiological and subjective/personal data.

ESTHER 1.3, an Android application, proposes a more reflective system to improve self-awareness in physical activity behavior (see Fig. 14.5). It is presented here as an in-between iteration to validate self-reflective mechanisms in a context that is less critical and sensitive than THR recovery patients. This prototype supports knowledge workers to reflect on their own physical behavior during working hours, allowing users to set targets of physical activity breaks over the day, monitor their progress and report on their mood states and current activities. By means of a

Fig. 14.5 ESTHER 1.3: *Left*; the application showing the state of 3/4 of a day gone, the planed activities (*outer green strips*), the actual physical activity progress (*inner red, yellow* and *green strips*) and the mood/activity reported (*outer emoticons*). *Right*; the mood self-reporting menu

pedometer, this application tracks the recommended healthy amount of steps during a regular working period, which for 8 h is calculated to 2000 steps [12].

ESTHER 1.3 builds on top of the Personal Informatics framework (PI) by implementing mini self-reflection cycles that empowers the user to have deeper reflection moments by means of in-situ self-reporting mechanisms. The rich information provided by ESTHER 1.3 aims to actively support people to reflect based on the integration of sensed data and people's own reports at several intervals. It is proposed that these mechanisms may subtly and even unconsciously influence knowledge workers' reflection and awareness during work hours. It is expected that the user will gain a personalized understanding of the data, which may trigger deeper and more critical reflection.

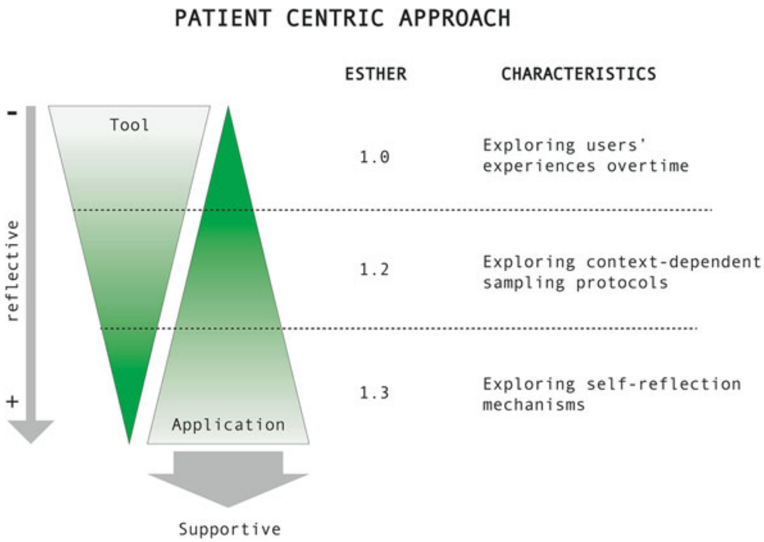

Fig. 14.6 Transformative method: from research tool to application by extending self-reporting techniques with self-reflection

14.6 Integrated Patient-Centric Approach: From Reporting to Reflecting

Total Hip Replacement served as a test bed scenario to demonstrate the implementation of ESTHER in the context of post-operatory recovery. Where the initial goal was to investigate the value of the tool to capture momentary experiences, a transition from acquiring insights into investigating the effects of a supportive tool were gradually revealed and iteratively explored along the interventions (see Fig. 14.6). Two points are identified that explain this transition. First, the transformation of an initially framed exploratory research to a more focused research opened the opportunity to support more complex participation. Gradually, the research tool evolved from an exploratory tool that offered open and technologically simple mechanisms, to a more focused tool that provided more specific and technological complex mechanisms. Second, as participants' needs changed along the recovery the tool was forced to adapt to such need to maintain a valuable experience.

