BOUNDED RECOMBINABILITY OF DIGITAL TECHNOLOGIES FOR PATIENT-CENTRED CARE

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Abstract

A central challenge for healthcare is technology innovation. The literature has reported on the many challenges to IT innovation efforts in hospitals and in digital health services in general. Recently, the increased use of mobile apps, personal devices, web interfaces – so-called lightweight technology – has introduced a novel innovation logic where recombinability seems to emerge as a core capability to enable innovation. However, we still know little about how recombination activities support digital innovation in healthcare. Specifically, we are interested to explore this issue in the context of digital innovation for patient-centeredness based on the adoption of lightweight technologies. Our research builds on a comparative analysis of two case studies in Scandinavia. The two cases show that recombinability is crucial to enable personalization and the collaborative management of illness between patient and healthcare and it entails reorganizing the healthcare practice. In addition, the findings show that the logic of recombinability was in both cases bounded by the patient and healthcare practice. We discuss bounded recombinability as a logic to maximize the value of digital innovation for a local practice.

Keywords: digital innovation, healthcare, recombinability, patient-centeredness.

1 Introduction

The healthcare sector is undergoing major digital transformation. One core area where this is taking place is the use of digital technologies to increase patient experiences and access to medical care. For instance, the widespread use of digital measuring devices, personal health apps and wearable sensors by patients and people in general has enabled novel health tracking and monitoring practices. Often, patients decide to adopt such technologies for self-care autonomously from health providers and demand these data to be considered in traditional care. They see the potential of using data from personal tracking devices to support care that is less episodic, and more personalized to their own needs and conditions (Fiore-Gartland & Neff, 2015; Mentis et al., 2017).

However, the adoption of these tools in traditional care has been slow and challenging. While some health care actors see the value of having access to, and working with, a continuous flow of patient data, others are more skeptical and point to the additional data work and competency needed for analysis (Cabitza et al., 2019), the lack of competency on how to integrate digital solutions into existing practices (Neff, 2013), the uncertainty around the actual usefulness of large amount of data (Neff, 2013). In addition, while patient-centered care, by definition, argues for tayloring solutions for the specific needs of each person, digital solutions in traditional care are designed around a set of standard patients' pathways seen from a medical perspective (Mintzberg, 2018; Bygstad and Bergquist, 2018).

Thus, it is still unclear how novel digital technologies and data practices can efficiently be taylored in order to transform traditional care to patient-centric care (Chung & Basch, 2015). In this paper we explore the innovation, adoption and use of digital technologies for patient-centredness in the context of chronic care. Rather than focusing on the barrier for adoption (Greenhalgh et al., 2017), we examine how leveraging recombinability of lightweight technology can support patient-centred care, and specifically we formulate the following research question: *how can recombinability support digital innovation for patient-centred care?* By addressing this question, we aim to discuss how the logic of recombination of digital technologies facilitates the conditions for patient-centred care. We understand patient-centred care as being about sharing the management of an illness between patient and healthcare especially for chronic problems. While there are many definitions of patient-centred care, it can be said to be characterised by the following three core aspects: communication with patients, partnerships, and a focus beyond specific conditions, on health promotion and healthy lifestyles (Little et al 2001). A common trait across these aspects is personalization, based on the argument that personalization of care improves the patient experience and increases patient engagement. Thus, patient-centered care aims at providing individualized support that considers patients' personal needs (Davis et al 2005). Accordingly, it is argued that patient-centred care is more than just empathic interviewing of patients, and it entails a re-organising of the healthcare systems to maximise the partnerships of patients and health practitioners (Von Korff et al 2002).

To address our research question, we have conducted a comparative study of two cases of digital innovation in healthcare. In both cases new digital capabilities are introduced to address current challenges in patient-health provider communication and information practices and with the aim to facilitate a patient-centred approach. The first case is set in the context of elderly chronic care in Norway, the second case is in cancer rehabilitation in Sweden. Both cases are about the design, implementation and use of digital solution to increase patient experiences and access to medical care. As discussed in (Grisot and Lindroth, 2020), two different strategies for recombinability are enacted in each case. In this paper, we build on our previous research and develop it further by focusing on how a logic of recombinability supports patient-centredness. With the use of lightweight technologies, chronic care is transitioning from episodic to continuous care. For instance, these technologies enable a continuous data flow between patients and health providers, and lower thresholds for patient-provider interaction. Based on the findings from the cases, we discuss the importance of understanding the characteristics of these novel digital technologies in relation to the flexibility and taylorability required by a patient-centred approach to care. Specifically, we discuss how in order to align the fit between the digital innovation, patients and healthcare collaborative management of an illness, recombinability should be bounded by the concrete needs of the local practice.

