

Research and theory

Development of a program for tele-rehabilitation of COPD patients across sectors: co-innovation in a network

Birthe Dinesen, PhD, Assistant Professor, Department of Health Science and Technology, Aalborg University, Fredrik Bajers Vej 7 D1, DK-9220 Aalborg, Denmark

Janne Seeman, PhD, Associate Professor, Department of Sociology, Social Work and Organisation, Aalborg University, Kroghstraede 7, DK-9220 Aalborg, Denmark, E-mail: seemann@socsci.aau.dk

Jeppe Gustafsson, PhD, Associate Professor, Department of Business Studies, Aalborg University, Fibigerstraede 4, DK-9220 Aalborg, Denmark, E-mail: jg@business.aau.dk

Correspondence to: Birthe Dinesen, Department of Health Science and Technology, Aalborg University, Fredrik Bajers Vej 7 D1, DK-9220 Aalborg, Denmark, Phone: +(45)2051 5944; Fax: +(45) 98154008, E-mail: bid@hst.aau.dk

Abstract

Introduction: The aim of the Telekat project is to prevent re-admissions of patients with chronic obstructive pulmonary disease (COPD) by developing a preventive program of tele-rehabilitation across sectors for COPD patients. The development of the program is based on a co-innovation process between COPD patients, relatives, healthcare professionals and representatives from private firms and universities. This paper discusses the obstacles that arise in the co-innovation process of developing an integrated technique for tele-rehabilitation of COPD patients.

Theory: Network and innovation theory.

Methods: The case study was applied. A triangulation of data collection techniques was used: documents, observations (123 hours), qualitative interviews (n=32) and action research.

Findings: Obstacles were identified in the network context; these obstacles included the mindset of the healthcare professionals, inter-professionals relations, views of technology as a tool and competing visions for the goals of tele-rehabilitation.

Conclusion: We have identified obstacles that emerge in the co-innovation process when developing a programme for tele-rehabilitation of COPD patients in an inter-organizational context. Action research has been carried out and can have helped to facilitate the co-innovation process.

Keywords

co-innovation, integrated care, tele-rehabilitation, COPD patients

Introduction

The health care sector is facing an increasing demand for effectiveness and improvement of care, treatment and rehabilitation of chronic diseases.

Innovation is forecasted as one of the tools for making the public sector more efficient, and the health-care system is no exception. Healthcare innovation can be defined as the process of turning ideas into reality, using a new concept, service, process, or

product to improve treatment, diagnosis, education, outreach, prevention and research, as well as enhancing quality, safety, outcomes, efficiency and cost [1]. The buzz word in Denmark is ‘creating innovation in collaboration in networks’—referred to here as ‘co-innovation’. There is no standard definition of the term ‘co-innovation’. Co-innovation takes place between users, public organizations, private firms and universities [2].

Patients with chronic obstructive pulmonary disease (COPD) pose a serious public health problem. It is estimated that 210 million people have COPD worldwide, and that more than three million people died of COPD in 2005, equal to 5% of all deaths globally that year [3]. Patients with severe and a very severe COPD have a readmission rate of 63% during a mean follow-up of 1.1 year, with physical inactivity among the most significant predictor for readmissions [4].

According to the global strategy for diagnosing, managing and preventing COPD, stable COPD is managed using a combination of interventions such as smoking cessation, pharmacological therapy, education, pulmonary rehabilitation, nutritional interventions, vaccinations, oxygen therapy and surgery [5]. However, the question remains as to the most effective means of delivering and coordinating multidisciplinary care to COPD patients according to the disease continuum and across the healthcare system [6]. Reviews of the disease management programs for COPD patients show programs that are heterogeneous in terms of interventions, outcome measures and study design. However, quality of life is improved, and triple intervention programs have resulted in lower probability of at least one hospital admission compared to usual care. The reviews also conclude that there is a need for more research on chronic disease management programs in patients with COPD across primary and secondary care [7, 8]. Studies of home tele-monitoring of chronic diseases, including COPD, indicate home tele-monitoring to be a promising approach that empowers patients, positively influencing their attitudes and behavior and potentially improves their medical condition [9, 10].

In the research and innovation project, called ‘Tele-homecare, chronic patients and the integrated healthcare system’ (the Telekat project), we have taken up the challenge of combining co-innovation, disease management and technology in order to develop a tele-rehabilitation program for Danish COPD patients. ‘Tele-rehabilitation’ can be defined as rehabilitation between the patient’s home and healthcare professionals with the support of communication and information technology. In the Telekat project, the patient

groups are those with severe or very severe COPD. The aims of the project are (1) to prevent re-admission of COPD patients by promoting home-based tele-rehabilitation; and (2) to develop and test a preventive program of rehabilitation for people with COPD across sectors.

The development of the program of tele-rehabilitation across sectors is based on a co-innovation process that involves COPD patients, their relatives, healthcare professionals and representatives from private firms and universities. Relatively little research has been conducted to explore co-innovation processes in complex healthcare networks that are constructed as innovation alliances [11]. There is limited systematic research on the development of system preparedness for participating in an innovation process and anticipating the impact of an innovation [12]. Findings from a study of the design and implementation phases of a telehomecare system identified several types of controversies that emerge as a part of the inter-organizational and inter-professional agenda. These controversies involved competing claims of jurisdiction over knowledge technologies or differences in network visions [13]. The research has focused mainly on the adoption phase of innovations rather than the earlier phases of idea development, conceptualization, obstacles and legitimization in the innovation process whereby new services and practices are established in the healthcare sector [14, 15]. In order to expand our understanding of co-innovation in a network, this paper focuses on identifying potential obstacles that might arise when developing an integrated program for tele-rehabilitation of COPD patients. The level of analysis is the various actors involved in the Telekat network: the COPD patients, relatives, healthcare professionals and university and private technology providers.