The reflection presented in this section touches upon the aforementioned points by discussing the experience gained in each intervention and the role that the technological developments of the tool have in what could be framed as transformative research: from reporting to reflecting. The iterations of ESTHER were implemented in small interventions with THR patients with different goals in mind. In ESTHER 1.0, five THR patients (three males, two females) participated. The goal was to explore patients' experience during recovery and get insights on the usefulness and value of reporting techniques in their recovery process. Participants were asked to use the tool during the first two weeks of their recovery at home. Data collection consisted of self-reports captured during the intervention together with exit interviews. ESTHER 1.1 was used during the first week of recovery by one patient. The goal was to explore the technical opportunities of integrating mobile and home devices to offer more instances for reporting. The patient received instructions on how to use the tool and he was asked to use it during the first week of recovery. Again, patient's reports and an exit interview were used to uncover his experiences with the tool. In ESTHER 1.2 the intervention involved the first 2 weeks of recovery observing four THR patients (three male, one female). The goal was to describe patients' practices with the tool and observer possible influences of the tool in patients' experiences, motivations, awareness and preferences when using the tool during the recovery. Monitored physical data, reports and exit surveys were analyzed. Patients involved in all these interventions were volunteers from the Department of Orthopaedics of Reinier de Graaf hospital in Delft, The Netherlands. More information about the setups, goals and results of these interventions can be found in [23].

14.6.1 The Evolving Needs of Patients Along the Recovery Process

The intervention of ESTHER 1.0 showed a distinction between the first week and second week of recovery. The first week, described by participants as a physical and emotional rollercoaster, was characterized by continuous ups and downs that involved a health condition that was new to the patient. Therefore, participants during the first week considered reporting a valuable experience as they could freely express their feelings and worries without having to bother their relatives. However, as the recovery became more familiar and stable along the weeks, reporting on a frequent basis was considered to be less valuable; instead participants expressed the need to keep themselves aware of their progress on a regular basis. Aligned with the two reflective phases defined by Li et al. [27], the value on reports experienced by participants in the first week relate to the discovery stage whereas their need for more awareness in the following weeks relate to the maintenance stage. Therefore, a tool that gradually becomes part of the recovery process needs to adapt its support from discovery to maintenance stage. In this manner the patients are continuously stimulated to report as they obtained valuable experiences in the different stages of the recovery.

Following up on these remarks ESTHER 1.1 was developed with the purpose to minimize the load of moment-to-moment reports while requesting a somewhat extensive and more reflective report at the end of the day. By prompting for shorter reports along the day, patients would be triggered to make mini reflections, which may at the end of the day facilitate an assessment of the experiences of the day. This relates to what [39] define as episodic experiences that involve reflection and assessment of a specific situation [39]. The intervention of ESTHER 1.1 showed that the reports captured at the end of the day were generally informative, but because the momentary prompts were time based and not context dependent, they did not

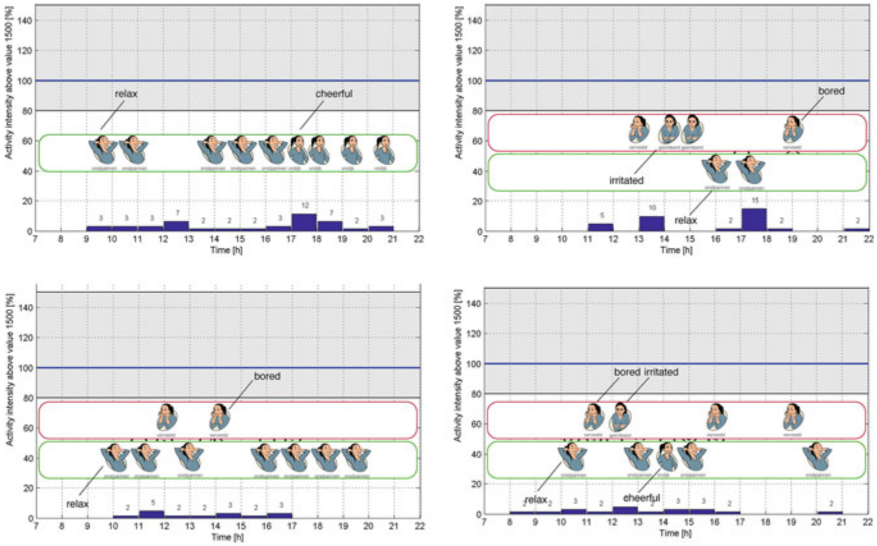

Fig. 14.7 The third day of physical recording and mood reports for each participant. The *blue bards* represent the level of physical activity per hour; positive mood reports are outlined in *green* (relaxed and cheerful) and the negative mood reports are outlined in *red* (bored and irritated)

support patients' reflection in relation to a critical moment. Critical moments such as underdoing and overdoing physical activity could provide richer reflections of that particular situation if the momentary reports (moods in this case) are explicitly linked to them.

