Innovative Simulation of Health Care Services in the Usability Laboratory

Experiences from the Model for Telecare Alarm Services-project

Berglind Smaradottir[1], Santiago Martinez[2], Elin Thygesen[2], Elisabeth Holen-Rabbersvik[2], Torunn Vatnøy[2] and Rune Fensli[1]

[1]Department of Information and Communication Technology, University of Agder, Grimstad, Norway
berglind.smaradottir@uia.no

[2]Department of Health and Nursing Science, University of Agder, Grimstad, Norway

Abstract

In Norway, a recent health reform urged municipalities to prepare for telecare alarm services to handle alarms associated to welfare technology and telecare technology in citizens' homes. That requires a re-organisation of health and social services in many municipalities and several are preparing to establish new telecare alarm services operated in inter-municipal response centres. In this context, the research project "Model for Telecare Alarm Services" aims to study how existing telecare alarm services in Norwegian municipalities are organised and operated, and identify critical factors when designing new models for future services. This paper presents how an innovative simulation of health care services was used in the research project, when key informants from several municipalities, research partners and industry tested different models of telecare alarm services in a usability laboratory. The lessons learned by the research group showed that laboratory simulation was an efficient way of testing different scenarios of new telecare service models, together with key informants from heterogenous end-user groups.

Keywords

Clinical Simulation, Usability Laboratory, Telecare Alarm Services, Health Informatics.

1 INTRODUCTION

Telecare technology has the aim to facilitate and support communication between citizens at their homes and services of health care [1]. Demographic changes, with growing number of elderly people in society, make telecare technology a potential aid to respond to this challenge addressing interdisciplinary cooperation across health care services [2]. The goal is to meet the special needs of older people and their families with an integrated and comprehensive approach, facilitating self-dependent living in own home as long as possible [3][4]. In Norway, the Coordination reform was adopted in 2012 [5], with the aim to improve continuity of care, coordination and collaboration across the traditional health services. Services that were traditionally provided by hospitals and specialized health care services, were transferred to primary care services. Because of the reform, municipal health- and social care services are now responsible for a 24/7 service in emergency health care (in Norwegian Kommunal øyeblikkelig hjelp), including a dedicated phone line service (116117). With the municipal focus on facilitation of self-dependent living, there is an increasing number of telecare- and welfare technologies dedicated to citizens' home. Due to this development, many municipalities are exploring how to establish a service for the management of alarms. More than half of the Norwegian municipalities are categorised as small size (less than 5000 inhabitants), making it challenging allocating resources to run a 24/7 service. To optimise resources, many small and medium sized municipalities have established inter-municipal cooperation (IMC) to provide new services, which in many cases requires re-organisation of the health and care services.

In this context, the research project Model for Telecare Alarm Services aimed to evaluate and propose models for telecare alarm services in Norway. Two research institutions, 18 Norwegian municipalities together with a company were partners in the research project. The project lasted three years, from (2015 until 2017), with the purpose of studying the management and operation of existing telecare alarm services in Norwegian municipalities. Workshops were organised early in the project including health care professionals, administrators and operators from existing telecare alarm service with focus on challenges in the existing services. The workshops identified user needs and critical factors that are important to take into account when proposing and designing new models for the telecare services of the future [6][7][8][9]. In a later project phase, the industrial partner (Imatis) developed a prototype solution consisting of a smartphone application and an information system for management of a telecare alarms. During the process

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of technology development, three clinical simulations together with project participants were performed in a usability laboratory. The scenarios simulated a home-based alarm and tested how the new technology could be integrated in different models for handling alarms by operators of telecare alarm services and municipal health care services.

Based on the conducted simulations in the usability laboratory, the research team reflected on lessons learned from the procedures. This paper reports the simulation procedures that were used in the Model for Telecare Alarm Service project. The following three research questions (RQs) were addressed:

RQ1: *What steps are relevant in the simulation of health care services for new telecare alarm service models in Norwegian municipalities?*

RQ2: *What procedures can facilitate the active contribution of end-user groups in health care service simulations?*

RQ3: *What methodological approaches and lessons were learned from the laboratory simulation procedures that can be applicable in other contexts?*

Following this introduction, an overview of related research is presented. In the consecutive section, the method and materials are explained, followed by descriptions of the laboratory simulation procedures. Later, the discussion reflects on lessons learned from carrying out the simulations during the project. Finally, the last section includes the conclusions and future work.