The structure of the paper is as follows: we first present the recombination perspective and the core concepts from IS research guiding our study. We then present our research methodology and provide details about the two cases. In working with the case material, we present our findings in section 4, and conclude the analysis section by summarising the key findings from the comparative analysis. Discussion and conclusion follow.

2 Conceptual framework

Digital innovation is about "combining digital technology in new ways or with physical components that enables socio-technical changes and creates new value for adopters" (Osmundsen et al., 2018). Accordingly, in this study we focus on recombinability as a central capability of digital technologies. Recombination is at the core of innovation (Henfridsson et al., 2018). However, it is also a broad term which point to issues of malleability and adaptability of a digital product or a set of products, as well as their flexibility. Recent research has pointed out that not all digital infrastructures enable recombinability (Øvrelid and Kempton, 2019), and that this is particularly difficult to achieve in the public sector (Holgersson et al., 2017) and in healthcare specifically (Bygstad and Hanseth, 2018). Healthcare is characterized by a legacy of heavyweight information technologies and their IT silo problem: "the fact that a large number of poorly integrated legacy systems constitute a barrier to organisational change and innovation" (Bygstad, 2017, p. 3). Differently, lightweight technology allow for a more experimental and agile approach to innovation (Bygstad, 2017).

In management and innovation literature, the recombination perspective is well known and argues that recombination is central in innovation processes. Innovation in this view derives from combining components which were previously unconnected, or by finding new ways of combining already associated elements. Originally, the concept of innovation as recombination is based on the work of Schumpeter (1934) who emphasised that innovation, as a process, is often a matter of reconfiguring what exists. In his work on the evolution of technologies, Arthur also identified the central role of recombination and argues that technology is an assemblage of practices and components where some form a core central assembly, and other have supporting functions (Arthur 2009). In this view, the logic of assembling parts lies in easier way to construct as well as to repair assemblage. Arthur also argues that grouping parts allows for separate improvements in the components of the technology and in simplifying processes of design (Arthur, 2009). Modularity is one architectural principle underlying recombination.

In IS, Henfridsson et al (2018) distinguish between design recombination and use recombination. Design recombination is a firm-centric view on recombination assuming that a firm designs for recombination as it is defined as "the activity of generating a value path by connecting digital resources as a value offer to users" (p.92). Use recombination is about how the design can be recombined at the point of use, which means that recombination is performed in use: "the activity of generating an individual value path by connecting digital resources in use" (p.92).

3 Research methodology

This paper is based on a comparative study of digital innovation in healthcare. The study is designed as two case studies on two novel digital tools used in clinical practice by nurses in the context of chronic care. The studies follow an interpretive approach (Walsham 1995; 2006) and are based on qualitative data. In both cases data were collected over an extended period of time through interviews, ethnographic observations and document analysis (Silverman and Marvasti, 2008; Wolcott 2005). In both cases the digital technologies implemented allows for recombinability and are implemented in the context of patient-centred care. The two cases are similar as they both concern telecare solutions for chronic care: patients are expected to generate data while at home as part of the care service. Nurses in clinical setting make use of the data for clinical decisions. In addition, the digital technology in both cases enables patients to access their patient record which includes graphical visualizations of data over time. However, in the cases the digital tools are used for two different aims. In case 1, the tool supports the generation of data in a continuous way for remote patient monitoring. In case 2, the tool is used by patients for a limited period of time and ahead of specialist visit as well as reaching more patients beyond the clinic. The case settings, context, and data collection methods are described in the following two sections.

3.1 Case 1: digital innovation in elderly care

In Case 1, the research reported is based on a case study on the use of a telecare system and an App for patients affected by cardiac diseases, diabetes and COPD. The study is part of large research project on the testing and adoption of digital technologies for remote care in Norway which started 2016 and is still ongoing. The study considered in this paper started in January 2017 and ended in April 2018. The focus of the study was a pilot for a remote care center in a small municipality south of Oslo, and run by a private company. During this period the center was staffed with four nurses and had ca. 150 patients. Specifically, we were interested in understanding the use of the telecare systems and the devices in addressing the specific needs of the patients.

