Technological Forecasting & Social Change 146 (2019) 352–365

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

The change of pediatric surgery practice due to the emergence of connected health technologies

Riikka Niemelä[f], Minna Pikkarainen[a,b,c,*], Mari Ervasti[b], Jarmo Reponen[a,d,e]

[a] Research Unit of Medical Imaging, Physics and Technology, University of Oulu, POB 5000, FI-90014 Oulu, Finland
[b] VTT Technical Research Centre of Finland Ltd, Kaitoväylä 1, POB 1100, FI-90571 Oulu, Finland
[c] Oulu Business School, Martti Ahtisaari Institute, Pentti Kaiteran Katu, POB 8000, FI-90014, University of Oulu, Finland
[d] FinnTelemedicum, Research Unit of Medical Imaging, Physics and Technology, Faculty of Medicine, University of Oulu, Finland
[e] Medical Research Center Oulu, Oulu University Hospital and University of Oulu, University of Oulu, Oulu, Finland
[f] Topcon Healthcare Solutions EMEA Oy, Otakaari 5A, Espoo, Finland

ARTICLE INFO

Keywords:
Pediatric surgery practice
Digital transformation
Connected health technologies
Social practice theory
Future hospitals

ABSTRACT

Purpose: Disruptive connected health technologies, or digitalization, are suggested to tackle the healthcare challenges and transform traditional care models. In Finland, the transformation is manifested by the development of various digital hospitals and citizen-centric care models that foster self-care by utilizing connected health technologies. In this paper we introduce qualitative research that uses social practice theory in order to understand how connected health technologies shape a pediatric day surgery practice in future digital hospitals. Major improvement needs were identified to center on *discursive* actions (i.e., communication that occurs between health professionals and patients), since hospital IT systems, data exchange, and internal and external communication were found to not support pediatric surgery *practice* as expected. To improve the current situation, we found out that there is a need to change the patient role to be more active, creating data that health professionals could use through their own patient record systems. Connected health solutions allow this type of interaction between things (i.e., communication through mobile apps, medical devices, etc.) and agents (i.e., health professionals). There is an urgent need to improve communication channels such as Chat, WhatsApp, and mobile applications that gather all necessary information and instructions from patients before and after the surgery. However, these solutions cannot be co-created separately from the clinical decision systems that allow discursive actions among healthcare professionals. These solutions, e.g. mobile applications designed to support patients going through the surgery practice, will also significantly impact and change pediatric surgery practice at hospitals.

1. Introduction

Healthcare is facing new challenges worldwide due to public health expenditure, ageing populations, increasing chronic illnesses and workforce deficiencies (Suzman and Beard, 2011). The paternalistic and episodic nature of healthcare, where the patient has been a passive recipient of "one size fits all" care, is no longer sustainable (Atanasova et al., 2016; Barello et al., 2012; Coulter and Jenkinson, 2005; Himidan and Kim, 2015; Trappenburg et al., 2013). Digitalized healthcare solutions are assumed to tackle these challenges and enable the much needed transformation of health and social care models.

Connected health means connecting technologies, data integration and sharing with patients, their care givers, and medical experts in a way that the integrated technologies can support faster and more efficient decision-making related to patient health and wellbeing (Down et al., 2018). *Connected health solutions* promote self-care and preventive personalized healthcare providing wider accessibility to services (Kharrazi et al., 2012; Liu et al., 2016; Yoo et al., 2016; Caulfield and Donnelly, 2013; Kvedar et al., 2014; Kreps and Neuhauser, 2010; Schneider, 2001; Barr et al., 2012; Iglehart, 2014). The conceptual model of connected health places a particular focus on connecting patients and health professionals via electronic services and data connected via the Internet-of-Things (IoT) (Yin et al., 2016). In the area of connected health, faster and more efficient decision-making can be supported by *user interface technologies* such as virtual reality, virtual health stations, *communication technologies* (such as virtual doctors),

* Corresponding author at: Oulu Business School, Martti Ahtisaari Institute, Pentti Kaiteran Katu, POB 8000, FI-90014, University of Oulu, Finland.
E-mail addresses: niemelri@gmail.com (R. Niemelä), minna.pikkarainen@oulu.fi (M. Pikkarainen), mari.ervasti@vtt.fi (M. Ervasti), jarmo.reponen@oulu.fi (J. Reponen).

https://doi.org/10.1016/j.techfore.2019.06.001
Received 21 June 2018; Received in revised form 23 April 2019; Accepted 2 June 2019
Available online 26 June 2019
0040-1625/

mobile health applications, and *artificial intelligence* (see e.g., Kreps and Neuhauser, 2010; Kvedar et al., 2014; Iglehart, 2014; Dias et al., 2017; Chiang et al., 2017; Barr et al., 2012;). The application possibilities of connected health are limitless when wireless communication, sensors, intelligent data analytics, and infrastructure are combined.

Co-creation is a term that has been widely used by academics and practitioners. It has been widely used to investigate customer relationships, stakeholder interactions, consumer centrism, co-design, self-service, co-production, relationship marketing, and experiential marketing (Kumar & Snooks, 2011). The need for rapid technology co-creation has also led to the emergence of a new concept, the *digital hospital*, in which everyday operations and record-keeping are carried out and maintained almost exclusively with various advanced technologies (Weiss, 2002). The idea is to deal with billions of connected "things", such as people, sensors, and medical devices (Trappenburg et al., 2013; Kharrazi et al., 2012; Liu et al., 2016; Schneider, 2001). All critical medical devices, intelligent information systems, and digital communication tools are fully integrated to improve staff productivity, hospital operations, patient safety, and the overall patient experience (Ervasti et al., 2016).

We have used the case study method, in which pediatric surgeons were interviewed in two hospitals that are under transformational change and experiencing a window of opportunity to become future digital hospitals by 2030. Renewal of the University Hospital started with the children's and women's hospital, whereby the provision of pediatric acute and day surgeries will be increased in the future. For future pediatric surgery processes, the aim is to create new process models utilizing advanced technologies and information systems in order to provide and secure the best patient care (Northern Ostrobothnia Healthcare District, 2016). The second studied Central Hospital will be entirely rebuilt to become a future intelligent hospital by 2020. The intelligent hospital means a new hospital building utilizing advanced connected health solutions in a hospital environment. The new hospital building is designed according to modern key principles of operation to support modernizing organizational and operational models. This is done by applying the newest connected health solutions. Understanding the available connected health solutions and how they can change future practices is an important step towards future digital hospitals. Moreover, by increasing the understanding of the future possibilities of connected health, we take a major step towards more efficient, patient-centric healthcare based on digital hospitals co-creating the newest connected health solutions.

The disruptiveness and advantages of connected health solutions are only rarely being felt in the field of surgical practices and instruments. Traditional surgical tools are becoming intelligent due to connectivity based on sensory data, processing, and analysis, which enable and enhance a surgeon's capacity and capability, hence transforming the traditional role and identity of a surgeon (Himidan and Kim, 2015). Thus, there are some studies that raise relevant questions regarding the real challenges in deploying new disruptive technologies and the resulting organizational and societal changes, especially in healthcare organizations and surgical practices (Christensen, 2013; Geiger and Hirschl, 2015; Kabra et al., 2017; Martikainen et al., 2014; Shin, 2014; Thakur et al., 2012). From a practical perspective, the deployment of the technologies in surgery creates many ethical challenges: safety of the technology, timing and deployment process of a new technology, informing the surgery patients before undergoing a new technology, evaluation of the outcomes, and responsibilities of individual patients (Geiger and Hirschl, 2015). From an organizational perspective, deployment of novel technologies in hospital practices seems to be especially difficult due to high bureaucracy (Llunch, 2016) and complex information and communications technology (ICT) (Vest, 2010). Also, human factors and societal and governmental issues will remain continuing barriers in adopting innovations and new technologies (Casselman et al., 2017; Chang et al., 2015; Martikainen et al., 2014; Thimbleby, 2013; Viitanen et al., 2011).

To understand the various technological, organizational, and medical aspects affecting the co-creation of connected health solutions in pediatric surgery practice, we apply the *theory of social practice* in this paper as the theoretical framework. *Social practice theory* is often utilized in diverse fields (including healthcare, organizational, and science studies) as an alternative to other social and cultural theories (Reckwitz, 2002). There have been several studies recently using social practice theory in change (see e.g. Shove and Walker, 2014) or in healthcare, such as in healthcare and daily practice (Maller, 2015), and public healthcare (Blue et al., 2016; Meier et al., 2017). Although researchers have already made some progress in using social theory in health research, theories of social practice have much to contribute to current understanding, particularly in the area of public health research (Maller, 2015). Although the social practice theory clearly helps to understand everyday practices with a view to intervention (Meier et al., 2017), there is not yet research that would use a social practice theory lens to understand the change that is happening in pediatric day surgery practice due to the co-creation of connected health solutions. Through a theoretical framework of *social practice theory*, we aim to identify the situation of surgery practice affecting the involved specialists, nurses, and patients from the two case study hospitals, which are in the middle of the renewal and digital transformation. The theory of social practice will help us to structure the qualitative study in this particular context as we map the social practice elements into the changing practice of pediatric day surgeries.

Our motivation for this case study is to answer the key research question: How is the co-creation of connected health technologies changing pediatric day surgery practice in the digital hospital context? Therefore, we approach the question by organizing the paper as following. In Section 2, we first aim to understand the key elements of social practice theory in the context of pediatric day surgery. In addition, to understand the possible driving factors behind transformational change in pediatric surgery practice in Finland. In Section 3, we present our case study and our qualitative research methods. In Section 4, we focus on analyzing the potential of connected health technologies in pediatric day surgery practice. In Section 5, we discuss our main findings. And in Section 6, we conclude our research.

2. Theoretical background for social practice theory in the connected health context

2.1. Social practice theory

The theory of social practice is applied in order to provide clarity to complex process-centric processes and digital transformations in hospitals. According to Bourdieu's (1990) logic, *practice* can be defined as a recognizable entity made by routinized actions or the reproduction of a habit (Bourdieu, 1990; Reckwitz, 2002; Smith-Strøm et al., 2016). For example, in playing football, the habit of kicking the ball is actively reproduced, but the recognizable entity comprises requisite elements that often include objects necessary to carry them out, e.g., the football. In addition, rules according to which the players act, the football field, and an audience (either physically present or following via TV or radio), are an integral part of the practice in terms of why and how the habit is reproduced (Reckwitz, 2002; Smith-Strøm et al., 2016). Reckwitz (2002) defines the key elements in social practice theory as 1) body, 2) mind, 3) agent, 4) knowledge, 5) things, 6) discourse, and 7) process.