2 BACKGROUND

Laboratory simulation of new health care service models refers to testing of scenarios, workflows and technology in a simulated clinical environment [10]. Such simulation in real clinical environments is usually unsuitable for legal, ethical and privacy reasons [11]. In a laboratory setup for clinical simulation, participants are asked to perform a role-based scenario while being observed and/or recorded, commonly used in nursing education to allow students to learn and apply theoretical principles of nursing care in a safe environment [12][13]. This kind of simulations can be combined with a think aloud protocol [14] were the students are instructed to verbalise thoughts while completing tasks [15]. In the context of the development of health information technology, clinical simulation with end-users has the potential of providing an insight about how technology and alternative organisational models may impact on existing procedures and workflow in health care settings before final implementation and installation. Traditional usability testing is usually performed individually in a usability laboratory, often with a think aloud protocol with the aim of assessing the technology [16][17][18]. The approach of clinical simulation in the usability laboratory introduces the dynamics of clinical workflow, in addition to evaluating the technology. The combination of think aloud protocol and clinical simulation provides an assessment of how the technology and work processes would interact in a clinical environment, allowing evaluation and redesign to augment clinical utilisation [19][20].

3 MATERIALS AND METHODS

The simulations of health care services in the *Model for Telecare Alarm Services* project were carried out as a realistic clinical situation in a usability laboratory together with project partners and end-users of the technology, applying a think aloud protocol. The scenarios were based on information gathered from previous workshops during the same project.

3.1 Test Environment Settings

The simulations were executed in the usability laboratory of the Centre for eHealth at the University of Agder, Norway. The usability laboratory consisted of four rooms, where three of them were used for the simulation: patients home, the telecare alarm service/response centre alarm operator room and the municipal nursing services, all with camera sources. A fourth room was the observation room where the observers could follow the simulation simultaneously on screens. Between one of the test rooms and the observation room, there was a one-way mirror that allowed the observers to closely follow the process and the technology interaction. The technical infrastructure for simulation has been further described in the research project [21].

3.2 The Research Team

The research team involved in the clinical simulation was composed of five people, see Table 1 for the participation in the different project phases. They had background from health informatics and human-computer interaction, all with working experience in health and technological environments. In addition, two senior researchers participated from the industry partner and research institute partner.

Researchers N=7	Sim 1	Sim2	Sim 3
Project leader and Professor	x	x	x
Associate Professor 1	x	x	
Associate Professor 2	x	x	x
Associate Professor 3	x		
Assistant Professor			x
Senior Researcher 1	x	x	x
Senior Researcher 2	x	x	x

Table 1 Participants in the Research Team

3.3 Participants

The participants in the clinical simulations were from the 18 Norwegian municipalities that were partners in the research project. The end-user groups were: nurses, assistant nurses, administrators, technicians, leaders and representatives from end-users. Simulation 1 had 25 participants, simulation 2 had 20 participants and simulation 3 had 16 participants.

3.4 Material

For replicability and information purposes, the technical material used during the simulations is presented grouped by rooms.

Test room 1 Patient's home

- GPS geolocation device for triggering alarm
- Fixed camera
- Boundary microphone

Test room 2 Telecare alarm service

- Laptop and desktops for the telecare alarm system
- Smart board display
- Portable camera
- Boundary microphone

Test room 3 Municipal nursing services

- Smartphone with the telecare alarm service application activated (and a tablet device)
- Fixed camera
- Boundary microphone

Test room 4 Observation room

- Desktop
- 4 monitors

Remote controller for fixed cameras

3.5 Data Collection

The simulations were audio-visually recorded. The recordings from the cameras were merged into one single video file using the software Wirecast v.4.3.1 0. Having all the camera perspectives merged in one file facilitated the data analysis, having one file with multiple video perspectives and one single audio channel.

3.6 Ethical Considerations

The Norwegian Centre for Research Data (NSD) 0 approved this study with the project number 44494. All participants received oral and written information about the project and they signed a consent form. Their participation was voluntary and they could withdraw at any time without any reason

4 THE SIMULATION PROCEDURE

Three simulations of health care were run in April, September and November of 2016. In each simulation, there were different role-based scenarios, each with a description of a context and a concrete situation to be handled. The roles were: a) patient at home triggering a

Figure 1. A group of four observers in the observation room

telecare alarm function, b) telecare alarm service operator, c) municipal home nurse on duty using a mobile device, d) observer in the observation room following the interactions. Each role was assigned a group of 2-4 participants/actors, and participants were distributed across the four test rooms together with a moderator from the research team.

In all the three simulations, the patient triggered an alarm at home that was sent as an electronic message with information to a receiver. Different models for receiving and handling alarms were tested with both a local telecare alarm service and regional response centre. In addition, automated routing with notification to municipal home nursing services was tested. Upon an alarm, a two-way voice or a video-voice channel was established with the patient. All sharing of information between telecare alarm service and home nurse was made electronically. The information flow and the interactions required between the participants' roles were specially taken into account for further analysis. Three test rooms were used simultaneously, with interactions through technology between the rooms, observed by a group in the observation room, see Figure 1.