Data were collected via interviews and observations. A total of 23 interviews and 27 hours of observation were conducted. This paper builds mainly on data from the interviews with the nurses at the remote monitoring center, the management team and the developers. We asked nurses to describe how they instructed patient in using the devices and the app for data reporting, how they made sense of the measurements received in the system, how they wrote messages to patients, how they in general interacted with patients based on the received data. We did not have access to the data in the system, patient records, and we could not interview patients.

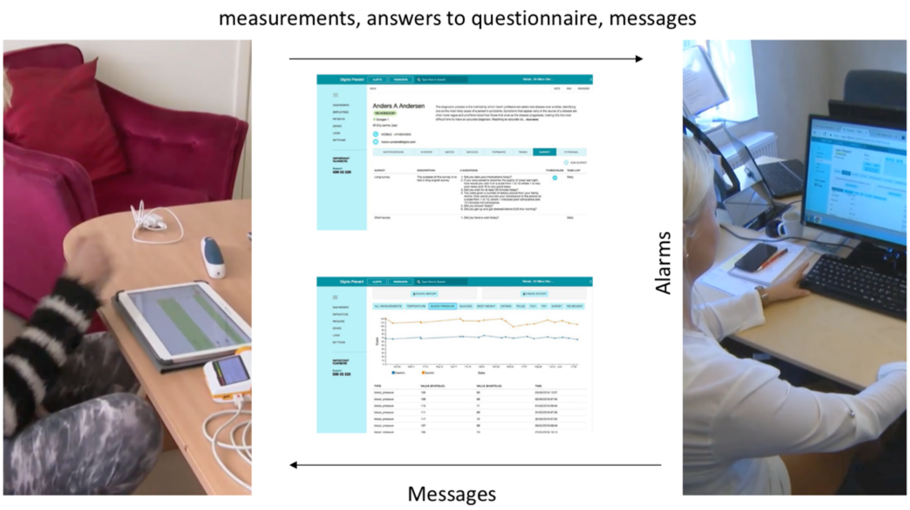

Figure1: the system set up (patient on the left and nurse of the right) with two illustrative screenshots.

Figure 1 illustrates how the telecare system works. In the care center, the nurses receive data in the system (ProAct) which is linked to the patients' App (MyProAct) used by patients on a tablet. ProAct is a telecare system which works as patient record and communication system. It is accessed by the patient via the ProAct app on the tablet, and by the nurses via a web view on their computers. ProAct runs on a secure cloud platform and collects data from measurements taken by patients in their homes with a set of personal digital devices. The devices are connected to the ProAct app installed on the tablet (i.e. iPad given to patients). The patients receive a set of devices according to the data that need to be tracked for their disease and for their health aims. For instance, patient with COPD are equipped with a digital spirometer which measures the volume of air inspired and expired by the lungs (FEV 1 and PEF); a digital pulsometer which measures the pulse (frequency of heart beats per minute) and the oxygen saturation; a digital thermometer which measures body temperature; and a digital scale which measures body weight. The patients are expected to use the devices at home with a frequency agreed with the nurses (e.g. every morning, or at morning and evenings). Every time they take a measurement, the device sends the data to the app and to the system. Data are collected in the patient record and displayed to the nurses in form of alert message. The message is colour coded (green, yellow or red depending on how the new measurement related with the set thresholds for each type of value). In the nurses' view, each record contains a number of tabs showing the patient profile (e.g. personal information, diagnosis, medicines, comments), incoming measurements, graphical visualization of the measurements, personal set up of the devices, messages between nurses and patients, and a personalized questionnaire. Nurses receive an alert also when patients send messages, answers to the structured questionnaires, and also in case they do not take measurements as agreed. When patients are enrolled in the service, they receive a home visit from one of the nurses who deliver the devices and explains how they should be used. Figure 2 below provide an overview of the similarities across the two cases.