Body is considered as a carrier of social practices, i.e., routinized bodily actions and interconnected complex behavioral movements. This includes human bodily performances such as writing, handling objects, talking, and reading. *Mind* is necessary in terms of understanding the world, desiring something, and knowing how to do something. *The agent* is the body/mind who carries out the practice and stands at the center of actions (Reckwitz, 2002).

The *agent* can be considered as self-interested *homo economicus*,

where the social world is populated with independent individuals who determine their own actions, or as the norm-following and role-playing *homo sociologus*, who sees the world as a system with expectations and rules, to which the agent has to conform (Reckwitz, 2002).

Specific social practices need specific forms of *knowledge*, which is essentially the way of understanding the world including objects, humans and oneself. It is highly culturally and historically specific and is therefore considered a form of collective and shared understanding (Reckwitz, 2002).

In order to carry out a practice, we commonly need *things*, or objects, to conduct a practice in a certain way. *Things* are indispensable resources and are necessary in many practices, such as the football in the practice of playing football. Social practices commonly consist of routinized relations between several *agents* and *things* (Reckwitz, 2002).

Discursive practices embrace forms in which the world is constructed around sign systems and language. In discursive practices, the agents accredit certain meanings to certain objects, which become "signs" to understand the difference of other objects in order to do something (Reckwitz, 2002).

Social structure consists of the routinization of *structure*, or *processes*: routines of moving the body, of understanding, and of using things that are interconnected in a practice. Similarly, institutionalized complexes are structured around routines of social practices. Routines imply repetition and temporality of a structure that occur in a time sequence. Processes are instead considered as an infinite actualization and application of the structure in action. Therefore, routines or structures are broken and shifted on an everyday basis and as crises in routines. This is due to the constellation of interpretative interdeterminacy and insufficient knowledge with which the agent can conduct a practice that is confronting a situation (Reckwitz, 2002).

2.2. Social practice theory elements in the pediatric surgery case

In this section, we map the social practice theory elements onto the *practice of pediatric day surgery*. The key elements discussed in detail in this article are *process*, *agent(s)*, *discursive*, and *things*.

1. *Process* (*incl. structure*): Typically, the pediatric surgery *process* (detailed in Section 3.1. Case-context) is at the center of the practice, i.e., the patient goes through a process-centric care model. According to practice theory, this fixed process has a certain flexible *structure*, that is, pre-, intra-, and post-operational phases, in addition to self-care. The pediatrics day surgery process typically includes multiple sub-processes as medical examinations and involves various health professionals.
2. *Agent* (*incl. body*, *mind and knowledge*): Health professional *agents*, who are interconnected with each other via many specialized hospital processes, are at the center of action. The health professional *agent* is considered as a norm-following and role-playing homo sociologus whose actions are based on specific professional *knowledge*, who follows specific policies and guidelines relative to his/her authority in the hospital hierarchy, and who uses his/her *mind* and *body* to perform the routinized actions in patient care.
3. *Things*: All medical devices, equipment, and connected health solutions that are necessary resources to carry out the practice of pediatric surgery. Based on the traditional conception of patient as object and passive recipient of care, patients are considered *things*. *Things* are not restricted to but can also include communicative features such as those associated with connected health solutions and patients. Therefore, the conceptual interface of *things* and *discursive* needs to be clarified. The difference is mHealth as *things* refers to a mobile device, whereas *discursive* action refers to communication through a mobile device for health management purposes.
4. *Discursive*: *Discursive actions* refer to all communication that occurs between health professionals and patients, internally and externally in an organization. It may be traditional communication or communication via systems, i.e., data exchange, ICTs, and health information systems in a hospital. *Internal discursive* action represents communication between health professionals, which is most often performed via information technology (IT) systems and other electronic interfaces in which the information can be coded into specific signs. The *external discursive* refers to communication external to the healthcare organization, that is, between patient and health professionals and is often performed traditionally via telephone, briefs, and face-to-face consultations. Communication through the integrated information systems acts as a promising internal and external communication channel in patient care (Martikainen et al., 2012; Martikainen et al., 2014; Mobasheri et al., 2015; Viitanen et al., 2011; Weinstein et al., 2014).

2.3. Towards understanding the transformational change in pediatric surgery practice

Smith-Strøm et al. (2016) stated that products alone are not valuable unless they have value within a *practice*. For example, lack of communication, lack of information transparency, and lack of interoperability and human-centric design of Information System (IS) in health organizations and among *agents* are commonly argued in various scientific studies (Martikainen et al., 2012; Martikainen et al., 2014; Llunch, 2016; Rossi Mori et al., 2016; Niès and Pelayo, 2010; Rigby et al., 2013; Al-Jabri and Roztocki, 2015). As a solution for this needs-based observation of a potential *internal driving factor*, it is suggested that the most fluent communication and medical record-keeping can be achieved with end-user designed integrated systems. Enabling access to patient-measured data via HIS is suggested to facilitate the professionals' daily tasks and promote self-management and quality of patient care (Martikainen et al., 2012; Martikainen et al., 2014; Lluch, 2011; Rossi Mori et al., 2016; Niès and Pelayo, 2010; Rigby et al., 2013; Al-Jabri and Roztocki, 2015; Vianna and Barbosa, 2017). Especially mobile health (mHealth) applications appear to be driving the transformation, providing more efficient clinical outcomes and enhanced health status (Bodenheimer et al., 2002; Dias et al., 2017; Robinson et al., 2008; Wanderley et al., 2018). Among others, Yoo et al. (2016) argued for citizen-centric mHealth applications to promote self-management of diseases. Similarly, Vianna and Barbosa (2017) stated that gamification improves self-treatment of mental illnesses and patient engagement.

We approach an understanding of transformational change in pediatric surgery practice, where patients and health professionals will work in partnership and promote self-care via an ever-expanding spectrum of connected health technologies (Barr et al., 2012; Mobasheri et al., 2015; IEEE computer society, 2013). To successfully implement a transformational change, it is all about implementing a functional ecosystem around the *practice* instead of individual innovations, technologies, and process solutions (Smith-Strøm et al., 2016). Similarly, Woo and Skarsgard (2015) suggested that a needs-based quality improvement in the pediatric surgery process will be enhanced by a combination of device innovation, revolutionized health connectivity, process improvement, and standardization in addition to greater awareness of quality and value metrics. For this to happen, co-creation with *agents* and service providers is necessary (Frow et al., 2016). Also Christensen (2013) describes how the adoption of innovations and disruptive technologies fails in markets without the support of industrial stakeholders.

3. Materials and methods

3.1. The case context

The national reform has initiated future hospital programs in the majority of Finnish healthcare organizations, such as the Future Hospital -program of the University Hospital, the first hospital part of our case study context. The program includes new buildings,

technologies, IT systems, clinical processes, and new citizen-centric services. The renewal will be implemented gradually, starting with the new children's and women's hospital. The transformational change process will require engagement and the close collaboration of service providers, researchers, and health professionals, among others. However, there is a wide variety of opinions, objectives, and knowledge of the actual situation among different stakeholders. Furthermore, another hospital, namely Central Hospital, complements the case study context through its ongoing future hospital project, the goal of which is to construct a completely new Central Hospital in order to improve the efficiency of healthcare, to change healthcare processes and logistics, and to integrate primary and specialized health care services.

The case study was implemented as part of an 18-month research project funded by Tekes (Finnish Funding Agency for Technology and Innovation). The project aimed to bring the stakeholders together by creating a service co-creation platform for the University Hospital's innovation and development facilities. The objective of the co-creation platform was to help startup companies and small and medium size enterprises build future hospital services together with doctors, nurses, patients, and large industries, thereby facilitating the adoption of new innovations in hospitals. Due to the acuteness of the children's and women's new hospital, pediatric surgery practice was selected as a relevant pilot case for the research project.

Pediatric surgery patients include children under 18 years old who require surgical treatment with anesthesia and therefore operated on in secondary healthcare. Pediatric surgeries are accessible only via a referral letter from primary healthcare, which is accepted by the pediatric surgeon. Day surgery can last from 10 min to 10 h, depending on the nature and complexity of the surgery. The most common day surgery operations are hernia, mole removal, fractures, and other orthopedic and vascular surgeries. Most of the surgeries at the University Hospital are pre-scheduled day surgeries, of which 40% are acute emergency operations. The provision of pre-scheduled day surgeries is increasing. The pediatric surgery department carries out more complex heavy surgeries, which are excluded from the study.

3.2. Data collection methods

Data collection was carried out with a focus on involving three end-user groups (health professionals, child patients' parents, and the healthcare industry) in the surgery case study. Research permissions were approved before initiating the actual co-creation activities. The research plan and other documents were evaluated by the Ethics Committee of the Hospital District, who declared that a statement by the ethical committee was not needed (the case study being a healthcare development project, not medical research). Furthermore, a decision from the Human Research Ethics Committee declared that an ethics statement was not necessary, based on the aim of the project. In addition, specific informed-research-consent forms were prepared for the involvement of end-user groups in the co-creation activities. The data collection methods and the number of stakeholders for each method are listed in Appendix 2.

The main empirical research data were based on the interviews. Workshops and online discussions that were organized to the participants in the different events, were considered complementary methods that would support the empirical research. The aim of the interviews, workshops, and online discussions was to understand current issues in pediatric surgery practice from various points of views and how connected health solutions could be utilized in pediatric surgery practice. The interview preparation was done together with one leading medical doctor at the hospital, who briefly told about the core steps and units that a patient has to go through while undergoing pediatric surgery at the studied hospital. After identifying the core process, we discussed with the leading medical doctor and leading nurse of each hospital unit (i.e. intensive care, hospital ward, pediatric surgery unit) with the purpose of finding knowledgeable persons at different levels in the organizational and professional hierarchy who had firsthand information and experience in the different aspects of pediatric surgery.