4.1 Simulation 1

In the simulation 1, a prototype version of the telecare alarm service information system and the corresponding app were used, based on low-fidelity software such as mock-ups of an early prototype, that described predefined steps in the scenario, see Figure 2. During the scenario, the screen/UI was changed by instructions from the moderators, who used a chat-channel in order to synchronise the roleplay screenshots for each actor.

The context was a patient in the test room *Patient's home* fell on the floor, triggering an alarm with the GPS geolocation device. Three scenarios representing different models for handling the alarm were tested.

In the scenario 1, the alarm was registered at the *Municipal nursing services,* where the nurse on duty accepted the alarm and visited the patient's home. The patient's family was contacted to follow-up the situation.

In the scenario 2, the triggered alarm had automatic notification directly to the *Telecare alarm service* which was assumed to be co-located with emergency primary

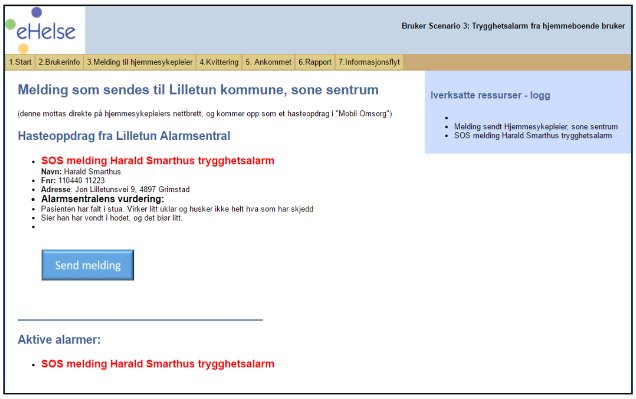

Figure 2. A screen shot from the prototype in simulation 1 (in Norwegian)

health care (in Norwegian *Kommunal øyeblikkelig hjelp* and *Legevakt*) with a responsible doctor on duty.

The operator established a voice contact with the patient and electronically sent an alarm message to the tablet device of the nurse in *Municipal nursing services.* The home nurse accepted the call out electronically and travelled to the patient's home, while the operator kept the contact with the patient. During the contact, the operator conferred with the doctor at duty that there was a need for assistance by an ambulance, which was also called out electronically, and updated notifications were sent to the home-nurse. At arrival, the home-nurse sent a message electronically to telecare alarm service by pressing the *Arrived* button in the tablet UI. In the tablet, the home nurse could fill in necessary documentation to the electronic health record, and by pressing the *Mission completed* button a notification was sent to the telecare alarm operator.

In the scenario 3, a regional telecare alarm service received the triggered alarm. The patient was called up, the operator evaluated the situation and called out the home-nurse by electronically sending a message. The home nurse accepted the alarm on the tablet device and travelled to the patient's home. On the way, the home-nurse initiated a voice-call to the patient. The need of assistance from an ambulance was acknowledged, and the home-nurse sent a message to the ambulance station. As the telecare alarm operator was not involved in the actions taken, no updated information or notifications were sent to the operator.

Between the scenarios and at the end of the day, there was a group debrief together with all the participants and research team to summarise the actions and related interactions.

4.2 Simulation 2

During the simulation 2, the smartphone app and the information system for telecare alarm service had been further developed and had additional functionality. Three models for handling alarms were tested. In the scenario 1, the alarm from the patient's home was automatically notified directly to the municipal home nurse, to the nurse on duty that had patient registered on a task list or was

Figure 3. The home nursing service at the patient's home

geographically closest to the patient. A home visit followed, see Figure 3.

In the scenario 2, the telecare alarm service received the alarm and electronically called out home nurse services for home visit. In the last scenario, the telecare alarm service also received the alarm, but was organised in a model with an own local team to call out for home visits. At the end of the day, there was a group debrief to summarise the scenarios.

4.3 Simulation 3

In the simulation 3, the app was used in the smartphone device (see Figure 4), and the information system was shown on a large display in the telecare alarm service room. Two models for handling alarms were tested.

In the scenario 1, the alarm from the patient's home was received in the information system in the telecare alarm service. A two-way conversation was established with the patient and the home nurse was called out electronically through the system. The nurse received the call out from a message in the app. The nurse contacted a colleague via the app, and together they went to the patient's home, at arrival the *Arrived* button was activated in the app.

In the scenario 2, the alarm from the patient had automatic notification directly to the home nurse.