3.2 Case 2: digital innovation in cancer rehabilitation

In Case 2, the research reported is based on a study of the design of a digital infrastructure in cancer rehabilitation (see Islind et al., 2019). The site of the study is a clinic specialised in cancer rehabilitation at a major university hospital in Sweden. The clinic receives patients, mostly women, who have been treated for cancer in the lower pelvic area and who suffers from chronic survivorship diseases (consequences of the cancer treat-ment including radiation, chemotherapy and surgery). The focus of the study has been on understanding the design and use of various components in the digital infrastructure to address the specific needs of the patients. The study is based on qualitative data from interviews and non-participants observations of the work practices of the nurses at the clinic, 20 nonparticipant observation days, four semi-structured interviews and seven individual interviews with patients. The aim of fieldwork was to understand the treatment process at the clinic, the different data- collection steps, how nurses set up the treatment plan and when they met the patient and what they talked about. In addition, the main data consist of four parts, (1) interviews with patients who had used the app and the webpage, directly after a video or telephone consultation with a nurse and (2) ten recorded telephone consultations between patient and nurse where data from the app were discussed during the call. (3) App log-data on the number of clicks in the app for each patient, number of seconds to add data to the app. (4) Ten weekly observations of the online community, its progression and the ongoing conversations.

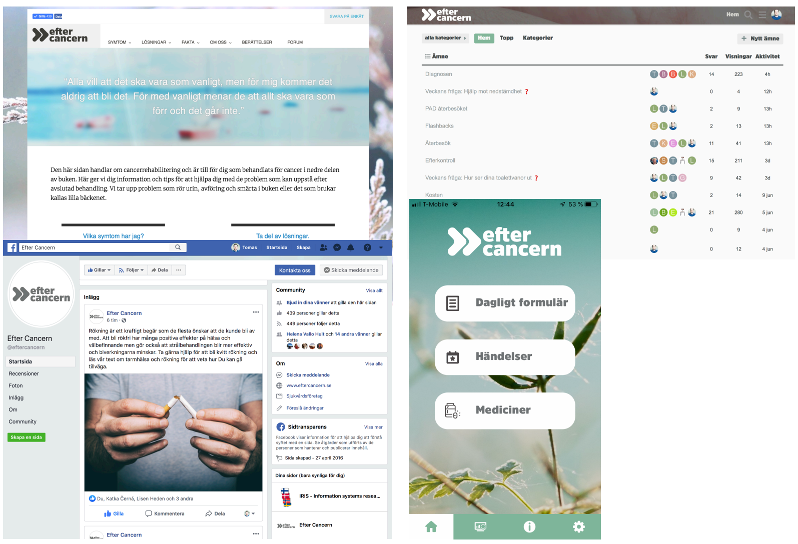

Figure 3: screenshots from the four digital components: webpage (top left), patient forum (top right), facebook page (bottom left), app (bottom right).

The clinic makes use of a digital infrastructure of various digital components: an app for patient-reported data with a web interface for nurses, a secure patient forum, an open webpage, and an Facebook page. The design of the infrastructure responded to the different information and communication needs of the health practitioners at the clinic. First, the clinic needed more accurate data from patients about their everyday experiences of living with their health conditions. Second, the clinic wanted to reach out to a larger population of patients including patients not enrolled at the clinic and living in other areas in Sweden. There are few clinics in Sweden offering specialised services for patient in cancer rehabilitation. Third, the nurses working at the clinic wanted to improve their interaction with the patients. Nurses were concerned about using most of the limited consultation time on asking patients to remember details about their condition. For instance, recollecting how many times they had used the toilet in the past weeks, and consistency and pain related to toilet visits. Additionally, they repeatedly were asked the same questions and basically repeating the same answer (See Lindroth et al., 2018).

As a result, various digital tools were implemented. To decrease the number of questions and to make information available to patients andhealth personnel in other parts of Sweden, the project created a webpage with information about diagnoses, symptoms, problems and advices on how to address them. This was built on the Open Source, WordPress Content Management System (CMS). To reach out to new patients, this webpage was linked to a Facebook page. Facebook was not used for content generation, but only for its capability to spread information to new patients. Nurses and the project's cancer communication expert posted links back to the portal. Between February 2016 and October 2017 this generated 2700 returning visitors out of 9000 total visits. In addition to, and part of the webpage, the project also designed an online peer-support community in the form of a discussion forum where patients within this specific group can support each other, share experiences and tips as well as get response from nurses specialized in oncology. The forum is based on Discourse which is an open source Internet forum management software. At present there are over 100 patients active in the forum. The goal with the forum is to support patient-centeredness and self-care through online peer-support.