3.2.1. Interviews with pediatric surgery professionals

In total, seven individual face-to-face, semi-structured interviews were conducted during April–May 2016. Interviews were conducted in Finnish, and the duration of each interview was around 60–90 min. Five pediatric surgeons (chief of the department, three specialists, and a specializing surgeon) were individually interviewed at the University Hospital. Two interviews were conducted at the Central Hospital, where an anesthesiologist and anesthesia nurse (responsible for the hospital's ICT development) were present in the first interview. The second interview at the Central Hospital was conducted with a medical doctor responsible for surgical practice development. Preliminary knowledge of the surgery processes gained in workshops with nurses was utilized in constructing a semi-structured interview template for the pediatrics specialists (presented in Appendix 1). The interview template was structured in six sections, with some variation in the formulation of the questions based on the interviewee's position, duties and interests. The purpose of the interviews was to gain a description of challenges and the corresponding connected health technology solutions that could be consistently mapped along the pediatric surgery practice. The interview structure was kept flexible and variable to some extent, enabling the interviewee's position, duties, and interests to lead the conversation.

3.2.2. Workshops with pediatric nurses

Three workshops, lasting from 2 to 3 h each, were organized with pediatric surgery nurses during February–May 2016 at the facilities of the University Hospital. The workshops were held as group interviews that were based on a structured pediatric surgery care journey (pre-, intra-, and post-surgery and home-care phases). The first two workshops focused on the day surgery process, including nurses with years of experience in the inpatient ward at the pediatric surgery department of the University Hospital. The aim of the workshops was to understand the roles and tasks of the relevant health professionals, who are involved in which phases throughout the surgery process, what their needs are, how they communicate with each other and the patient, and what happens in each phase of the surgery process both at the hospital and at home. The third workshop focused on more complex pediatric surgeries, which require longer hospitalization and involve a wider group of professionals from different hospital departments. The objective was to interview four nurses from the inpatient ward, anesthesia, the intensive care unit in order to understand the overall performance of the pediatric surgery department.

Data collection activities performed during workshops resulted in a set of transcribed observations, workshop discussion recordings, and notes based on a common understanding of the needs and technological solutions for nurses. Data collection for each workshop involving the nurses was performed by three to four researchers, of which two researchers also participated in the data analysis. The information gained from all workshops was utilized to construct a semi-structured interview template for the pediatric surgeons to analyze the perspectives and motivations among nurses, surgeons, and patients.

3.2.3. Online discussions and workshop with patients' parents

Parents of surgery patients were recruited to a closed online discussion group. In the group, six parents actively participated in discussions and shared their first-hand stories of the pediatric surgery experience. One workshop was held with six parents who either had a child who had gone through the surgery journey or was currently undergoing hospital care. The parents' perspectives, needs, and innovation ideas related to the child's surgery care journey—from home to surgery and back to home—were clarified in these activities. This led to an understanding of the problems and opportunities encountered throughout the patient journey. Data about parents' interests and motivation factors related to participation and engagement in the user

community of the co-creation platform were also collected. In the parent workshop, the data collection was performed by four researchers, who each participated in the data analysis.

3.3. Data analysis

The information collected from the interviews, workshops and online discussions were archived according to the following. The pediatric surgeon interviews, which were originally recorded in MP3 (audio) format, were all transcribed. The nurse and parent workshops were recorded in MP3 (audio) format and written notes were taken during the workshop sessions. In addition, ideas from the workshop discussions were systematically recorded on sticky notes and mapped to the surgery process flowchart by both the researchers and the end users (involved nurses and child patients' parents). The sticky notes were later transcribed. The parent stories shared in the online discussion group were analyzed and utilized to complete and specify the workshop and interview results.

At first, the results were systematically analyzed according to the process structure (pre-, intra-, post-surgery, and home-care) since it was the most logical approach to understand the practice. Current actions, development needs, ideas, technologies and solutions from all three end-user perspectives were first collected by systematically going through the transcripts phase by phase. Similar ideas and topics were then identified in each process phase, and it was found that some results appeared to affect the whole surgery process, whereas some ideas were case- and user-specific. The findings appeared to be highly detailed and loose from a process context. Some solutions appeared to be beneficial only for one individual phase or task. For instance, some solutions were beneficial only if used throughout the process or across hospital interfaces. Therefore, a process-centric approach did not seem to be ideal for data analysis and for clearly presenting the results. Independent of the process, we identified four key categories among all the end-users, which we found to be aligned with the key elements of social practice theory. Therefore, we mapped and analyzed our results, as presented in Appendix 3. Data collection was coded in terms of each practice theory category. In total, of the 398 codings found from the data, 58 were related to things, 153 were related to discursive, and 94 were related to the process (Appendix 3).

4. Results

In the following sections, qualitative research data are mapped according to the theoretical framework of social practice theory in terms of the four selected key elements within the practice of pediatric day surgery. Each element is examined in-depth, both from the point of view of the current and future state of the given practice theory element in order to understand the transformational change.

4.1. Transformation of agents

Agents in pediatric day surgery practice are considered as active carriers of the practice, including pediatric surgeons, anesthesiologists and nurses among others. In the current care model, professionals are the end-users who have the final decision-making power in terms of adopting new innovations. According to professionals' knowledge and hierarchical role, different needs and attitudes towards new connected health solutions were identified. For example, ward nurses manage pre- and post-surgery arrangements, including preparation of patients and informing, collecting, and delivering huge amounts of patient data. It was estimated that nurses and surgeons use approximately 30% of their face-to-face time with the patient for the use of information systems.

Therefore, nurses' improvement needs were addressed mostly in the patient, or customer, interface as well as in internal communication and information management.

Most of the nurses showed a positive attitude towards co-creation of mHealth and connected health solutions, since intelligent data acquisition and IT systems between patient and hospital would automate and facilitate many excess tasks in documentation and patient data management and preparation. With the time saved, more focus and effort could be used to encounter patients, which will remain as the most important task of nurses, especially with child patients and their families. It was, however, important for nurses that the data could be shown in a simple way and only through one patient record system.

Among the surgeons, different attitudes and ideas on how to co-create future connected health solutions during the pediatric surgery practice were identified, depending on their personal interests and field of specialization. In addition to operating surgeries, the daily tasks of surgeon include accepting referrals, responding to electronic consultation requests, and consulting and collaborating with other professionals and stakeholders in primary and secondary healthcare. Some surgeons were working on their specialization and a few participated in R&D&I projects. The interviewees favored hands-on work and basic face-to-face communication due to children being the patient group. Yet interviewees thought that future technologies, especially connected health solutions, would change surgeons' roles. New doctor graduates and younger generations in general were considered as being more technophilic than their older colleagues. Hence, younger generations could be more positive in adopting innovative solutions in their everyday work.

Commonly, both the surgeons and nurses hoped they could focus more on the patient in the future. Instead of time-consuming and redundant double data logging, many current functions with IT systems and patient data collection could and should be automated, saving valuable time for actual clinical work. It was suggested that with connected health solutions, a multidisciplinary team of health professionals could have a video consultation with patients in under-served rural areas, if not in urban cities as well. Hence, the main change for professional agents was the idea of “virtual doctors”, who could remotely consult with the patients via a “virtual health station”. Consulting “virtual doctors” would involve performing necessary medical examinations with the assistance of an educated medical nurse. Communication technologies could be used to deliver medical examination data from the health station directly to the virtual doctors.

Family-centric solutions are seen to bring a change to the *agent* perspective. Our major finding is that families would become more active in the process through citizen-centric connected health solutions. As a result of utilizing connected health solutions, parents as passive *things* are transformed into active *agents*. Co-created connected health solutions that drive this change are mainly related to the quantification of one's health status in the pre-surgical phases. Quantification and tracking of health status were seen as giving more responsibility to the patient also in post-surgical phases and especially in self-care. Therefore, patients would be more engaged in the process, becoming interactive partners in healthcare, from home to hospital and back to home, and thus providing typically missing anesthesia data, informing the care team about situations affecting the surgery (e.g., flu), informing the care team about the child's progress in the post-operational phase, and discussing remotely with medical professionals (e.g., if suspecting a wound infection).

4.2. Transformation of things

As stated previously, patients are currently considered as “*things*” due to their passive nature in the present process-centric care model. Parents reported feeling insecure, as they were only “*things meandering through an unknown process*”. This statement was supported at the workshop: “*Sometimes the parents and children have been found at the wrong place of the same hospital, which has caused a chaotic situation when all the surgeries have to be rescheduled*” (pediatric surgery nurse, University Hospital). Parents of children in pediatric surgery were critical that “*sometimes the time that we waited at the hospital before surgery*

was really long. In these situations, information about the waiting time and brief information about what is happening next would have been useful."

"The problem is that we can change the surgery time of the first patient, but not the second because the timing of the second operation is dependent on the time of the first operation" (pediatric surgeon, University Hospital). "Sometimes there can be difficulties with anesthesia, for instance, or there is a complication in the operation, and the surgery can take much more time than planned" (pediatric surgeon, University Hospital). To solve the dilemma, family-centric things, i.e. connected health solutions, were seen as bringing more transparency to the patient's process where the next actions, contacts, and meetings would be centrally visible. Moreover, new family-centric things should be developed and provided to engage patients in the process, hence supporting self-care and promoting the transformation of passive patients as things into new active agents. For example, self-monitoring devices operating via an IoT platform, i.e. patients' health information systems, could help in decision-making and management of diseases. Commercial fitness and health trackers were seen as potential data providers for pre-surgery purposes, since they may provide supplementary useful information about the patient's health and wellbeing.

In addition to patients, other passive things identified in the current practice were surgical equipment, hospital facilities, and other resources needed in the practice of pediatric day surgery. These "*things*" were mostly mechanical and manual devices for surgical purposes, with the surgeons preferring them to remain as such. Common future "*things*" were identified as being based on connected health solutions. "*Comparing the situation to 30 years ago, all kinds of technologies, new devices and instruments have invaded the surgery halls*", reported a pediatric surgeon at the University Hospital. It could be said that a similar improvement trend will continue in the future. Although surgeons did not see any upcoming revolution in existing clinical resources and surgical equipment, digital and smart "embedded" features in "*things*" were seen as providing a whole new dimension within a digital hospital. "*The short-term influence of technology is overrated, whereas the long-term efficiency is under-estimated,*" stated a pediatric surgeon at the University Hospital. Co-creation of digital features in surgical equipment would enhance automated data collection and exchange via wireless sensors and communication possibilities. The future digital hospital would include intelligent automated operations in room configurations and patient and resource-tracking. Anesthesia personnel were interested in smart monitoring devices and new parameters for vital signs. Inpatient ward nurses were interested in sensor hubs installed in hospital beds that collect and deliver vital signs wirelessly from wearable technologies. Therefore, current *things* will also become *discursive* in nature in the future. Future "*discursive things*" can be seen as connected health solutions interacting via the IoT platform.