Presentation of the Telekat case study

We begin by introducing the context and parties in the case study, followed by a presentation of the design of the co-innovation process. Finally, we describe how the tele-rehabilitation process developed despite obstacles in the co-innovation process.

Presentation of context and parties

In 2007, the Danish healthcare reform transferred responsibility for rehabilitation from the hospitals to the municipalities. Today, Danish patients with severe and very severe COPD are offered rehabilitation when

the clinical symptoms limit their functional level and quality of life. The rehabilitation includes physical training, instruction in the disease, nutrition guidance, pulmonary physiotherapy, assistance to stop smoking, etc. The rehabilitation typically takes place as an instructional course administered by the municipality or hospital. The course, of six weeks' duration, is held away from the patient's home. Clinical experience shows that COPD patients attend the rehabilitation course several times to prevent further worsening of the disease.

The Telekat project has attempted to develop a tele-rehabilitation program which takes place in the patients' own homes and in collaboration with various healthcare professionals, such as district nurses, general practitioners (GP), nurses and doctors at a healthcare centre and hospital. Rehabilitation can thus become a part of everyday life and eventually help break an often downward spiral of decreasing well-being for the person suffering from COPD. The following parties were involved in the co-innovation process:

- *Healthcare center* aims at elaborating and implementing rehabilitation programs for patients with a chronic disease, such as COPD patients. The center has had more than 700 COPD patients for rehabilitation since early 2007.
- *Pulmonary Medical Clinic at a university hospital* is the regional competence centre for COPD patients with a severe and very severe illness. Specialized nurses and doctors see the patients regularly at the outpatient clinic.
- *District nursing* takes care of those patients with chronic diseases who need monitoring, counseling and special assistance, such as administering medication in their homes. The Danish healthcare reform has changed the district nurse's role so that their work also has a preventive focus.
- *GP* is the patient's doctor. The GP must coordinate patient care and treatment across sectors and advise the patients on rehabilitation options.
- *The firms*—are specialized in IT and telehealth solutions and operate in the national and international markets.
- *COPD patients and relatives*—the COPD patients suffer from severe or very severe illness and have attended courses in rehabilitation at the healthcare center.
- *Universities*—have research experience within user-driven innovation and telehealth.

None of the healthcare professionals, COPD patients and relatives has experience with tele-rehabilitation technology.

Design of the co-innovation process

The Telekat project began in January 2008 and ends in June 2011. The project is divided into four phases, and this paper focuses on phases I and II.

- Phase I (January–June 2008): Design phase.
- Phase II (July 2008–June 2009): Clinical testing of tele-rehabilitation program.
- Phase III (July 2009–June 2010): Conducting a randomised study.
- Phase IV (July 2010–June 2011): Testing the programme in a new context with other healthcare professionals.

Findings and results from phases III and IV are now being prepared for publication.

The co-innovation process has been centered on two forums: a user panel and a network laboratory. [Table 1](#) shows an overview of aims for the forums, members and numbers of workshops during phases I and II.

In preparation for the first workshop in the user panel, researchers had conducted qualitative studies in the homes of the COPD patients in order to identify their expressed and unarticulated needs [16] in connection with rehabilitation technologies. Second, the data were presented and integrated into ideas and concepts in the user panel. Concurrently, prior to the first workshop in the network laboratory, researchers conducted participant-observation (see Methods), following healthcare professionals at work in order to identify professional issues concerning rehabilitation of COPD patients. The observations were presented and integrated into the work of the network laboratory. Alongside these workshops, working groups were set up to deal with specific technological and clinical issues. Researchers facilitated the co-innovation process via action research (see Methods) in order to create collective reflections, empower the participants to generate new ideas and established synergy between the forums.

Emerging themes in the development of the program

In the development of the program, our field observations revealed several key issues in connection with the co-innovation process between the parties. The COPD patients wanted to move rehabilitation activities to their homes but to still have the possibilities to be in contact with healthcare professionals. They expressed the desire to learn more about their own disease while carrying out their daily routines at home, and they wanted to learn more about monitoring their own symptoms.

Table 1. Overview of forums in the co-innovation process

	Aim	Members	Phase I workshops	Phase II workshops
User panel	To transform identified known and unknown needs derived from ethnographic studies in homes of COPD patients to ideas for new services and technologies for COPD patients. To develop new ideas for new technologies and a programme for tele-rehabilitation of COPD patients.	COPD patients Relatives 4 district nurses 2 nurses from healthcare centre 1 physiotherapist 2 nurses from hospital 1 doctor from hospital 1 GP 3 representatives from firms 3 researchers	2×4 hours	4×4 hours
Network laboratory	To transform researchers' observations on professional issues concerning rehabilitation of COPD patients based on participant observations following healthcare professionals at work. To develop a new programme for tele-rehabilitation of COPD patients between sectors in the healthcare system.	2 district nurses 2 managers from district nursing 2 nurses from healthcare centre 2 nurses from hospital 2 managers from pulmonary ward, hospital 2 doctors from hospital 1 GP 3 representatives from administration at the municipality 6 representatives from firms 5 researchers	1×4 hours	2×4 hours