The purpose of the app is for patients to report symptoms and events as they are experienced, and not as they are remembered. With the app, patients can report the number of toilet visits, level of pain, and use a standard scale which is a diagnostic medical tool (the Bristol scale) to classify the form of faeces. The patient is expected to use the app and log measurements for two weeks prior to a face-to-face consultation. The information is then accessible to the nurse as they are reported. In this way, nurses no longer have to reconstruct the patient’s experiences and symptoms by asking questions during the consultation, but have direct access to the reported patient data. This reduces the risk of memory bias and the uncertainty surrounding the quality of the data. The app is available in both the App Store and Google Play. The app was designed to enable accurate data reporting. The app supports patient in reporting these details. When the patient takes contact with the care provider, by phone, video consultation or physical meeting, both the nurse and the patient have access to similar visualizations of the same reported data.

	Targeted health condition	Goal	Technology	Data	Communication	Communication content	Temporality	Materiality	Interpretative complexity
Case 1	Hearth failure, diabetes, COPD.	Long term monitoring to avoid exacerbation and support patient to self-manage.	Telecare software, telecare app on tablet with a series of connected digital devices: e.g. thermometer, spirometer.	Data from measures by medical devices. Visualizations of data for both parties. Data from structured questionnaire.	Mainly text messages, occasional phone calls.	Patients' personal experience of the illness and daily concerns. Nurses' feedback and questions for data interpretation and for reflection.	Asynchronous text messages, real time daily measured data, continuous use, daily use (e.g. morning, evening)	Physical medical devices occupying space in patients home. Possible to transport, but not without frictions.	Medium to high complexity of a combination of measurments.
Case 2	Cancer related radiation induced diseases: fecal leakage, loose stools, sexual dysfunction.	Titrate medication and adjust diet, support patient to self-manage.	App on patients' personal mobile phone, web-based interface for nurses. Information portal, online peer-support community.	Data estimated by the patient. Visualizations of data for both parties. Forum posts.	Phone calls, occasional face-to-face visits. Online peer-support	Patients' personal experience of the illness and daily concerns. Questions about the meaning of data to increase mutual understanding.	Synchronous phone every second week or less, and measurements everyday for two weeks. Measuremens takes up to 20 times a day. Weekly forum posts.	Patients own mobile phone. Mostly digital environments. Highly mobile.	Medium to low complexity of data. Medium to low complexity of forum posts.

Figure 3: Similarities and differences across the two cases.

4 Findings

Our findings are focused on how the recombinability of digital technologies was leveraged to support patient-centred care. As mentioned, patient-centredness implies that care moves towards supporting for patient-health providers communication, partnerships, and a focusing beyond specific conditions, on health promotion and healthy lifestyles. In the following subsections, we first identify the different information and communication needs in the two cases, and then we analyse how the three aspects of patient-centredness – supporting communication, partnership, and health promotion - were supported by the logic of recombination.

4.1 The need for recombinability

In the two cases various digital technologies were implemented to facilitate patient-health provider interaction. In both cases the need for recombinability emerged both in design and in use and for the different actors involved in the care process, patients included.

In the first case, the need for recombinability emerged both for patients and for nurses attending to the telecare service. Patients in the pilot were selected according to three main diagnosis (diabetes, COPD and heart failures). For each of these conditions a combination of digital tracking devices was selected. For instance, patient with COPD were given a digital scale to track body weight, a spirometer to track their pulmonary capacity, a digital blood pressure device and a digital thermometer to track body temperature. The devices are selected by the company, certified, tested and connected to the tablet and the system. Thus, the telecare system allows for receiving data from various set of devices. It is possible to add, substitute or dismiss devices.

However, each patient experienced his/her condition in a specific way and the nurses needed a tool which allows them not only to provide patients with the tracking devices they need, but also to combine various functionalities in a personalised way in the telecare system. One example of this is the use of the questionnaire for the patient. The system receives the data from the tracking devices and supports two main modalities for interaction, text messages and questionnaire. The questionnaire is a structured set of questions with answers. Patients are asked to reply to the questions on a daily basis. For instance, a patient with diabetes is usually asked questions about nutrition, type of meals, frequency, quantity etc. The answers offer additional information to the nurses and support their sensemaking practices when interpreting the data from the devices. For instance, if a value show low blood sugar level, the nurse would triangulate this value with details about the meals of the day that the patient has provided. The questionnaire is not given, and nurses can formulate questions in a personalised way for each patient. Also, the type of answer scale can be personalised. Thus, nurses adapt and recombine the functionality of the system to facilitate patients' reporting of data.