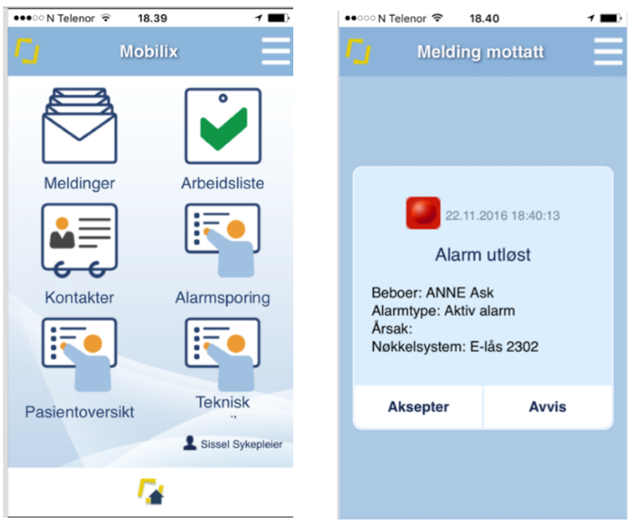

Figure 4. Screenshots from the smartphone app

The nurse had to touch the *Received Alarm* button, contact a colleague and establish a two-way communication with the patient during the travelling to the patient's home. At arrival, the *Arrived* button had to be touched.

Each scenario was repeated twice, and the participants changed groups between the scenarios, so each participant acted more than one role. Between the repetitions of the scenarios there was a group debrief, which was also held at the end of the day.

5 DISCUSSION

This paper has presented how to practically perform laboratory simulations of health care services, based on the experiences from the research project Model for Telecare Alarm Services. The lessons learned by the research team showed that this kind of simulation was an efficient way of testing different organisational models for telecare alarm services, together with key informants and end-user groups.

The three research questions (RQs) formulated at the beginning of this paper are answered below based on the results from the study.

About the RQ1, asking about which steps are relevant in a simulation. It is recommended to have a high level of realism in the context of a simulation [11][24]. Based on the experiences in the project, the initial workshops together with end-users provided an in-depth understanding of the context and important details to consider when preparing the simulations. Each day started with introduction to the technology and the scenarios, followed by signing of an informed consent form. The research team composed the groups, with a focus on the professions and experiences of the participants.

The RQ2 asked about what procedures can facilitate the active contribution of the end-user groups in simulations. As the focus was on actual work procedures and necessary information flow between the actors, the debrief session at the end of each scenario had an important role for the participants to discuss what had happened, in line with [18][25]. It was discussed how they had experienced the situation and whether anything in the workflow of corresponding information flow should have been changed to make the necessary functions more effectively or with improved quality. During the debrief, a process model of the workflow was presented and discussed, which gave all participants a good understanding of all details in the actual situation and the actions taken. Such visual representations are meaningful in workflow discussions, to show who did what and at what time, it became clear that the icons used should be standardised so the drawing can be used for documentation of workflow procedures and to make standardized treatment plans in the future.

About the RQ3 that asked about methodological procedures and lessons learned that are applicable in other contexts. The defined roles and with acting by the participants made the scenario realistic, also described in [20]. The group construction, with 2-4 participants assigned to each role, can be recommended as that added the element of dynamics to the simulations. In addition, the role in the observation room, allowed the participants to actively follow the simulation process and making notes, which contributed at a detailed level to the group debrief.

This paper on simulation had some limitations such as a reduced number of actual roles included in the defined scenarios, and a limited number of simulations (n=3). However, the study had a number of participants with different professions that meaningfully represented the end-user groups of telecare alarm services. The empirical research data from user workshops and simulations regarding workflow and functionality of telecare alarm technology under development were not in the scope of this paper, as the main focus was the methodological procedures for simulation of health care services.

6 CONCLUSION

This study was framed within the research project *Model for Telecare Alarm Services*, in order to provide experiences on how to practically perform laboratory simulation of new and innovative organisation of health care services. The main contribution of this study lies on the descriptions of the procedures for simulation, how to facilitate the active contribution of the end-user groups and methodological approaches transferable to other telecare and development projects in health care services. The results presented are congruent with other studies of simulation in laboratory environments [10][11][19] and showed the importance of involving the different end-user groups when simulating the interactions. The role-play was useful and informative, in line with [20], even though it caused a complexity that required a large test team. The dynamic character of the post-test group debriefs, inspired by 0[18], provided a platform for discussion for the participants and is recommended to other innovative simulation procedures. The usability laboratory provided a controlled environment, with audio-video recordings to retrospectively reflect the collected data. In terms of future work, a detailed analysis of the empirical data in the research project will be made for publication purposes.

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