The healthcare professionals, researchers and firms expressed a vision of being able to empower the COPD patients in managing their own disease so that the COPD patients could avoid readmissions. The healthcare professionals wanted to be able to use each other's competence across sectors for the benefit of the patients, to share data and to give the patients more responsibility and quality of life by having them carry out rehabilitation activities in their own homes; this would improve their physical and mental condition. In the process of developing the concept of tele-rehabilitation through the workshops, the following themes emerged:

- *Responsibility between COPD patients and healthcare professionals:* How much responsibility can we give the patients? Who has the responsibility to act if the measured values fall outside the acceptable range?
- *Time period for the tele-rehabilitation:* How long time do the patients have to measure values in order to learn about their own symptoms?
- *Sharing data between COPD patients and healthcare professionals:* How often do the patients' have to measure their values?
- *Knowledge-sharing between healthcare professionals:* How can we use each other's knowledge? How can we use the technology to access data on the patients?
- *Who will pay for the tele-rehabilitation program?*

The Telekat tele-rehabilitation program

The program consisted of the following operations:

A telehealth monitor box is installed in the patient's home. Using wireless technology, the telehealth monitor can collect and transmit data about the patient's blood pressure, pulse, weight, oxygen level, lung function, etc. via the Internet network, transmitting the data to a web-based portal or directly into the patient's electronic health care record. Healthcare professionals, such as district nurses, GP, nurses, doctors and physiotherapists at the health care centre or hospital, can assess the patient's data, monitor the patient's disease and training inputs and provide advice to the patient. The patients and relatives can also view the data on the web portal, and they can also decide with whom they want to share their data (see [Figure 1](#)). The patient has the equipment placed in the home for four months. The patient receives an individual training program by a physiotherapist and may carry out home-based exercises. A tele-rehabilitation team consisting of health care professionals from primary and secondary care meet virtually to coordinate and discuss the individual rehabilitation programme for the COPD patients.

Theoretical framework

A combination of theories based on network and innovation constitutes the conceptual framework for this study. Classic organizational theories tend to overlook

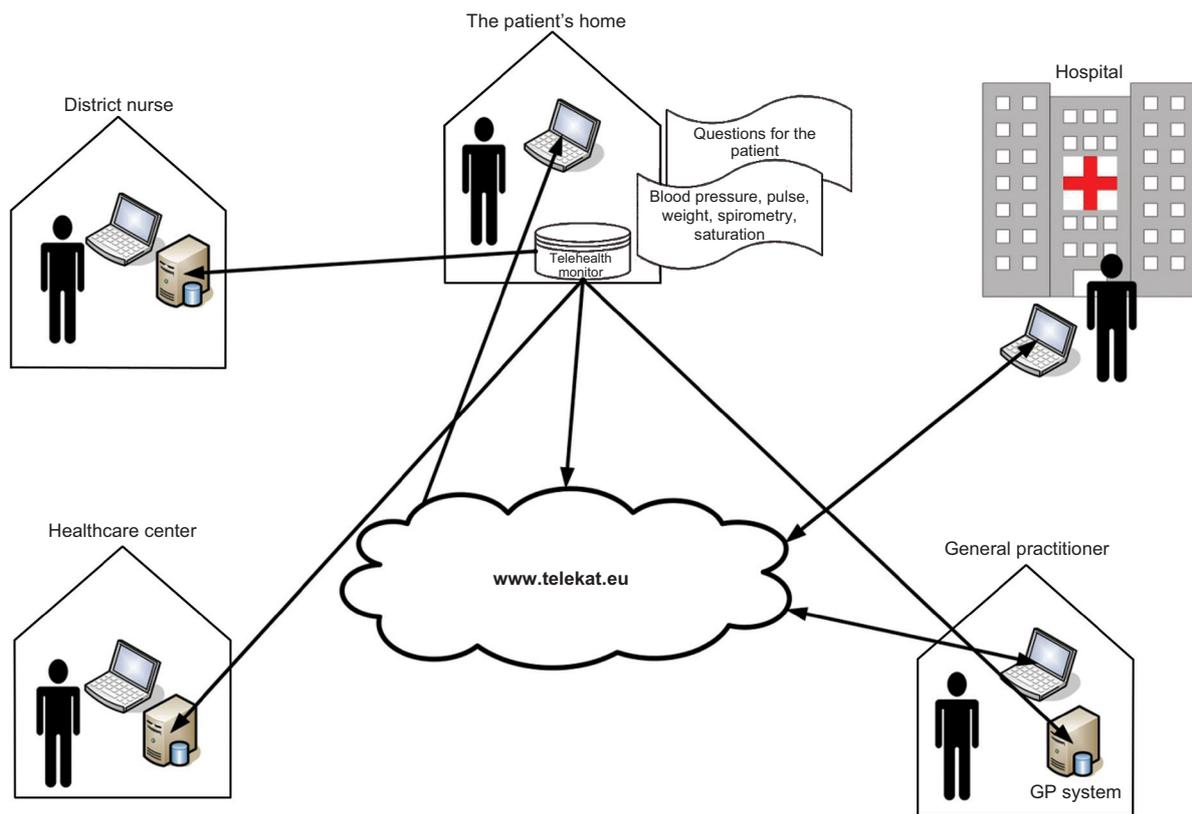


Figure 1. The Tele-rehabilitation program

network issues, paying attention only to the parties carrying out their respective share of the combined processes and tasks. Network theory opens up the boundaries of the organizations and helps explain network dynamics and processes. Theories of innovation in networks can elucidate the dynamics, interactions and creative process that take place between parties when developing new services and concepts.