In the second case, the need for recombinability emerged from the local practice at the clinic and the information and communication needs of nurses, as well as from the patient everyday situations. These needs are varied and heterogeneous and required a combination of different digital tools. At the clinic, the health professionals voiced a concern for having a more efficient way to deal with the questions posed by patients, often via phone calls. Thus, nurses asked for support that could relieve them from some of the repetitive work and at the same time assist the patient in becoming better at self-care. In addition, they needed better data from patients. During phone calls or face-to-face visits, the patients struggled to remember exact information (e.g. number of toilets visit per day, stool consistency, pain intensity). As patients suffer from serious side effects, they are not always in the status to remember or to report data.

In addition to focusing to the needs of the patients enrolled at the clinic, nurses also felt the need to reach out with their know-how beyond their clinic. This was motivated by several reasons. First, since the clinic is offering a unique service in Swedish healthcare, the clinic received an increasing number of referrals from other parts of Sweden. However, considering its limited resources, they could not attend to all requests. Still, the nurses wanted to make their specialised knowledge available and accessible. In addition, cancer survivor patient may have health issues that makes travelling difficult, thus they recognize that it was critical to create online resources for patients. Second, every week the nurses received phone calls from primary care doctors in other parts of the country who heard about the clinic and need support. These are usually primary care doctors treating patients with radiation induced conditions, and in need of advices for how to treat them. Third, patients themselves also expressed the need to talk to other patients who had similar experiences and conditions. They wished a peer – not only a nurse - to ask questions to, share personal experiences and feel heard.

4.2 Recombinability for patient care

The logic of recombinability was applied differently in the two cases. In case 1 the company has designed a system for telecare which supports different activities. It supports the recording of the data from the patient measuring devices in real time, and it visualize these data for the nurses in different ways. It also supports communication between nurses and patients both structured (via questions and answers) and unstructured via text messages. It supports patients access to their own record via the app on the tablet. The company seeks to offer a tool for patient-nurse collaboration which can be adjusted according to the different needs of patients. Thus, the system support personalization in relation to which data is recorded, how the communication is setup for each patient and how and when the nurse and patient interact. In case 2, the project team has designed four components to meet the needs of both the clinical practice and patients. Different components were combined for their different purpose: to reach out to patients and practitioner in need of specialised information, to enrol patients, to support patients, and to gather quality data. The components in the infrastructure are loosely coupled. For instance, the Facebook page and the webpage are regularly updated in a coordinated way. For each new update in the text of the webpage, a new post is posted in FB with a link to direct users to the webpage.

In case 1, recombinability was used to address mainly issues of personalization. Thus, shifting care towards patient-centredness in this case was an effort towards addressing the specific needs of patients. About *supporting communication*, the system supports a very tailorable way for patient-nurse communication. Nurses and patients write text messages in free text, which can be modified and adapted. For instance, nurses know which patients can read long messages, and which one would prefer to have short and concise messages. About *partnership*, the data show that the use of the personal devices for taking measurements in combination with the messages and the questions/answers allows for a continuous interaction between nurses and patients. Differently from episodic care, where nurses and patients meet e.g. once per week or per month, the system allows for a continuous flow of information in both directions as an ongoing dialogue or conversation between nurses and patients. About, *health promotion*, the data show how the possibility to closely monitor patient and to tailor the measurements to their needs, shifts the care practice from reactive to proactive. This means that nurses engage patients in prevention practices.

In case 2, recombinability was used to address mainly issues of dissemination, education and efficiency. Thus, shifting care towards patient centerdness in this case was an effort to scale the services of the clinic and reach out to new patients, support health professionals, improve the work of the nurses and their communication with patients. About *supporting communication*, the infrastructure supports various modalities of communication and to various target groups, not only patients. The combination of the various digital resources allows for improved communication in relation to patients' data reporting practices, dissemination of specialised information, and reaching out to new patients in need. About *partnership*, the data show that the use of various digital resources allows for creating new partnership (e.g. enrolling more patients) but also improving the quality of the current data practices. Patient data are reported 'closer' to the patient experience, and the conversation between nurses and patients (at the core of their partnership relation) shift focus from striving to remember facts, to discussing what the reported data actually indicate and how care can be improved (e.g. by changing medication). About, *health promotion*, the data show how the possibility to publish relevant information easily, let more patient know about the clinic, and engage with primary doctors' education in cancer rehabilitation support promotion practices. The combination of a Facebook page, the Wordpress site and the Discourse forum made it possible to reach out to patients, but also to allow patients to explore and interact around information on their disease based on their own premises when they need it, not when the nurses think it is time to inform them.