4.3. Transformation of discursive actions

In **external discursive actions**, the needed anesthesia information for surgery preparation is collected from a family with a preliminary phone call the day before the operation. In this phase, "*there is a need to know the health situation of the patient, is he or she taking some medication that interacts with anesthesia, etc.*" (pediatric surgery nurse, University Hospital). The other information required in this stage are about allergies, earlier medications, earlier surgeries, chronic illnesses, if the person has lived in other countries, some vital signs, and other health history. Currently all this information is collected from the patient using a paper form, which is filled and then fed by the nurse into the system after the call. Nowadays, "*parents are often calling back to the hospital after the pre-call if they missed or forgot to ask some information on the phone*" (pediatric surgery nurse, University Hospital). In this stage, the information that cannot be seen is "*patient information from the psychiatric site*, [even though] *it could have impact on a diagnosis, e.g. in some cases if the patient has really strong somatic symptoms*" (pediatric surgeon, University Hospital).

For future **external discursive actions**, a common idea among health professionals was self-measured vital signs and health history data provided by the patient, hence supporting the previous findings about *agents* and *things*. For example, if some information is missing before the surgery, "*the parent could add it into the system before the nurse's phone call*" (pediatric surgery nurse, University Hospital). The discussion could specifically focus on the patient's questions and fears instead of anesthesia data collection. In addition, the self-provided data by the patient could be utilized by professionals by integrating the data into their decision-making systems: "*There are intelligent decision-making systems around the corner waiting for us…already today if I order some medicine and the patient is allergic, the system gives an alert.*" (pediatric surgeon, University Hospital).

Secondly, the parents in the workshop hoped for more transparency for the process and commonly reported that they lacked information about the next steps in the care process, creating anxiety and stress: "*I would have liked to have real-time information about what is happening to my child at the hospital*" (child patient's parent, University Hospital). Parents also commented that they wanted to have centralized information piece by piece at the opportune time, preferably in digital form and not handed out at once as a large number of printouts and verbal information. In addition, they would like to be able to ask questions anytime from the health professionals. From the hospital perspective, nurses commented that "*we are giving the information to the parents all the time, but they are in shock and therefore they cannot absorb all the information that we give to them*" (pediatric surgery nurse, University Hospital). Both health professional agents noted that this dilemma would be easily solved with an mHealth solution that centrally provides all guidelines, information and data exchange possibilities, and giving the chance to go back to the information afterwards. The same application could be used to reschedule a surgery and ask additional questions via chat or video conference, such as whether the child is too sick to have the operation.

The importance of information exchange and communication after surgery remained essential. This change related to the **discursive things** will happen rapidly at the future digital hospitals when all the guidelines and protocols at the hospital will be changed from the traditional paper based guidelines to the digital form. Although patients and their family are well-informed prior to being discharged home, they often have questions for the nurses and doctor, for example, on whether the surgery wound could become inflamed. On the other side, the need for feedback collection was mentioned by pediatric nurses, surgeons, and anesthesia personnel, who wanted to have online chat services so as to be able to quickly contact the patient for minor data collection. The continuous feedback collection would help health professionals to realize in which situations communication was needed more and in which less. The surgeons also hoped for more information on whether the surgery went well and with respect to long-term recovery: "*I should know how well the patient recovered after the operation*" (pediatric surgeon, University Hospital).

Issues with **discursive things**, such as communication via health information systems, were one of the most frequently addressed problems among the health professionals. It was found that there were many independent health information systems in each hospital department that did not interact with each other. The problems with incompatibility of health information systems, patient data exchange and poorly designed user interfaces (UIs) caused great frustration among the professionals, in addition to delays and excess workload such as double data logging among the hospital departments. In worst case, patient safety is risked in acute situations. Again, the health professional agents highlighted the importance of being present with the patient instead of using their valuable time struggling with the health information systems. Therefore, improvements and updates for the health information systems were acutely needed, and considerable effort from the hospital's IT department in close collaboration with health professionals and other hospital parties was hoped for. In addition to

incompatibility and UI development needs, need was expressed for new integrated features such as self-measured patient data, structured data, automatic data acquisition, and an intelligent decision support system working seamlessly between healthcare organizations.

4.4. Process structure

The pediatric day surgery process is structured in pre-, intra-, and post-surgical and home-care phases, now and in the future. However, the content of each process phase can be modified and revolutionized with the previous findings in terms of *agents*, *things*, and *discursive* actions due to the utilization of connected health solutions. These decision support systems will build the future digital hospitals, which are based on maximally intelligent and automated hospital management, where *things* and *agents* interact, or engage in *discourse* seamlessly via an IoT platform internally and externally, hence transforming pediatric day surgery practice.

The most visible change in the transformation *process* is the change from a process-centric care model into a patient-centric care model supported by citizen-centric connected health solutions. As passive patients (*things*) turn into active participants (*agents*) within the *practice*, more emphasis will be laid on the pre-surgical and home-care phases. In the future, the aim is to minimize the use of specialized health services and the time spent in hospital on the day of surgery. *"The cheapest patients are the ones who do not need specialized care in hospital"* (pediatric surgeon, University Hospital). Therefore, more and more optional health care solutions and models are sought in preventive health care and self-care. The importance of self-management via virtual health services, stations, and doctors with the help of advanced technologies to enable better interaction and co-operation between health organizations was highlighted.

According to the interviewed general physician from Central Hospital, pediatric day surgeries are going to change a lot due to the influence of connected health technologies. With an enhanced health information ecosystem and better internal and external communication, the health professional *agents* will have more time and space for clinical work and for utilizing the potential of their resources. For example, with the emergence of connected health technologies, some clinical daily tasks will disappear due to the digitalization of care processes. Other interviewees had similar ideas, i.e. that the nature of surgeries will remain as variable as always: *"Based on the last 10 years, the next 10 years could be predicted somehow, but not the next 20–30 years. Many of the surgeries done in the past can nowadays be treated with medication, gene therapy and other non-invasive methods. It is predicted that surgeries will diminish in the future. On the other hand, the number of surgeries has increased due to new surgery needs and increased life cycles. In addition, the duration of surgery processes has shortened. For example, a gastric ulcer was a demanding surgery in the past, requiring a 6-month sick leave. Nowadays it is treated with antibiotics without any sick leave. On the other hand, optical surgeries did not exist 20 years ago, but now vision correction surgeries are common operations. Osteoarthritis is very commonly operated at the moment. In the future, they will be probably treated with non-invasive methods"* (pediatric surgeon, University Hospital).

4.5. Summary

Table 1 summarizes the key findings of this study related to the change in pediatric surgery practice. According to our study data, the following key changes are likely to happen through the co-creation of connected health solutions.

5. Discussion and conclusions

The focus in this article was to understand how the co-creation of connected health solutions is changing pediatric day surgery practice in the digital hospital context. Future hospital technologies as well as health professionals' and patients' parents' needs were analyzed according to their fundamentals by means of *social practice theory*, which successfully described the key elements of digital transformation in pediatric surgery practice. The analysis was done based on the identified improvement needs and roles of three end-user groups (patients, specialists, and nurses from several involved hospital departments), mapped according to the key elements of social practice theory. The transformation of pediatric surgery practice was selected as a case study for investigation due to the acuteness of the digital hospital projects at the studied two hospitals. Picture 1 compiles the specifiable ontology of the created concepts by looking at the current relationships between social practice theory concepts in the pediatric day surgery context, as described by Blaschke et al. (2018).

In the current model, passive patients and health professionals are having communication that impacts hospital guidelines and protocols that are typically paper-based. Over time, the communication and guideline updates will also change pediatric day surgery practice. Picture 2 shows the ontology in the future when the situation will change due to co-creation and adoption of connected health solutions.

Drawing from social practice theory ontology about the core concepts (Pictures 1 and 2), it can be summarized that the patient role will become more active, and communication occurs more in a digital manner, which creates data that will be automatically transferred and used by intelligent integrated solutions. The data can be used either to support health professionals as part of their own patient record systems or to support patients in their communication with health experts. Digital communication can be further used to make intelligent solutions more intelligent and to update digital guidelines and protocols related to the pediatric surgery process. All this will significantly change pediatric surgery practice in future digital hospitals.

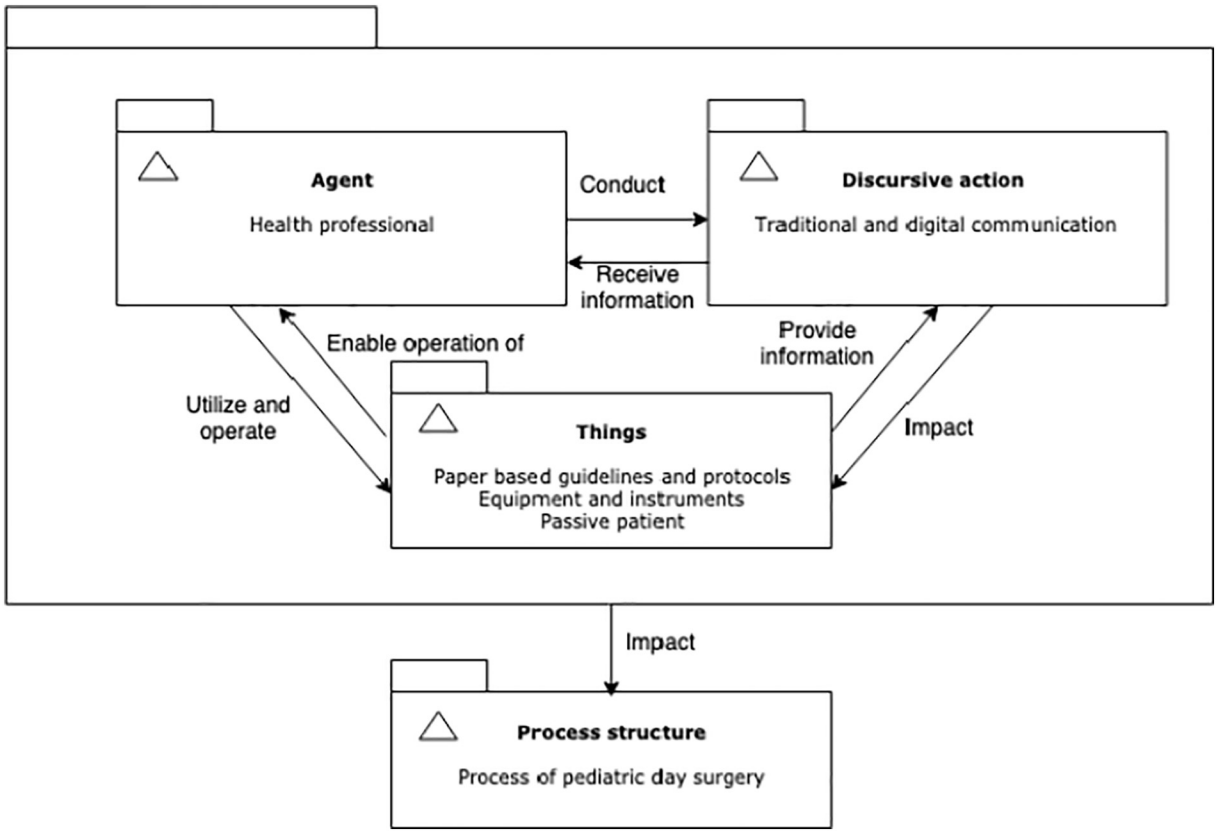
Introducing aspects of practice theory means conceptualizing the dynamics of demand (Shove and Pantzar, 2005). In our case, the demand was the co-creation of connected health solutions that were assumed to improve patient care and efficiency of pediatric surgery practice. Therefore, the theoretical contribution of this paper lays in a new conceptualization of the change that is happening in the pediatric surgery practice domain due the co-creation of connected health solutions.