A network is defined as: “the basic social form that permits inter-organizational interactions of exchange, converted action, and joint production. Networks are unbounded or bounded clusters of organizations that, by definition, are non-hierarchical collectives of legally separate units” [17, p. 46]. The network literature reveals different models of networks [18, 19]. The Telekat network can be characterized as systemic. It contains different parties with unequal capabilities working together in a value chain in an inter-organizational field to solve a joint task, for example, tele-rehabilitation of COPD patients. Any network consists of five elements: parties, processes, vision, and architecture and culture. The parties are the resources of the network. A crucial element in relations between the network parties is trust. Network processes are centered on exchange of coordination, information and

joint problem-solving between the organizations. A vision for the network is a joint vision, in this case, the effective tele-rehabilitation of COPD patients. The network architecture shapes the structural framework for collaboration. Formal and informal culture in the network constitutes the norms and values for interaction between the parties. Competencies in the network are attached to the parties’ ‘home’ organizations, such as the mental models and attitudes of the parties or their knowledge and skills.

The innovation literature distinguishes between incremental and radical innovations. Incremental innovation consists of small steps whereby services or workflows are improved [20]. In contrast, a radical innovation is a new idea that is being implemented. Creating co-innovation between multi-organizational networks involves two types of change: creating an initial network and managing change within an established network. Change processes in networks are complex and not well understood in the literature [21]. Building a new network entails establishing new relations between parties, building new roles, establishing a new vision in the system, etc. Changing an existing network must account for relationships between organizations within the whole system. The multiple and complex relation-

ships in a ‘fusion of networks’ produces emergent phenomena which are difficult to explain just by knowing the parties. Hence, it is difficult to predict how the networks will react over time [21].

In the Telekat project, we have focused on creating radical process innovation in a co-innovation process. The co-innovators are network parties: the COPD patients, relatives, public and private organizations. The literature distinguishes according to their level of analysis within co-innovation [21, 22, p. 3–4]. There can be co-innovation (1) between departments within a firm, (2) between firms in a horizontal and vertical dimension, including public and private organizations, and (3) at a meso- and macro-level, where the co-innovation is a co-evolving process between technical and institutional innovations in a long-term perspective. This article focuses on the second type of co-innovation, the horizontal and vertical dimension. In this type, there are multiple levels of interaction involving a network of users, public and private organizations.

The ambition is to create a radical innovation in the Telekat project that includes robust changes of actors’ perceptions and changes in the existing network composition. These changes involve actors, their positions and access rules [23, p. 226]. In the case of new initiatives, such as tele-rehabilitation in a new network domain, uncertainty can hinder collaboration and interaction due to uncertainty about boundaries of each other’s domains or fear for losing one’s own domain. A formalizing of competencies and domains of actors in rules can bring certainty, and they can design new domain agreements on issues, such as responsibility [22, p. 212–32]. In this perspective, it is essential to identify the obstacles in a co-innovation process.

Methods

Case study

The case study method [24] was chosen as the overall research strategy for this study. The case study was used to elucidate the co-innovation process of an integrated program for tele-rehabilitation of COPD patients in the operational context. The case study approach makes it possible *at present* to study the obstacles that emerge in the co-innovation process. The study included an ongoing process analysis during the design and clinical testing phases of the program of tele-rehabilitation. The theoretical framework informing the process analysis was based on network and innovation theory as a means of understanding the factors that facilitate or impede the co-innovation process.

Action research

Action research can be defined as an umbrella for research based on values where knowledge contributes to collective actions that change existing situations and mindsets. Action research can be defined as research that contributes to empowerment of processes [25]. Doing action research means going beyond the traditional expert role and seeing oneself as a co-creator of democratic and change-oriented knowledge in cooperation with the other parties.

The aim of the Telekat project was to facilitate the co-innovative process of development of an integrative program of rehabilitation of COPD patients across sectors using tele-rehabilitation technology. Many parties with different interests participated in the process, and in order to identify the obstacles and facilitate user dialogue, action research was carried out. Interventions were carried out when discussions reached a deadlock or became too personal. To avoid bias in the use of action research, discussions [26] were carried out with research colleagues and field notes written prior to the intervention being carried out.

Data collection techniques

A triangulation of data collection techniques has been used in order to provide multiple sources of evidence [24] in the case study. The sources are documents, participant observation and qualitative interviews.

Documents

In order to obtain a basic knowledge about the context of the case, different documents such as public reports, rehabilitation plans, minutes from meeting and home-pages were studied in the initial phase. Documents related to the project, such as minutes from meetings in working groups and workshops, were studied from phases I and II.

Qualitative interviews

Qualitative interviews [27] were conducted in order to identify the motivations of participants and the perceived obstacles they faced within the activity of the Telekat network. The respondents were selected for interviews came from the following groups involved in the network:

- Representatives from district nursing, hospital, healthcare center, GP and firms;
- Managerial staff from the pulmonary medical ward at the hospital, district nursing and healthcare center;
- Principal participants from the IT- and administration in the municipality and region.