5 Discussion

This study seeks to examine how recombinability plays out in relation to a shift towards patient-centred care. For this purpose, we have conducted a comparative analysis of two empirical cases of digital innovation where lightweight technologies were implemented to redesign chronic care delivery. The two cases follow two different strategies for recombination (Grisot et al. 2019). In the first case, innovation revolves around a core system which can be tailored at different levels according to the patient's needs. In the second case innovation comes from the combination of different digital resources to address the various needs of the patients and of the clinic. These novel forms of care aim to transform the way health providers and patient interact towards a care model that is patient-centric. Thus, they are both bounded by the local practice.

Our research was guided by the following research question: how can recombinability support digital innovation for patient-centred care? Based on the findings from the comparative case analysis we identify two core ways in which the logic of recombination of digital technologies has supported a shift towards patient-centred care in the two cases. First, both cases take as a point of departure the existing information and communication needs of the patients, or the clinic. Thus, the introduction of lightweight digital technologies is driven by *concrete needs* and thus, making it possible to align the features of the technology with the situated needs from the *local practice*. Second, as patients' needs *evolve and change in time*, the digital tools implemented needed to be flexible and adaptable. As chronic care follows patients for a lifetime, the technology must be able to adapt along with the patient, while maintaining an easy to use and engaging interface. In addition, also the need of the clinic change over time, for instance by wanting to address and support a large patient population. The digital tools selected also supported scalability. Thus, in the two cases the logic of recombinability has proven critical in order to address the heterogeneity and variety of actual needs, and the prospect that these needs would change over time.

Different from the cases usually discussed in digital innovation literature (e.g. cloud services, home entertainment, digital maps), in the healthcare context innovation processes face a complex installed base of existing structures, practices, regulations as well as legacy systems (Aanestad et al 2018). The possibilities for supporting recombination are limited. However, we show how the use of lightweight technologies brings about new recombination logics. Leveraging recombinability requires specific competences and skills, and processes, and it is not simply a matter of ‘plug’n’play’ or combine a given set of digital resources. Our findings show that significant adaptation is needed, and that the logic of recombinability plays out differently according to specific local needs. For instance in case 2, a set of standard digital resources were adapted and combined to address the specific needs of the clinic: a webpage for information divulgation, Facebook page for reaching out to, attracting and enrolling users, app for capturing patient generated data and for data visualization and an online community for facilitating peer support. These software and platforms combine Social Network Systems and open sources software loosely knit together by the local practice at the clinic. Differently, in case 1, different standard medical devices were combined to monitor medical parameters for a patient particular combination of diseases. Thus, standard components were recombined and then tailored to the needs of each particular patient as well as the care practice. We propose to use the term ‘bounded recombinability’ to indicate a recombinability that is tailored to both personalized care for the patient and the local care practice. In our cases, recombinability is bounded by the limited set of components tailored to the specific and concrete needs of the local practice. This limits the number of tools and interfaces both nurses and patients have to learn to use. As a result, for each new recombination the actors involved in the care practice do not need to re-learn a set of completely new tools. Bounded recombinability is thus a logic that is sandboxed to maximize the value of digital innovation for a local practice. This is in line with the argument made by Arthur (2009) who recognize the central role of recombination and argues that technology is an assemblage of both the local practice and a variety of digital components (Arthur 2009).

6 Conclusion

This study deals with the challenge of enabling digital innovation in healthcare. The literature has pointed out to several aspects of this challenge, from dealing with the existing legacy systems, regulations, structures, routines (Aanestad et al 2017), to more architectural challenges related to the existing silo logic which hinders information flows within health organizations and across the sector (Bygstad, 2017; Bygstad and Hanseth, 2018; Rodon and Chekanov, 2014). In our study we have examined two cases of digital innovation based on lightweight digital technologies. The two cases show that recombinability is crucial and could support different aspects in the shift towards patient-centered care.

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