Self-management as a means to improve patient care represents a key priority in the service literature. However, only a few studies have examined the potential of connected health solutions from the perspective of all end-users, i.e. specialists, nurses and patients (AlDossary et al., 2017). The most important finding of our study was that the change in pediatric surgery practice resulted from the need for better *discursive* actions (i.e., communication that occurs between health professionals and patients). We found that there is an urgent need to improve communication channels such as Chat, WhatsApp, and mobile applications that gather all necessary information and instructions from patients before and after the surgery. However, these solutions cannot be co-created separately from the clinical decision systems that allow *discursive actions* among healthcare professionals. An interesting idea of one interviewed pediatric surgeon was that intelligent decision-support systems would gather information from a patient's behavior and self-measured data, which was argued by Jiang et al. (2016), Vianna and Barbosa (2017), and Sharma and Kaur (2017). Similarly, Miah et al. (2017) developed an "on-cloud healthcare clinic" to support doctors to remotely evaluate and diagnose patients' data and medical history.

In our study, the parents of the patients also clearly stated their need for better *external discursive actions*, that is, better information transparency and accessibility to health services throughout the care process, especially in the pre-surgery and home-care phases. Both the health professionals and the patients agreed that a mobile application designed to support the patients going through surgery practice would enhance and facilitate the *process*. Also, Aal-Nouman et al. (2018) argue that one of the most important requirements for healthcare is the accessibility of healthcare services anytime and anywhere. Therefore, Aal-

Table 1
Glossary of social practice theory extended concepts.

Concept	Definition/explanation	Example related to pediatric day surgeries
Agent	Passive patient *things* will transform into active *agents*, acting in collaboration with the health professionals via citizen-centric connected health solutions.	A new type of agents emerges when parents become more active "agents" in pediatric surgery journey, e.g. giving more information needed for anesthesia. E.g. information required: allergies, earlier medications, prior earlier surgeries, chronic illnesses, if person has lived in other countries, some vital signs, and other health history
Discursive action	*Discursive* actions will be the basis of the future digital hospital: the importance of external digital communication solutions will be highlighted in future self-management actions, and internal communication will be based on the highly automated data management of patient care and interoperable health information systems.	The self-provided data by the patient could be utilized by professionals. This would require data integration with hospital decision support systems. The importance of information exchange and communication after surgery through a mobile solution as well as continuous feedback collection were evaluated as essential discursive actions.
Discursive things	*Discursive things* will dramatically change the future of pediatric day surgery practice: Traditional paper guidelines and protocols will be changed to digital form. Mechanical *things* will become communicative and intelligent (e.g. artificial intelligence, rapid self-diagnostics, quantified self) (intelligent solutions), in addition to hospital facilities, as connected health solution will interact seamlessly via the Internet of Things platform.	In the future, decision support systems will build the future digital hospitals, which are based on maximally intelligent and automated hospital management, where *things* and *agents* interact or engage in *discourse* action seamlessly via the Internet of Things platform, internally and externally.
Process structure	The content of the *process structure* in future pediatric surgery (and surgery professionals' roles) during each phase will dramatically change due to the aforementioned transformations.	Pediatric day surgeries are in the continuous change due to the influence of connected health solutions.



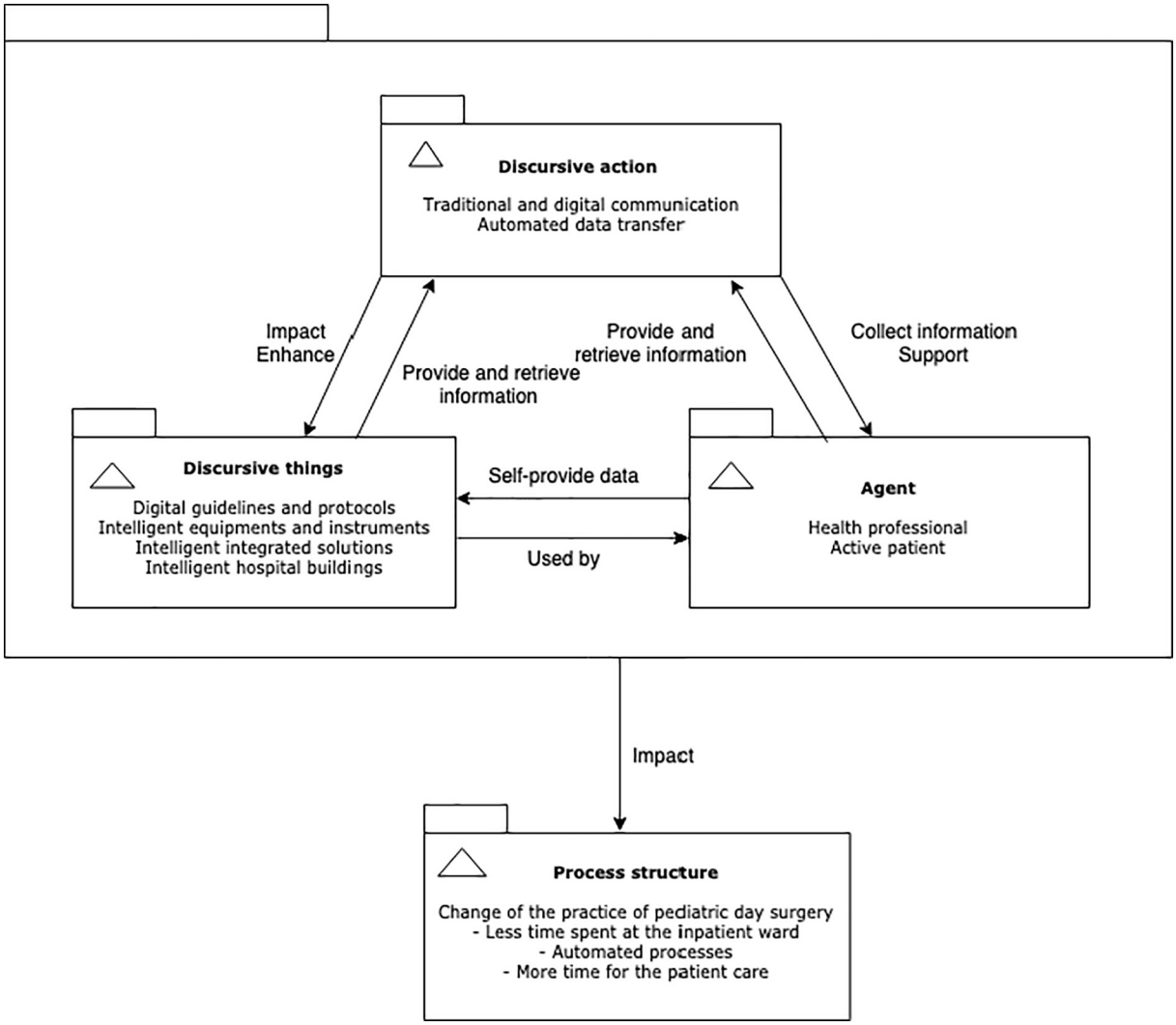
Picture 1. Social practice theory ontology of the key concepts related to the pediatric day surgery practice.

Nouman et al. (2018) developed an alternative communication channel (Random Access Channel), which enables communication of health information anytime, anywhere without an Internet connection.

Another essential need noted among health professionals was to enhance *internal discursive* actions (communication between health professionals), both between the hospital units and between the healthcare providers, e.g. between primary and special care units. These needs were mainly related to the health information systems' transparency and interoperability. As the *internal discursive actions* are improved and supported by the development of connected health solutions for *external discursive* actions, we face major changes in *things*, *agents*, and the *process* accordingly.

We identified two essential influences on *things* based on the aforementioned transformation and importance of improved *discursive* actions. Our study findings show that the adoption of connected health solutions in the *practice* of pediatric day surgery will transform *things* into *discursive things*, (i.e., passive devices, instruments, and other resources will have embedded communication and data exchange features). These family-centric connected health solutions (*discursive things)* could act as new channels for communication, information, and data exchange between patients and healthcare professionals.

Due to the appliance of *discursive things (*i.e. communication through mobile apps, medical devices, etc.), the future digital hospital is not restricted to the physical boundaries of a hospital building, and



Picture 2. Future social practice theory ontology of the key concepts related to the pediatric day surgery practice.

healthcare professionals are more reachable. Similar results are argued in many articles discussing the benefits of telenursing, home telecare, and telemedicine (Bikmoradi et al., 2017; Kumar and Snooks, 2011). In these articles, it is stated that telenursing can support the monitoring and protection of patients and their families without time and place restrictions, in addition to improving the quality of care through patients' providing needed information (Bau, 2011, Chiang et al., 2017; Kumar and Snooks, 2011).

Discursive things, e.g. *communication through a mobile solution*, could be used to improve the collection of anesthesia data in the preoperative phase of the surgery, allowing time savings for nurses who normally take time calling patients and collecting missing data. Thus, these types of solutions could provide a means to improve the patient experience in a cost-efficient manner in the future children's and women's digital hospital. In this context, such co-created value is not homogeneous but rather a result of different approaches, models, and roles that can be adopted (Zhao et al., 2015).