Table 2 provides a description of the interviewed respondents in phases I and II. A total of 32 interviews were conducted.

All respondents gave their oral consent to participate in the interviews. The interviews were conducted as semi-structured interviews lasting 1–1.5 hours. The interviews were recorded and transcribed. Transcriptions of all interviews were carried out by one person. The same two researchers conducted all interviews.

Focus group interviews

By the end of the co-innovation process in phases I and II, focus group interviews had been carried out with the user panel. The aim of the focus group interviews was to validate observations and issues from interviews. The respondents in the focus group interviews gave their oral consent to participate in the interviews. Patients in the user panel gave their written consent to participate in the interviews. The focus group interviews were conducted as semi-structured interviews and lasted 1.5 hours. The interviews were recorded and transcribed. Transcriptions of all interviews were carried out by one person. The same researchers conducted all focus group interviews.

Participatory observations

Through the innovation process in phases I and II, participatory observations [28, 29] were carried out. The aim of the observations was three-fold. First, we sought to observe interactions and discussions among the participants while developing the program of tele-rehabilitation across sectors. Second, we wanted to pose questions about observed obstacles in order to obtain an understanding of participants' motivations in the project. The observations were conducted at

meetings in working groups, workshops and in the network laboratory, all of which were forums where participants took part in the co-innovation process. Third, we sought to observe how the concept of tele-rehabilitation was tested in clinical practice. These observations took place while accompanying nurses and doctors at work in the hospital, in patients' homes and at the healthcare center. Observation checklists were used and field notes were taken. Three researchers carried out the observations, and a total of 123 hours were used for observations during phases I and II.

Data analysis methods

All the transcribed interviews were coded with Nvivo 8.0 software and analyzed using methods inspired by Kvale and Brinkmann (2009). The data were analyzed using a combination of deductive and inductive strategies. The code tree was formed on the basis of central definitions and concepts (in vitro nodes) from the theoretical framework and from interviews (in vivo nodes). When formulating the concepts from the respondents, 10 qualitative interviews were studied and coded on the basis of a first-off impression. These interviews introduced two district nurses, one nurse from the healthcare center, one GP, one hospital doctor and nurse, one hospital manager, one manager of district nursing and one employee and manager from two firms. The next step was a rough coding, followed by more refined coding following a review of the coded material and adjustments. This step sought to identify topics and patterns, and the interpretation was widened to include a framework of understanding beyond the respondents. This phase included an in-depth interpretation held up against common-sense understanding. In this phase, the interviews were analyzed with a view to inferring motivations and underlying perceptions. The process was carried out in dialog with research colleagues.

There are certain sources of bias in the application of a computer program for data analysis. First, computer coding entails a decontextualisation of the data. Second, the software has been developed on the basis of grounded theory—an inductive approach—and in the Telekat project, a combined code strategy is deployed. Third, the application of the software gives the researcher a 'feeling of being distant' from the data. Throughout the project, all data collected through phases I and II were validated in collaboration with research colleagues, an ongoing dialog with healthcare professionals and through the triangulation of data sources.

Limitations of the research design

In relation to conducting a case study, one of the recurring discussions concerns its generalizability. In order

Table 2. Survey of interviewed respondents in phases I and II

Respondents	Numbers of interviews carried out
District nurses	4
Manager of district nursing	4
Nurses at hospital (from pulmonary medical outpatient clinic)	2
Doctor at the hospital (from the pulmonary medical ward)	1
Manager at the pulmonary medical ward (head nurse and consultant)	2
Nurses at the healthcare center	2
Manager of the healthcare center	1
General practitioners	3
IT and administration, municipality	3
Employees from firms	2
Managers from firms	3
College	2
Chronic Unity Region	1
Focus group with user panel	2
Total number of interviews performed	32

to optimize generalization of case studies, the case study literature [24, 30] tends to recommend strategic case selection or analytical generalization. Here we can simply point out that in the Telekat project, analytical generalization has been applied by using a theoretical framework. A triangulation of data collection and analysis supports the process of analytical generalization. In this way, obstacles in the co-innovation process can be singled out. The researchers' involvement in the case study makes it important to distance ourselves in the integration of data in relation to theory in order to prevent the process from becoming theoretically tautological.

Ethical approval

Ethical approval was obtained from the local Ethics Committees (August 27, 2008/N-20080049). The study was performed according to the Declaration of Helsinki. The project was reported to the Danish Data Protection Agency (August 7, 2008).

Findings

Table 3 presents a thematic listing of the obstacles identified in the co-innovation process.

1. Network context

1.1 Management of healthcare accords

The healthcare professionals have work routines that require them to organize their working plans six weeks in advance. This means that meetings and workshops in the innovation process had to be planned at least two months in advance in order to respect the daily work routines. A nurse at the hospital stated: "It gives us discontinuity in the creative process, and if we get some new ideas and want an extra meeting, we have to wait until the next working schedule has been planned".

Table 3. Identified obstacles in the co-innovation process

Type of obstacles	Example
Network context	<ul style="list-style-type: none"> • Management of accords • Lack of learning culture
The mindset of the healthcare professionals	<ul style="list-style-type: none"> • Accepting shared responsibility between healthcare professionals and patients • To think 'out of the box'
Inter-professional relations	<ul style="list-style-type: none"> • Viewing patients as co-innovators • Specialist versus generalist
Technology as a tool	<ul style="list-style-type: none"> • Working proactively with technology • Technology creates information overload
Competing visions	<ul style="list-style-type: none"> • Business versus healthcare visions

1.2 Lack of learning culture

Management and employees within district nursing and healthcare center state that they do not have time or take the time for reflections and joint discussions about the innovation process. As a district nurse explained: "If I had discussed the ideas from workshops about the concepts of tele-rehabilitation with my colleagues, I probably would have brought more new aspects into the innovation process".