The following iteration, ESTHER 1.2, explored more explicit links between sensing and subjective data by triggering questions only when special events were detected. In ESTHER 1.2 the benefits of providing an overview of momentary reports linked with physical performance were expected to explicitly support the report of episodic experiences by means of reflections based on richer visualization of momentary reports. The preliminary results were analyzed based on similar visualizations that the patients could see, integrating both the intensity of physical activity per hour and the reported mood when available. Figure 14.7 shows the third day of recovery of each patient to illustrate the value of integrated visualizations using physical and mood reports. Looking at patients 1 and 2, it can be observed that though their physical activity was comparable their mood changes were clearly different. Similarly, patients that showed hardly any physical activity, like patients 3 and 4, also varied in their reported moods. The reported moods were also in line with the insights gained from informal discussions and exit interviews, where patients' personalities and individual cases corresponded to their daily mood overview. Patients 1 and 3 were confident and felt easy with their operation and recovery. Patient 2 struggled with a difficult recovery, and patient 4 was the only female and was more expressive than the male participants.

At this stage, the first explicit move towards a supportive system was envisioned. However ethical considerations impeded the exploration of the next iteration of ESTHER with THR patients. Therefore, as an interim step ESTHER 1.3 was developed as an intervention to assess the potential of these visualizations in a more accessible context where reflection and awareness on physical activity is also an issue. The sedentary working style of knowledge workers has been considered as a high risk for their health [3]. Therefore ESTHER 1.3 was designed to support self-awareness and self-reflection of their physical activity during working hours. The intervention will involve 12 knowledge workers at one IT company. They will use the tool on a daily basis for a period of 4 weeks. Two conditions will be introduced at an interval of two weeks each to assess momentary reports as mini cycles to support richer and well-informed reflections.

14.6.2 Towards a more Complex Intervention: From Tool to Application

The prompting mechanisms in ESTHER, evolved from a simple fixed protocol to a context-dependent sampling protocol that combined sensing and subjective data. This complexity is the result of a gradual transformation of the design research from exploratory to analyzing the influence that different reporting mechanisms have on participants' experience.

The analysis of the three iterations of ESTHER localizes significant events and actions that describe the recovery process of a THR patient. Patients' emotional and social aspects vary over the day affecting their progress. For instance, the visit of a patient's granddaughter in the morning, or a notification to slow down walking during a visit to the physiotherapist, replicate in the physical and emotional state of the patient. The in-situ mechanisms explored in ESTHER opens opportunities to offer more personalized overviews of ones progress, bringing insights into the value of data integration to empower people in a particular situation.

The impact of an integrated and patient-centric approach in the development of ESTHER, results in further investigations on the value of supporting patients' active role of patients in the data integration process to personalize automatic captured data. Context dependent prompts opened the possibility to explore self-reports as personal tags of relevant moments in the day to support the reflection of momentary and episodic experiences. The current development of ESTHER 1.3 is a response to this transition. With the focus on supporting self-reflection by means of self-reporting, the new challenge is to understand how explicit visualizations of mini prompts would support self-reflection and eventually self-management of peoples' own actions.

Based on [26] stage-based model of Personal Informatics, ESTHER 1.3 aims to support patients' journey from integration to reflection by means of mini-prompts to ask for quick reports on their state. Integrated visualizations of automated health

Fig. 14.8 Micro-cycles of self-reflection: personalization of data via self-reports

information with patients' mini self-reports are expected to support richer reflections and empower the self-management of actions.

Figure 14.8 illustrates an adaptation of Li's model to represent the vision to support the collection of raw data with mini prompts, which resulted in visualizations of data that has been stamped with personal reports. This stamped data is expected to make the momentary reflections captured along the day visible supporting a richer assessment towards setting and eventually reaching ones goals.