On the other hand, the second main influence stemming from the previous findings and the appliance of *discursive* into *things* was identified as transforming passive patients *(things)* into active *agents*. We found that the patients' parents gained a more active and essential role in their children's treatment throughout the *process*, especially in the pre-surgery and rehabilitation phases by using citizen-centric connected health solutions. Many studies have noted that in the future, patients will be more interactive partners of healthcare and will become more responsible for the efficiency of their treatment (Corbin et al., 2001; Kinnunen et al., 2016; Lamprinos et al., 2016). In our case, we also found that the patient empowerment achieved through family-driven connected health solutions would improve and transform the daily tasks of current *agents*. Parents could provide data to health professionals via web services, and a mobile application would prevent excess workloads, such as double data logging at the hospital. Connected health solutions could also play an important role by delivering the needed medical guidelines for patients in the right situation, e.g. utilizing waiting times at the hospital. Chiang et al. (2018) concluded a similar analysis of home telecare in Taiwan. Thus, discursive things and *active agents* provide the means for the transformation from the process-centric care model towards a patient-centric *practice*.

Finally, the impact, value, and satisfaction of the connected health solutions have been assessed by many authors from the perspective of patients and clinicians (Taylor, 2005). In addition to *things* becoming *discursive things*, passive *things* transforming into active *agents*, and *agents* (health professionals) sharing responsibility for the care with the new *agents* (patients), the digital hospital concept not only creates new workflows between professionals but also between the patient's home and the hospital. Therefore, connected health solutions as remote monitoring and the exchange of health data can potentially transform the content of the *process* by removing and/or increasing some clinical tasks in the pre-, intra-, post-surgery and home-care phases. For instance, Smith-Strøm et al. (2016) have revealed in their analysis that in

many cases, taking an image with a mobile phone could quickly capture changes in the healing of the patient. In these cases, the home care nurse can take mobile phone images and forward them to the expert team at the clinic, allowing both of them to evaluate the situation and discuss what treatment course to take. As a consequence, preventive care and self-management of health issues are promoted. Therefore, *discursive things* will also disrupt traditional organizational interfaces between primary and secondary healthcare and social care, hence promoting and leading to digital transformation of the whole healthcare *practice*.

6. Future research and limitations

An interesting area for future research would be the utilization of connected health solutions, especially gamification and modern chat and video services in the post-operational phase of pediatric surgery practice. It would be particularly interesting to see if the connected health gamification and the use of a WhatsApp-type communication solution among health professionals could lead to the successful remote rehabilitation of the child. In some cases, WhatsApp has already been used experimentally by orthopedic surgeons as an intra-departmental tool for quality improvement innovations in patient care through the establishment of clinical communication between surgical teams (Khanna et al., 2015). This preliminary investigation has already shown perceived benefits of WhatsApp use among general and emergency medical teams. Similarly, gamification for the rehabilitation of post-stroke disability has shown statistically significant improvement in the rehabilitation process (Hossain et al., 2018). Although gamified connected health solutions may not be suitable for everyone, our study indicates that gamification might be a useful approach to support children to prepare for and go through surgery. In addition, gamified solutions have been suggested as changing the health behavior of patients (Alahäivälä and Oinas-Kukkonen, 2016; Dias et al., 2017). For future research, it is essential to pay more attention to the utilization and benefits of gamification in the pediatric surgery process.

One interesting research angle would also be to analyze the data collected for this research via the ontology of Service Dominant Logic, as described by (Blaschke et al., 2018). Key concepts such as value co-creation and value in use could be used more specifically as described in S-D logic to evaluate the marketing perspective of pediatric surgery practice. Additionally, there is an opportunity to develop a dedicated (domain-specific) modeling method for connected healthcare ecosystems. This is because interviews and studies such as the one presented in this paper are typical sources of requirements for modeling methods or enterprise architecture changes.

The major limitation of this study is the relatively small sample size of study participants (i.e., patients' parents, nurses, and doctors), which limits the ability to generalize the findings. Although the data from interviews, online discussions, and workshops allowed us to reach saturation, a bigger sample that would include various national contexts and their comparison would lead to more conclusive findings. A quantitative study on a larger sample of health professionals from pediatric surgery units in different hospitals might also be an appropriate method to further validate the results of this qualitative study.

A second limitation of this study is that in the interviews, pediatric surgeons were asked to explain their current practice and discuss from their own perspective the potential of connected health solutions in pediatric surgery practice. This perhaps led to the problem of bias, as the interviewees might have brought up those technology needs and ideas that had already been under discussion, either in the hospital's internal communication or publicly at the time of the interview.

Declaration of Competing Interest

None.

Acknowledgements

This work was done in Wille (Wireless Lab Environment for Business) project, which was funded by Business Finland. Acknowledgement for all project consortium partners of their great support for the conducted research.

Appendix 1. Interview template of pediatric surgery professionals' interviews

Interviews structure	Example questions
Introduction	What is your role and tasks? In which process phase(s) are you acting?
Pre-operation	What essential information or patient data is needed before surgery? How should ideal communication be implemented among healthcare organizations and patients, internally and externally? Are there any technologies that would facilitate the preparation work at the hospital?
Surgical operation	What essential information or patient data is needed during the surgery? How is it transferred?
	What kind of communication tools or solutions facilitates surgery?
Post-operation	How is the patient's status archived? Would wireless solutions facilitate post-operation? How do you collect customer feedback?
Home care	Could technology usage assist in providing home care instructions and certificates for patient and family?
	What patient data and information would be useful for surgeons to monitor in home care?
	What alternative methods could be used in home care with patient communications? How do you transfer the patient data and records to other healthcare organization?
Professional's motivation and future innovation projects	How do you see your job 10–15 years from now?
	What kinds of process quality meters and value are there?
	What should be monitored more, and how are they being followed?
	How could care process transparency be improved for patients and their families throughout the process?
	How are development ideas reported and analyzed in the hospital?
	How often are development ideas considered?
	What would be the best way to pilot new products and services into hospital use?
	How should hospital co-creation and communication be implemented with companies?
	What would motivate and engage professionals in Research & Development & Innovations (R&D&I) projects in the future?

Appendix 2. Data collection method

Data collection method	No. of health care professionals	No. of patient representatives
1st workshop with nurses	2 (nurses)	
2nd workshop with nurses	3 (nurses)	

3nd workshop with nurses	4 (nurses)	
Online discussion and questionnaire with patients		6 (parents)
Workshop with patients' parents		6 (parents)
Semi-structured interviews with doctors	7 (doctors)	
In total	Total 16 (7 doctors, 9 nurses)	12

Roles of the medical doctors interviewed

Interview number	Specialty	Viewpoints	Hospital district
1	Pediatric surgery	Administration, teaching, hospital development, technologies, and innovations	University Hospital
2a	Anesthesiology	Anesthetics, New hospital project	Central Finland
2b	Anesthesia nurse	New hospital project Hospital ICT	Central Finland
3	General practice	Secondary-primary healthcare, care process design	Central Finland
4	Pediatric surgery	Urology, surgery, administration	University Hospital
5	Pediatric surgery	General surgery	University Hospital
6	Pediatric surgery (specializing)	Specializing, own research	University Hospital
7	Pediatric surgery	Gastrology	University Hospital

Appendix 3. Data analysis

Data analysis in terms of data collected from the specialists

Data collected vs. data analysis

		Data analysis in social practice theory			
		Things	Agents	Discursive	Process
Data collected	**Definition/topics**	Citizen-centric solutions, citizen's needs, and physical connected health technologies. Devices, patients, other physical resources or technologies needed in the practice.	Roles, tasks, needs, ideas, and attitudes of health professionals.	All communication among health professionals and with patients. Traditionally face-to-face or via systems. Data collection, communication, and hospital information systems.	Perspectives on the current and future process in terms of adoption of novel technologies throughout primary and secondary healthcare.
	Pre-surgery Current topics	• Parents often calling back to the hospital after the pre-call if they missed or forgot to ask some information on the phone	• Preparation of patient and surgery • Collection and delivery of information • Estimation of surgery need • Accepting referrals and planning the surgery • Resistance to changes • Lack of technical knowhow • Lack of resources for innovation work and technologies	• Patient data collection face-to-face or by phone • Time-consuming and redundant double data logging • Many current functions with IT systems and patient data collection could and should be automated, saving valuable time for actual clinical work. • Security, ownership, and visibility of patient data	• Most time-consuming process phase • Inefficient communication, process phase, and tasks among health professionals • Organizational and political difficulties in change process • Poor flexibility for changes of organizations • Treatment will be focusing on preventive care and self-care • Thus face-to-face humanitarian contact cannot be replaced with technology
	Improvement needs and ideas	• Video conference • Commercial fitness and health trackers potential data providers • Family-centric solutions engaging patient • Passive patients as things transforming into active agents • Gamification	• Time saved for focusing on patient and treatment • New health professional roles (“Virtual doctors”, personnel focusing on innovation development) • Multidisciplinary teams through the whole process • Technology know-how	• Digitalizing paper work • Better information and communication management • Intelligent data acquisition and IT systems between patient and hospital • Intelligent decision-support systems and reminders • Self-measured vital signs and health history data • Solutions should be developed with doctors	• Excess process phases should be eliminated or automated (documentation, patient data management and preparation) • New healthcare services and stations • New effortless cooperation solutions with companies (innovation campuses) • Checklists
	Codes	17	40	75	37
	Intra-surgery Current topics	• Parents reported feeling insecure, as they were only “things meandering through an unknown process.” • Lost patients in the hospital buildings • Lack of proper screens and technologies • Patient safety • More new devices all the time	• Care team has to adapt to unexpected situations • Interaction and informing the patient about the surgery • Fear manage-ment and comforting the patient and the parents	• Patients' parents missing information • Lack of information about issues affecting the scheduled surgery • Communication problems via health information systems • Several information systems • Frustrating problems with incompatibility of information	• Unexpected changes in daily schedule • Delays, cancellations, and excess workload due to miscom-munication, fear of the patient, unexpected examinations and waiting times • The cheapest patient is the one who does not need to come to hospital • Fluctuating nature of what is treated with surgery