2. The mindset of the healthcare professionals

2.1 Concern about sharing responsibility between healthcare professionals and COPD patients

The healthcare professionals expressed concern about sharing responsibility between themselves and the COPD patients in how patients would react when their measured values were beyond acceptable range. Observations showed that the professionals raised questions, such as: "Will the patients expect us to follow the measured values all the time?" "Will the patients be able to react on time if the values are out of range?"

In order to learn more about this problem, action research was carried out with the goal of having the healthcare professionals reflect on how responsibility for patients' condition could be most effectively shared between professionals and patients.

2.2 To think 'out of the box'

During interviews, the clinicians expressed the view that is difficult to work in a creative mode and think utopia. They expressed the view that they were not used to working creatively in interdisciplinary groups across sectors for the purpose of developing a joint concept for tele-rehabilitation.

In order to facilitate a creative innovative process, action research was used in order empower the healthcare professionals to generate new ideas.

2.3 Viewing patients as co-innovators

In the interviews, healthcare professionals stated that they found it difficult to collaborate with the COPD patients in order to innovate a new concept for tele-rehabilitation. The healthcare professionals saw themselves as the experts on the COPD patients' needs.

Observations from workshops showed that the healthcare professionals responded with reservations when confronted with the ideas from patients compared to ideas from firms, researchers or healthcare professionals. A GP stated "How does COPD patients know what their tele-rehabilitation needs are".

3. Inter-professional relations

3.1 Specialist versus generalist

Nurses at the hospital and healthcare expressed doubt that the district nurses had the necessary competence to counsel COPD patients on rehabilitation. A hospital nurse stated: “How can a district nurse have the knowledge to guide a patient on rehabilitation activities—they are generalists in homecare”.

Action research was carried out in order to stimulate the group of healthcare professionals to reflect on what level of knowledge was necessary in order to guide a COPD patient during tele-rehabilitation.

4. Technology as a tool

4.1 Using technology to work preventive

All groups of healthcare professionals expressed the view that they found it difficult to combine preventive rehabilitation with technology. They raised questions, such as: “What can we use all the measured values for? “Will the COPD patients become more worried about their illness?” “How will the patients’ quality of life be affected by measuring the values?”

Action research was conducted among the healthcare professionals in order to create joint reflections on how the measured values could become an issue for counseling the COPD patients in their rehabilitation activities in their everyday lives, e.g., for monitoring the development of their symptoms.

4.2 Technology creates information overload

The GPs were concerned that the tele-rehabilitation equipment would cause an information overload in GPs electronic patient record. The GPs asked, “What happens if we do not pay attention to measurements that are out of range?” Can you design some intelligent software to help us with decision-making?

Observations showed that the GPs were worried about potential information overload in the patients’ records. However, the firms insured the GP that they could insert ‘intelligence’ in the software so that the GP would not have to fear a situation where they neglected to see a key danger signal in the measurements.

5. Competing visions

5.1 Business versus healthcare visions

The firms have visions for product and concept development due to the firms’ market strategies. They place priority on developing software and hardware that can sell on a national and international market, independent of the specific organizations of healthcare systems in other regions or countries. A representative of one firm

explained: “We have to create concepts that fit both the national and international market on telehealth”.

Discussion

We have explored and identified obstacles that needed to be overcome in the initial phases of a co-innovation process. In the network context, work contracts are an inherent obstacle that can conflict with the planning innovation process in the public sector. These work responsibility conflicts can be overcome if management is flexible and has the possibility (resources) to integrate the creative activities with the daily work. Lack of learning culture (knowledge sharing between colleagues) in the organizations can be a major obstacle to overcome in order to insure a culture and readiness for attending innovations processes.

Catalyzing the mindset of the healthcare professionals for thinking ‘out of the box’ and recognizing patients as co-innovators, action research was carried out to empower the healthcare professionals and the patients. The innovation process was designed so that the patients’ ideas became a direct part of the process. The intent was to eliminate aberrations in the process of developing the program for tele-rehabilitation at the expense of the healthcare professionals’ authority. We cannot identify studies that have focused on this issue, and further research is needed.

An issue that reached a deadlock was how to share responsibility between healthcare professionals and COPD patients in facilitating tele-rehabilitation. We observed that the healthcare professionals exhibited varying perspectives on COPD rehabilitation and how to share responsibility. In order to facilitate this dilemma, action research was carried out so as to create collective reflection in the sense-making process. This step was important, as the intervention served as a springboard for a joint understanding and concept to be tried out in clinical practice. Weick et al. (2005) state that the process of sense-making unfolds as a sequence in which people are concerned with identity in a social context and are engaged in ongoing circumstances from which they extract cues and make sense retrospectively and still enact in the ongoing process [31].

Creating co-innovation between multi-organizations and professionals is complex (see theoretical framework), and discussion of knowledge-sharing between specialists versus generalists occurred as an obstacle. This issue is seen in a similar study of developing a telehomecare solution in an inter-organizational field [13].