14.7 Future Outlook

Acceptance of technology is a major threat in the design of innovations for daily use. Designing innovative technologies that aim to positively influence people and their lifestyles, require a holistic and realistic understanding of people's experience in relation to their everyday lives [37]. This realistic view request a shift from laboratory studies to research practices that are applied into real life settings. One common critic to this approach is the general low cardinality of subjects involved, considering the complexity of studying real settings and even more when the goal is to assess the effect of technology based interventions. As Rogers' argues for a shift in the way these works are assessed where the question should move away from how many participants to what the time span and the granularity of the data collection. ESTHER offers a way to enrich the monitoring of the functional aspects of the recovery process by capturing the full experience of being a THR patient. The approach discussed in this chapter proposes new research practices to capture people's experiences using interventions that gradually become part of the daily life practice of patients in their home environment.

Considering the four user experience stages described by Roto et al. [39] interactions with technology in daily life practices are anticipated, experienced, assessed, and reflected upon. The emergence and adoption of new practices will succeed if the assessment and reflection of experiences is positive. To support that assessment innovative technologies are expected to provide reflective mechanisms to facilitate peoples' ability to self-reflect and become aware of their situation. This opens the opportunity to design for supportive technologies that aim to empower people to try out and adopt new practices helping them through out the stages of anticipating, experiencing, assessing and reflecting upon new practices.

The holistic, subjective and dynamic aspects of experiences bring interesting challenges to the design of interactive technologies that aim to positively influence the experience around certain practice [17]. Yoshiuchi et al. [51] point out the importance of assessing the relationship between symptoms in physical conditions with psychosocial factors in natural settings. ESTHER addresses these challenges by obtaining an understanding of the patient's situation in context, based on self-reports and involving physical and emotional aspects around the recovery. The addition of self-reports to monitoring data is expected to support patients to assess and improve their overall health status by providing meaningful and personal feedback. Considering the two reflective stages of Li et al. [27], discovery and maintenance, an integrated and personalized visualization may empower self-management by providing a stage of understanding and a stage of awareness. The technology is there; the challenge lies in an understanding what reporting and reflective mechanisms are best suitable for each case.

Although ESTHER iterations gradually focus only on the patient, opportunities to extend it to involve other stakeholders are considered relevant for further investigation. As concluded in Jiménez Garcia et al. [22], the self-report data gathered in ESTHER 1.0 could help physiotherapist to build a more personalized judgment of the progress of patients' recovery. The patient's in-situ reports represented patients' background and attitudes, which eventually could help the physiotherapist to have a more sensitive judgment compare to only looking at the objective information of a patient. In addition, considering self-reports a less dense data collection in terms of data points (compare to sensor data) it was perceived as potential filters of the sensor data to be able to raise flags when attention is needed. This could address one of the important trade offs between physiotherapist's workload and their need for more personalized support to patients. In the same study, when consulting the needs of the medical community, the non-systematic nature of the self-report data (as patients were not obliged to provide constant feedback), defied the need of the community for quantified metrics on the subjective wellbeing of patients. Future work may look at existing measurements and investigate the value of deploy them as part of the-situ self-reports to personalized the objective data gathered.

ESTHER is an example of a tool that follows an integrated and patient-centric approach to understand patients' experiences regarding a care situation. Throughout the four versions this chapter presented the evolution of ESTHER from a research tool to a design intervention and to an application, with the shared goal of informing future iterations and introduce an application that supports patients to reflect on their own recovery. The shift in the role of ESTHER can be seen as part of a process to inform the design of supportive technologies while uncovering challenges in relation to technological (stability, complexity), research (validity, resources), user (engagement, acceptance) and design (interaction mechanisms, feedback). Furthermore, ESTHER was found to empower patients in ways that were not intended. The question of whether this unintended influence results in positive or negative experiences opens an ethical discussion on the implications that complex interventions may have on patients' care situation. One way to address such concerns is by adding interim interventions to validate new elements of the method in a similar but less sensitive context. This is the case of ESTHER 1.3, which due to its complexity will be first tested in a different context than THR. The associate cost would likely embrace some adaptation to fit the tool in the new context. The adaptation could affect design and technical components, but it seems necessary to take this interim step to validate the mechanisms proposed and minimize the risk of negatively influencing the patients' recovery experience. This requires a careful selection of the alternative context in which to apply the intervention.