		• Waiting for patient to be ready for surgery • Hands-on work and surgeon's skills preferred rather than technologies	systems, patient data exchange, and poorly designed user interfaces	• Patients arriving on scheduled slots vs. all at the same time in the morning
Improvement needs and ideas	• Family-centric connected health solutions • More transparency on the patient's process • Wireless sensors • Intelligent automated environments • Smart monitoring devices • Wearable technologies • Current things will become discursive in nature in the future	• Easier and more efficient communication with patients • Robotics and virtualization in some cases, mostly for training or for adult surgeries • Ergonomy	• Patients could ask questions anytime from health professionals • Automated data collection • Quantification of one's health status prior to the surgery • mHealth application with centralized information and communication	• New method for dealing unexpected changes • Maximally intelligent and automated hospital management • Things and agents interact or engage in discourse seamlessly via an IoT platform internally and externally • Robotics and automation
Codes	17	30	14	18
Post-surgery				
Current topics	5. Patients are transferred from the operating room to waking up 6. Parents see the child first time in the discharge room.	7. Follow-up on recovery, pain, etc. 8. Documentation 9. Informing about self-care 10. Instructions 11. Agreeing on follow-up	• Face to face, by phone • Patients given huge amount of information on paper • Codings • Automation of data logging	• Post documentation • Duration some hours before discharging • Continuity of patient care
Improvement needs and ideas	• Wireless sensors to measure vital signs • Commercial solutions as fitness trackers	• Seamless communication and cooperation among other healthcare providers	• Centralized in digital form • Automation of data input • Real-time information	• The aim is to minimize the use of specialized health services and the time spent in hospital on the day of surgery.
Codes	15	15	16	7
Self-care				
Current topics	• Patients contacting the nurses and doctor although they were well informed prior to discharge on whether the surgery wound could become inflamed, etc. • Recovery depends on the patients and their engagement in the process	• Patients contacting the nurses and doctor • Inflamed surgery wound, etc. • No resources for tracking the self-care phase or feedback • Agreed controls	• Phone calls to hospital by the patient	• Change from process-centric care model into a patient-centric care model supported by citizen-centric connected health solutions. • As passive patients (things) turn into active participants (agents), more emphasis will be laid on the pre-surgical and self-care phases. • No regular quality assessment • Face-to-face humanitarian contact cannot be replaced
Improvement needs and ideas	• New family-centric things • Patient engagement • Self-management • Self-monitoring devices operating via an IoT platform • Smart homes/intelligent health stations	• Time and resource management is difficult to organize • Flexibility when patients change care provider	• Continuous and long-term feedback collection • Online chat services • Quantification and tracking of health status giving more responsibility to the patient in post-surgery and especially in self-care • Centralized systems between care providers and patients • Secure connections	• More optional health care solutions and models in preventive health care and self-care. • The importance of self-management via virtual health services, stations, and doctors with the help of advanced technologies to enable better interaction and co-operation between health organizations • Long-term quality measures of patient's life, treatment, and technologies • Continuity of treatment in early phases
Codes	4	11	48	32
Codes in total	53	98	153	94

References

Aal-Nouman, M., Takruri-Rizk, H., Hope, M., 2018. Transmission of medical messages of patient using control signal of cellular network. Telematics Inform. 35 (1), 267–281.

Alahäivälä, T., Oinas-Kukkonen, H., 2016. Understanding persuasion contexts in health gamification: a systematic analysis of gamified health behavior change support systems literature. Int. J. Med. Inform. 96, 62–70.

AlDossary, S., Martin-Khan, M., Bradford, N.K., Smith, A.C., 2017. A systematic review of the methodologies used to evaluate telemedicine service initiatives in hospital facilities. Int. J. Med. Inform. 97, 171–194.

Al-Jabri, I.M., Roztocki, N., 2015. Adoption of ERP systems: Does information transparencymatter? Telematics Inform. 32, 300–310.

Atanasova, S., Kamin, T., Petrič, G., 2016. Exploring the benefits and challenges of health professionals' participation in online health communities: emergence of (dis)empowerment processes and outcomes. Int. J. Med. Inform. 98, 13–21.

Barello, S., Graffigna, G., Vegni, E., 2012. Patient engagement as an emerging challenge for healthcare services: mapping the literature. Nurs. Res. Pract. 1, 1–7. https://doi.org/10.1155/2012/905934. (PMID:23213497).

Barr, P.J., McElnay, J.C., Hughes, C.M., 2012. Connected health care: the future of health care and the role of the pharmacist. J. Eval. Clin. Pract. 18 (1), 56–62.

Bau, I., 2011. Connected for health: the potential of health information and communications technologies to reduce health care disparities. Natl. Civ. Rev. 100 (3), 15–18.

Bikmoradi, A., Masmouei, B., Ghomeisi, M., Roshanaei, G., 2017. Impact of tele-nursing on adherence to treatment plan in discharged patients after coronary artery bypass graft surgery: a quasi-experimental study in Iran. Int. J. Med. Inform. 86, 43–48.

Blaschke, M., Haki, M.K., Aier, S., Winter, R., 2018. Value co-creation ontology – a service dominant logic perspective. In: Multikonferenz Wirtschaftsinformatik 2018, (Lüneburg, Germany).

Blue, S., Shove, E., Carmona, C., Kelly, M.P., 2016. Theories of practice and public health: understanding (un) healthy practices. Crit. Public Health 26 (1), 36–50.

Bodenheimer, T., Lorig, K., Holman, H., Grumbach, K., 2002. Patient self-management of chronic disease in primary care. JAMA 288 (19), 2469–2475.

Bourdieu, P., 1990. The Logic of Practice. Stanford University Press.

Casselman, J., Onopa, N., Khansa, L., 2017. Wearable healthcare: lessons from the past