Using action research as an approach to overcome the obstacle as ‘the active use of technology as a

tool' in clinical practice for new concepts, new ways of interactions with patients is seen in more studies. Action research can help participants in an innovation process to see the potentials of the technology, create utopia and provide a better adoption of the technology in clinical practice [32].

In the innovation alliance—the Telekat network—a competing vision of business versus a healthcare vision was an obstacle that was inherent due to different mandates, goals, tasks, competences and cultures among the parties. Action research was carried out in order to encourage the parties to see beyond their own immediate mandates and professional concepts. Lundin et al. (2008) confirm that doing action research in a network context raises issues, such as the local versus the global aspect; in our study, this was relevant to the national market versus the international market [33].

Action research is subject to constant debate concerning difficulties of generalization due to the role of the intervening researcher [30]. In order to deal with this critique, we have documented our observations and interventions as field notes, carried out a collective reflection in the process of problem identification, data gathering, and joint diagnosis of the problem before action taking in the Telekat network. Through we have experienced some difficulties in carrying out action research, such as avoiding 'lecturing' the employees in dialogues, and avoiding conflicts of power between management and employees. We regard action research as an important tool for facilitating the co-innovation processes in a network containing multiple organizations and new technologies. Action research was used to facilitate interlocking interactions in the innovation process or to raise questions in the discussions that reached a deadlock. Researchers in a Swedish study argue that an action researcher creates new relationships, actor conceptions and becomes an active creator of the discourse, thus shaping the collaboration in an inter organizational network [34]. Further research is needed in order to gain more knowledge of the obstacles to the co-innovation process.

The project seems to have overcome the initial obstacles and reached the point of co-innovation. The tele-rehabilitation program is now being tested in clinical practice and seems to show promising results in helping patients to avoid readmission, fragmentation and the potential discontinuities related to distance treatment of COPD patients [35]. Bonney et al. (2007) con-

firm that co-innovation in a network is possible when the parties create shared vision, consistent structures and processes, opportunities for mutual benefits and co-operation. A successful tele-rehabilitation program both relies on, and can generate, relations of trust and commitment [36].

Conclusion

We have identified obstacles that emerge in the co-innovation process when developing a program for tele-rehabilitation of COPD patients in an inter-organizational context. Obstacles are identified in the network context; the mindset of the healthcare professionals; inter-professionals relations; seeing technology as a tool and, finally, in competing visions. Action research has been carried out and can have had a mediating role in helping the co-innovation process to succeed.

Acknowledgements

We wish to thank the COPD patients and relatives participating in the project as well as clinical and industrial partners (for details, see www.Telekat.eu). The Telekat project is funded by the Program for User-driven Innovation, the Danish Enterprise and Construction Authority, Center for Healthcare Technology, Aalborg University, and by various clinical and industrial partners in Denmark. We also wish to thank Claus Ugilt Oestergaard for reviewing the manuscript. Finally, we would like to thank the reviewers for their inspiring comments.

Reviewers

Jorgen Bansler, PhD, Associate Professor, Technical University of Denmark, Centrifugevej, Building 371, Room 228, Informatics and Mathematical Modelling, 2800 Lyngby, Denmark

Erling Havn, PhD, Associate Professor, DTU Management, Department of Planning, Innovation and Leadership, Technology, Organization and Work, Technical University of Denmark, Produktionstorvet, Bygning 425, Room 121, 2800 Kgs. Lyngby, Denmark

Stephen Abbott, PhD, Research Fellow, School of Community and Health Sciences, 20 Bartholomew Close, London EC1A 7QN, UK

References

1. Omachonu VK, Einspruch NG. Innovation in healthcare delivery systems: A conceptual framework. *The Innovation Journal: The Public Sector Innovation Journal* 2010;15(1):Article 2.