Acknowledging that the digitalization of medical data provides substantial information to physicians and eventually to patients, it is argued that only exposing patients to data is far from providing them with meaningful information and ultimately meaningful experiences for the patient. The data remains static and patients are playing an inactive role towards their own information. The reflections discussed here, address opportunities to make patients active participants in the creation of information about their recovery, with the ultimate goal to empower them to become self-managers of decisions and actions regarding their own recovery.

A review of the last decade research developments in supportive technologies for physical activity shows the interest in the design of glanceable (non-literal) displays that provide feedback using abstract representations of physical activity. Fish'n'Steps [28] provides real-time information with glanceable visualizations about levels of physical activity with the purpose to serve as external motivation and provide awareness. Houston [6] is a mobile application that tracks step counts allowing users to set weekly goals and promote physical activity awareness, sharing their goals and meet targets within a group. Of particular relevance to this research, is the work of [5] UbiFit Garden, where the idea of manual journaling was explored by inviting users to tag the activities inferred by the system with corrections or personal comments. Although the mechanisms for journaling were perceived as light and simple, participants reported that the value of the journaling could be improved if better integrated with sensor data. Other commercial devices for fitness and sports such as Nike+ or Adidas miCoach automatically collect physical activity data and display it in the form of graphs and statistics. While they also support some kind of journaling this is done in a form of reconstruction of the activity after it was finished, therefore the focus is more on assessing the experience rather than collecting aspects of the experience itself. But as argued in this paper, episodic experiences are hard to assess if no view on the momentary experiences is presented. Just presenting overviews and statistics of one physical performance is not enough to help individuals to become self-management of their own goals and actions. As mentioned by Moore et al. [31], current personal information technology is being designed to optimize productivity rather than self-understanding. Li [25] similarly states that physical activity behavioral change is also related to identify opportunities for change; focusing only on the amount of physical activity, it is argued to be insufficient to help find opportunities. Optimizing performance relates to systems that have a stronger persuasive approach where the user gets little opportunities to learn, but just receive instructions. The value of reflection has been critically examined as a positive influence in providing empowerment to change behaviors [36]. To our understanding, there are no systems that support Total Hip Replacement patients in capturing deep reflections in physical recovery and activity. The approach here presented and ESTHER are first steps in helping THR patients to find opportunities to improve their condition and become active managers of their recovery process.

14.8 Conclusions

This chapter discusses an integrated patient-centric approach to design homecare technologies considering patients' personal experiences and context as crucial aspects when providing care support. It reflects on the authors' experience in developing and implementing a research tool that aims to capture the recovery process of Total Hip Replacement (THR) from the perspective of the patient and contextualized to when and where it takes place. The goal is to extend the design research from functional to experiential aspects of a recovery, which requires a closer intervention in the context of patients' home to capture the changes they go through in relation to their physical and emotional state during the recovery. In-situ methods and tools are therefore developed to investigate their power to provide a holistic view of patients care experience as well as support interventions in the context of use.

Given that THR is a dynamic process that involves important physical and emotional changes overtime, ESTHER is proposed as a means to support patients in self-reporting their experiences during their recovery at home. Based on Experience Sampling Method (ESM) the tool aims to provide a description from the patient's view of their states and the changes throughout the recovery period. Four iterations were designed and implemented as situated design interventions where self-reporting mechanisms and the combination of sensing and subjective data analysis were considered to better address patients' needs during recovery.

The implementation of ESTHER in the context of THR recovery gradually revealed the effects that reflective mechanisms could have to support the patient which were iteratively explored along the interventions. Two points are identified to explain this transition. First, as participants' needs changed along the recovery the tool was forced to adapt to such need, to maintain a valuable experience for participants. Second, this transition was also explained by the transformation of an initially framed exploratory research to a more focused research. The complexity of the prompting mechanisms in ESTHER is the result of a gradual transformation of the research goal from exploratory to explain the effect of different reporting mechanisms on participants' experience.

The integration and patient-centric approach of the development of ESTHER, led to investigating the value of data integration where the patient has an active role in personalizing automatic captured data. The shift to more context dependent prompts opened the possibility to explore self-reports as personal tags of relevant moments in the day to support the reflection of momentary and episodic experiences. ESTHER addresses a holistic approach where subjective and dynamic aspects of experiences are integrated by obtaining an understanding of the patient's situation in context, based on self-reports and involving physical and emotional aspects around the recovery.[53–56]

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Further Readings

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