and a peek into the future. Telematics Inform. 37, 1011–1013.
Caulfield, B.M., Donnelly, S.C., 2013. What is connected health and why will it change your practice? QJM 106 (8), 703.
Chang, I., Chang, C., Wu, J., Huang, T.C., 2015. Assessing the performance of long-term care information systems and the continued use intention of users. Telematics Inform. 32, 273–281.
Chiang, K, Wang, H, Chien, I, Liou, J, Hung, C, Huang, C, et al., 2017. Healthcare providers' perceptions of barriers in implementing of home telecare in Taiwan: A qualitative study. Int J Med Inf 84 (4), 277–287.
Chiang, K., Wang, H., Chien, I., Liou, J., Hung, C., Huang, C., Yang, F., 2018. Healthcare providers' perceptions of barriers in implementing of home telecare in Taiwan: a qualitative study. Int. J. Med. Inform. 84 (4), 277–287.
Christensen, C., 2013. The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. Harvard Business Review Press.
Corbin, C.L., Kelley, S.W., Schwartz, R.W., 2001. Concepts in service marketing for healthcare professionals. Am. J. Surg. 181 (1), 1–7.
Coulter, A., Jenkinson, C., 2005. European patients' views on the responsiveness of health systems and healthcare providers. Eur. J. Pub. Health 15 (4), 355.
Dias, L.P.S., Barbosa, J.L.V. & Vianna, H.D. 2017, Gamification and serious games in depression care: a systematic mapping study. J. Med. Internet Res. Vol. 19 Nro 5, p. 141.
Down, W., Cowell, A., Regan, D., Moran, K., Slevin, P., Doyle, G., Bray, J., 2018. An exploratory cost effectiveness analysis of the connected health intervention to improve care for people with dementia: a simulation analysis. Health Serv. Outcome Res. Methodol. 18 (1), 47–62.
Ervasti, M., Pikkarainen, M., Muuraiskangas, S., Reponen, J., Alalääkkölä, T., 2016. WILLE Project - Co-developing Digital Services for Future Hospital Environments. Finnish Society of Telemedicine and eHealth, Jyväskylä.
Frow, P., McColl-Kennedy, J.R., Payne, A., 2016. Co-creation practices: their role in shaping a health care ecosystem. Ind. Mark. Manag. 56, 24–39.
Geiger, J.D., Hirschl, R.B., 2015. Innovation in surgical technology and techniques: challenges and ethical issues. Semin. Pediatr. Surg. 24 (3), 115–121.
Himidan, S., Kim, P., 2015. The evolving identity, capacity, and capability of the future surgeon. Semin. Pediatr. Surg. 24 (3), 145–149.
Hossain, M.S., Hoda, M., Muhammad, G., Almogren, A. & Alamri, A. 2018 "Cloud-supported framework for patients in post-stroke disability rehabilitation", Telematics Inform., Vol. 35 Nro. 4. pp. 826–836.
Iglehart, J.K., 2014. Connected health: emerging disruptive technologies. Health Aff. 33 (2), 190.
Jiang, Y., Sereika, S.M., DeVito Dabbs, A., Handler, S.M., Schlenk, E.A., 2016. Using mobile health technology to deliver decision support for self-monitoring after lung transplantation. Int. J. Med. Inform. 94, 164–171.
Kabra, G., Ramesh, A., Akhtar, P., Dash, M.K., 2017. Understanding behavioural intention to use information technology: insights from humanitarian practitioners. Telematics Inform. 34 (7), 1250–1261.
Khanna, V., Sambandam, S.N., Gul, A., Mounasamy, V., 2015. "WhatsApp"ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching center. Eur. J. Orthop. Surg. Traumatol. 25 (5), 821–826.
Kharrazi, H., Chisholm, R., VanNasdale, D., Thompson, B., 2012. Mobile personal health records: an evaluation of features and functionality. Int. J. Med. Inform. 81 (9), 579–593.
Kinnunen, M., Mian, S.Q., Oinas-Kukkonen, H., Riekki, J., Jutila, M., Ervasti, M., Ahokangas, P., Alasaarela, E., 2016. Wearable and mobile sensors connected to social media in human well-being applications. Telematics Inform. 33 (1), 92–101.
Kreps, G.L., Neuhauser, L., 2010. New directions in eHealth communication: opportunities and challenges. Patient Educ. Couns. 78 (3), 329–336.
Kumar, S., Snooks, H., 2011. Telenursing. Springer.
Kvedar, J., Coye, M.J., Everett, W., 2014. Connected health: a review of technologies and strategies to improve patient care with telemedicine and telehealth. Health Aff. 33 (2), 194–199.
Lamprinos, I., Demski, H., Mantwill, S., Kabak, Y., Hildebrand, C., Ploessnig, M., 2016. Modular ICT-based patient empowerment framework for self-management of diabetes: design perspectives and validation results. Int. J. Med. Inform. 91, 31–43.
Liu, L., Stroulia, E., Nikolaidis, I., Miguel-Cruz, A., Rios Rincon, A., 2016. Smart homes and home health monitoring technologies for older adults: a systematic review. Int. J. Med. Inform. 91, 44–59.
Lluch, M., 2011. Healthcare professionals' organisational barriers to health information technologies—a literature review. Int. J. Med. Inform. 80 (12), 849–862.
Lluch, M., 2016. Healthcare professionals' organisational barriers to health information technologies—A literature review. Int. J. Med. Inf. 80 (12), 849–862.
Maller, C.J., 2015. Understanding health through social practices: performance and materiality in everyday life. Sociol. Health Illn. 37 (1), 52–66.
Martikainen, S., Viitanen, J., Korpela, M., Lääveri, T., 2012. Physicians' experiences of participation in healthcare IT development in Finland: willing but not able. Int. J. Med. Inform. 81 (2), 98–113.
Martikainen, S., Korpela, M., Tiihonen, T., 2014. User participation in healthcare IT development: a developers' viewpoint in Finland. Int. J. Med. Inform. 83 (3), 189–200.
Meier, P.S., Warde, A., Holmes, J., 2017. All drinking is not equal: how a social practice theory lens could enhance public health research on alcohol and other health behaviours. Addiction Debate. https://doi.org/10.1111/add.13895.
Miah, S.J., Hasan, J., Gammack, J.G., 2017. On-Cloud Healthcare Clinic: An e-health consultancy approach for remote communities in a developing country. Telematics and Informatics 34, 311–322.
Mobasheri, M.H., Johnston, M., Syed, U.M., King, D., Darzi, A., 2015. The uses of smartphones and tablet devices in surgery: a systematic review of the literature. Surgery 158 (5), 1352–1371.
Niès, J. & Pelayo, S. 2010 "From users involvement to users' needs understanding: a case study", Int. J. Med. Inform., vol. 79, no. 4, pp. e76-e82.
Northern Ostrobothnia Hospital District, 2016. OYS future hospital 2030. Accessed at: http://www.oys2030.fi/english.php, Accessed date: 19 December 2017.
On the Application of the Internet of Things in the Field of Medical and Health Care. Proceedings of the, 2013. IEEE International Conference on Green Computing and Communications and IEEE Internet of Things and IEEE Cyber, Physical and Social Computing Washington, DC. IEEE Computer Society, USA, pp. 2013.
Reckwitz, A., 2002. Toward a theory of social practices a development in culturalist theorizing. Eur. J. Soc. Theory 5 (2), 243–263.
Rigby, M., Ronchi, E., Graham, S., 2013. Evidence for building a smarter health and wellness future—key messages and collected visions from a Joint OECD and NSF workshop. Int. J. Med. Inform. 82 (4), 209–219.
Robinson, J.H., Callister, L.C., Berry, J.A., Dearing, K.A., 2008. Patient-centered care and adherence: definitions and applications to improve outcomes. J. Am. Acad. Nurse Pract. 20 (12), 600–607.
Rossi Mori, A., Mazzeo, M., Mercurio, G., Verbicaro, R., 2016. Holistic health: Predicting our data future (from inter-operability among systems to co-operability among people). Int. J. Med. Inf. 82 (4), e14–e28.
Schneider, T, 2001. Easy access to a world of information: using a handheld computer. J Emerg Nurs 27.
Sharma, P., Kaur, P.D., 2017. Effectiveness of web-based social sensing in health information dissemination—a review. Telematics Inform. 34 (1), 194–219.
Shin, D. 2014, A socio-technical framework for internet-of-things design: a human-centered design for the internet of things. Telematics Inform., Vol. 31, Nro 4, pp. 519–531.
Shove, E., Pantzar, M., 2005. Consumers, producers and practices. J. Consum. Cult. 5 (1), 43–64.
Shove, E., Walker, G., 2014. What is energy for? Social practice and energy demand. Theory Cult. Soc. 31 (5), 41–58.
Smith-Strøm, H., Iversen, M.M., Graue, M., Skeie, S., Kirkevold, M., 2016. An integrated wound-care pathway, supported by telemedicine, and competent wound management—essential in follow-up care of adults with diabetic foot ulcers. Int. J. Med. Inform. 94, 59–66.
Suzman, R., Beard, J., 2011. Global Health and Aging, World Health Organization, National Institute on Aging. pp. 1–23.
Taylor, P., 2005. Evaluating telemedicine systems and services. J. Telemed. Telecare 11 (4), 167–177.
Thakur, R., Hsu, S.H.Y., Fontenot, G., 2012. Innovation in healthcare: issues and future trends. J. Bus. Res. 65 (4), 562–569.
Thimbleby, H., 2013. Technology and the future of healthcare. Journal of Public Health Research 2 (3), e28.
Trappenburg, J., Jonkman, N., Jaarsma, T., van Os-Medendorp, H., Kort, H., de Wit, N., Hoes, A., Schuurmans, M., 2013. Self-management: one size does not fit all. Patient Educ. Couns. 92 (1), 134–137.
Vest, J.R., 2010. More than just a question of technology: factors related to hospitals' adoption and implementation of health information exchange. Int. J. Med. Inform. 79 (12), 797–806.
Vianna, H.D. & Barbosa, J.L.V. 2017, In search of computer-aided social support in non-communicable diseases care. Telematics Inform., Vol. 34 Nro. 8, pp. 1419–1432. doi:https://doi.org/10.1016/j.tele.2017.06.005.
Viitanen, J., Hyppönen, H., Lääveri, T., Vänskä, J., Reponen, J., Winblad, I., 2011. National questionnaire study on clinical ICT systems proofs: physicians suffer from poor usability. Int. J. Med. Inform. 80 (10), 708–725.
Wanderley, G.M.P., Vandenbergh, É., Abel, M., Barthès, J.A., Hainselin, M., Mouras, H., Lenglet, A., Tir, M., Heurley, L., 2018. CONSIGNELA: a multidisciplinary patient-centered project to improve drug prescription comprehension and execution in elderly people and parkinsonian patients. Telematics Inform. 5, 913–929 Nro 4.
Weinstein, R.S., Lopez, A.M., Joseph, B.A., Erps, K.A., Holcomb, M., Barker, G.P., Krupinski, E.A., 2014. Telemedicine, telehealth, and mobile health applications that work: opportunities and barriers. Am. J. Med. 127 (3), 183–187.
Weiss, G., 2002. Welcome to the (almost) digital hospital. IEEE Spectr. 39 (3), 44–49.
Woo, R.K., Skarsgard, E.D., 2015. Innovating for quality and value: utilizing national quality improvement programs to identify opportunities for responsible surgical innovation. Semin. Pediatr. Surg. 24 (3), 138–140.
Yin, Y., Zeng, Y., Chen, X., Fan, Y., 2016. The internet of things in healthcare: an overview. J. Ind. Inf. Integr. 1, 3–13.
Yoo, S., Jung, S.Y., Kim, S., Kim, E., Lee, K., Chung, E., Hwang, H., 2016. A personalized mobile patient guide system for a patient-centered smart hospital: lessons learned from a usability test and satisfaction survey in a tertiary university hospital. Int. J. Med. Inform. 91, 20–30.
Zhao, J., Wang, T., Fan, X., 2015. Patient value co-creation in online health communities: social identity effects on customer knowledge contributions and membership continuance intentions in online health communities. J. Serv. Manag. 26 (1), 72–96.

Riikka Niemelä received her M.Sc in Electrical Engineering from the University of Oulu, Finland in 2015, and MHSc in Medical technology from the University of Oulu, Finland in 2016. She is currently working as a project manager at KIDE Systems promoting the delivery of cutting edge clinical imaging solutions to the medical industry. She has previously worked in Germany as a project manager in order to digitalize and internationalize the conservative medical technology industry in the area of Tuttlingen - "The World Center of Medical Technology". Her previous research interests have been topics of how to promote healthcare services, their accessibility and patient journeys with connected health technologies and digital health solutions.

Minna Pikkarainen is a joint Connected Health professor of VTT Technical Research Centre of Finland and University of Oulu/Oulu Business School, Martti Ahtisaari Institute and Faculty of Medicine. As a professor of connected health Minna is doing on multi-disciplinary research on innovation management, service networks and business models in the context of connected health service co-creation. Professor Pikkarainen has extensive record of external funding, her research has been published large amount of journal and conference papers e.g. in the field of innovation management, software engineering and information systems. During 2006–2012 Professor Minna Pikkarainen has been working as a researcher in Lero, the Irish software engineering research centre, researcher in Sirris, collective "centre of the Belgian technological industry" and business developer in Institute Mines Telecom, Paris and EIT (European Innovation Technology) network in Paris and Helsinki. Her key focus areas as a business developer have been in healthcare organizations. Previously, Minna's research has been focused on the areas of agile development, software innovation and variability management.

Mari Ervasti received her M.Sc. in Information Networks from the University of Oulu in 2007, and D.Sc. (Tech.) degree in Human-Centered Technology from the Tampere University of Technology in 2012. She is currently working as a Senior Scientist in the Wellness and Living team at VTT Technical Research Centre of Finland Ltd. She has worked at VTT since 2007 as a project manager and researcher in several multi-disciplinary research projects dealing with human-centered interaction and service design, and she has over 40 scientific publications in the field. During 2016-2017, she worked also part time in Centre for Health and Technology (CHT) at the University of Oulu. Dr. Ervasti's research focuses on user experience design and evaluation of novel digital services covering many different application domains with the purpose of creating services that provide value for the end-users. She is experienced in conducting user-centered research dealing with user understanding and participatory design, with a special focus on user involvement and engagement in new service development by utilizing user-driven methods. In her research is furthermore addressed the need for predicting and estimating the impacts and value of novel technologies for different stakeholders. During the past few years, Dr. Ervasti has focused on the co-creation of novel connected health services together with patients, healthcare professionals, and companies in the context of future digital hospitals.

Jarmo Reponen serves as a professor of Health Information Systems at the Faculty of Medicine, University of Oulu, Finland. He has more than 25 years of experience in the development, implementation and evaluation of hospital information systems, especially in the field of electronic patient record and radiology systems. His group co-developed the world's first mobile app for smartphones 20 years ago. Currently their research focuses on the effects of digitization in healthcare, with target areas of availability, use and usability of the information systems. Reponen is the responsible teacher for the special competence of information technology for physicians and eHealth introductory courses for medical students.