2. Danish Enterprise and Construction Authority. Copenhagen: the programme for user driven Innovation 2007–2010 [cited 2011 March 10]. Available from: <http://www.ebst.dk/brugerdreveninnovation.dk/about>.
3. World Health Organization. Chronic obstructive pulmonary disease (COPD). Fact sheet No 315; 2009 Nov. [cited 2011 March 10]. Available from: <http://www.who.int/mediacentre/factsheets/fs315/en/>.
4. Garcia-Aymerich J, Ferrero E, Felez MA, Izquierdo J, Marrades RM, Anto JM. Risk factors of readmissions to hospital for a COPD exacerbation: a prospective study. *Thorax* 2003 February;58(2):100–5.
5. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease (Updated 2009). Global Strategy for Diagnosis, Management, and Prevention of COPD; 2009 [cited 2011 March 10]. Available from: <http://www.goldcopd.com/Guidelineitem.asp?l1=2&l2=1&intId=2003>.
6. Niesink A, Trappenburg JCA, Weert-van Oene GH, Lammers JWJ, Verheij TJM, Schrijvers AJP. Systematic review of the effects of chronic disease management on quality-of-life in people with chronic obstructive pulmonary disease. *Respiratory Medicine* 2007 November;101(11):2233–9.
7. Lemmens KMM, Nieboer AP, Huijsman R. A systematic review of integrated care use of disease management interventions in asthma and COPD. *Respiratory Medicine* 2009;103:670–91.
8. Peytremann-Bridevaux I, Staeger P, Brideaux PO, Ghali WA, Burnand B. Effectiveness of chronic obstructive pulmonary disease-management programs: systematic review and meta analysis. *The American Journal of Medicine* 2008;121(5):433–43.
9. Paré G, Jaana M, Sicotte C. Systematic review of home telemonitoring for chronic diseases: The evidence base. *Journal of the American Medical Informatics Association* 2007;14(3):269–77.
10. Dinesen B. Implementation of telehomecare technology—impact on chronically ill patients, healthcare professionals and the healthcare system. Aalborg: Aalborg University; 2007. PhD thesis.
11. Phillips W, Johnsen T, Caldwell N, Lewis MA. Investigating innovation in complex health care supply networks: an initial conceptual framework. *Health Services Management Research* 2006;19(3):197–219.
12. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O. Diffusion of innovations in service organizations: systematic review and recommendations. *The Milbank Quarterly* 2004;82(4):581–629.
13. Dinesen B, Gustafsson J, Nørh C, Andersen SK, Sejersén HM, Toft E. Telehomecare technology across sectors: claims of jurisdiction and emerging controversies. *The International Journal of Integrated Care* [serial online] 2007 Nov 21;7 [cited 2011 March 10]. Available from: <http://www.ijic.org>. URN:NBN:NL:UI:10-1-100459.
14. Länsisalmi H, Kivimäki M, Aalto P, Ruoranen R. Innovation in healthcare: a systematic review of recent research. *Nursing Science Quarterly* 2006;19(1):66–72.
15. Mandell MP, Steelman TA. Understanding what can be accomplished through interorganizational innovations. *Public Management Review* 2003;5(2):197–224.
16. Hoppel von E. Democratizing innovation. Cambridge: MIT Press; 2005.
17. Alter C, Hage J. Organizations working together. Newbury Park, California: Sage Publications; 1993.
18. Gustafsson J. Ledarskap i interorganisatoriska nätverk för folkhälsa och välfärd [Management in an interorganisational network for public health and welfare]. In: Axelsson R, Axelsson SB, editors. *Folkhälsa i samverkan mellan professioner och samhällssektorer*. [Public health in inter-professional relations and social sectors]. Pozkal (Poland): Student litteratur; 2007. p. 61–86. [In Swedish].
19. Kickerts WJM, Klijn EH, Koppenjan JFM. Managing complex networks. London: Sage Publications Ltd; 1997.
20. Tidd B, Bessant J. Managing innovation: integrating technological, market and organizational change. West Sussex: John Wiley & Sons Ltd; 2009. p. 3–96.
21. Strogatz S. Exploring complex networks. *Nature* 2001;410:268–78.
22. Royer A, Bijman J. Co-innovation, quality and institutions: A CoQA programme concepts exploration. CoQA Working Paper no. 2009-01, p. 1–14. [cited 2011 March 11]. Available from: <http://coqa.nl/documents>.
23. Koppenjan J, Klijn EH. Managing uncertainties in networks. New York: Routledge; 2006. p. 212–32.
24. Yin R. Case study research design and methods. London: Sage Publications Inc; 2009.
25. Kemis S. Critical theory and participatory actions research. In: Reason P, Bradbury H, editors: *Handbook of action research participative inquiry and practice*. London: Sage Publications; 2008. p. 21–138.
26. McNiff J, Whitehead J. Doing and writing action research. London: Sage Publications Inc; 2009.
27. Kvale S, Brinkmann S. Interviews: learning the craft of qualitative research interviewing [second edition]. Los Angeles: Sage; 2009. p. 97–218.
28. Delamont S. Ethnography and participant observation. In: Seale C, Gobo G, Gubrium JF, Silverman, editors. *Qualitative research practice*. London: Sage Publications; 2007. p. 205–17.
29. Kristiansen S, Krogstrup HK. Deltagende observation: introduktion til en forsknings metodik. [Participant observation: Introduction to research methodic]. Copenhagen: Hans Reitzels Forlag; 2004. [in Danish].
30. Flyvberg B. Five misunderstandings about case-study research. In: Seale C, Gobo G, Gubrium JF, Silverman D, editors. *Qualitative Research Practice*. London, England: Sage Publications; 2007. p. 390–404.
31. Weick KE, Sutcliffe KM, Obstfeld D. Organizing and the process of sense making. *Organization Science* 2005;16(4):409–21.
32. Hansen S, Robertson T, Wilson L, Hall R. Using an action research approach to design a telemedicine system for critical care: A reflection. Brisbane, Australia: OZCHI proceedings Cairns, QLD; 2008. p. 255–8.

33. Lundin J, Svensson L, Pareto L, Snis UL. Coping with dualities in network action research: methodological issues. *Information Technology and People* 2008;14(1):46–59.
34. Huzzard T, Ahlberg BM, Ekman M. Constructing interorganizational collaboration: The action researcher as boundary subject. England: Proceeding of the 5th Critical Management Studies Conference, Manchester Business School; 11–3 July 2007.
35. Dinesen B, Ege BM, Nielsen C, Grann O, Toff E, Hejlesen OK, et al. Tele-rehabilitation of COPD patients across sectors. In: Jordanova M, Lievens F, editors. *International Society for telemedicine and ehealth. Luxembourg: Proceedings of the Global Telemedicine and eHealth Updates, Knowledge Resources*; 2010 Apr 14–16. p.198–202.
36. Bonney L, Clark R, Collins R, Fearn A. From serendipity to sustainable competitive advantage: Insights from Houston's farm and their journey of co-innovation. *Supply Chain Management: An International Journal* 2007;12(6):395–9.