Usability Evaluation of Electronic forms and Collaborative Assessment Report in an Inter-municipality Health Care team for Dementia Diagnose

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Abstract

Despite that paper-based medical procedures have historically been the most common way of registering and exchanging patient data, it does not avoid the potential risks of unauthenticated access, unregistered data loss, legibility and difficulty to share the data with third parties. The Coordination Reform 2009 (Samhandlingsreformen) has demanded from municipalities to implement health services for citizens based on electronic messaging that eases the access to and sharing of patient data. In the context of the Research project "Collaboration without borders" (Samhandling uten grenser), in this study electronic forms and collaborative assessment report by videoconference have been usability tested in order to evaluate the potential application of these electronic tools in an inter-municipality workflow of dementia assessment. The results showed that electronic forms helped to reduce the paper load of the process, allowing repeated access to the forms for retrospective amendments and reviews. The videoconference with document sharing was reported to be a very effective and satisfactory tool to cooperatively work on the final report of the assessment between the members of the dementia team.

Keywords: eHealth, dementia, health care team, health information technology, videoconference, collaboration

Introduction

The Norwegian Coordination Reform [1] demanded from municipality health care services to implement structural changes and facilitate the increasing use of ICT solutions to improve collaboration and coordination services. In addition, the Norwegian Association of Local and Regional Authorities (KS) [2] pointed out the need for effectively coordinated services that combine medical expertise with the experience from other sectors such as technology, research and innovation. In this context, the research project *Collaboration without borders* (*Samhandling uten grenser*), aimed to evaluate new opportunities for interaction and development of technological solutions that facilitates electronic sharing of information between the municipal care service professionals, users and relatives. One of the objectives of the project was to investigate whether the introduction of electronic communication through the establishment of inter-municipal professional teams required changes at an organizational level. Thus, the introduction of electronic communication presents inherent challenges for municipality health professionals who are used to work on paper-based procedures. The intrinsic benefits of the progressive transformation of physical documentation into digital documents that are electronically available have to be validated from a usability, operation and satisfaction perspective of the health professionals and patients involved.

This usability evaluation is preceded by a qualitative case study [3], which analysed work procedures and workflow regarding documentation practices in inter-organizational care teams in four small municipalities in Southern Norway. In that study, the workflow of a Dementia team was analysed (see Fig. 1) and revealed a need for improving communication processes, especially those paper-based, which lack of secure data storage and limited availability. The study specified user requirements and proposed the use of electronic tools that could support access and exchange of medical information of inter-municipality care teams.

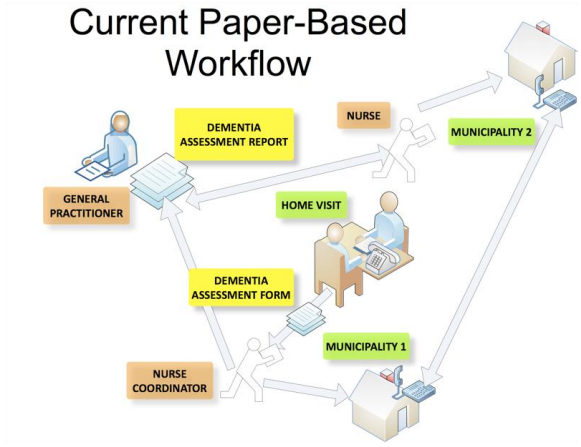

Figure 1- Scheme of the current paper-based workflow in the inter-municipality dementia team in Southern Norway

This paper presents the usability testing of two electronic communication tools, electronic dementia assessment forms and videoconference with shared document visualisation, to support the assessment of potential dementia patients, reduce the paper-based load and introduce digitally stored documents in their workflow. The research questions of this study were:

> *Does the replacement of paper-based dementia assessment evaluation forms by electronic versions impact on clinical practice and workflow in inter-municipality dementia teams?*
>
> *Does a collaborative tool such as videoconference with a shared visualisation document impact on the*

workflow of a dementia assessment report creation by the members of an inter-municipality dementia team?

Research Background

Underdiagnose of dementia has been demonstrated in research [4][5][6][7][8][9], with as few as 50% of dementia cases being diagnosed by physicians [10]. From there, the importance of early assessment and diagnose mechanisms that could improve the medical detection on patients, with evidence of increasing case finding [5][7][11][12]. However, negative attitude towards assessment and diagnose and, especially, added visit time, still represent barriers for physicians to efficiently diagnose cognitive impairment [4][10]. During their patient visit, physicians document and store the information related with dementia assessment and diagnose with a great variance in their methods: from personally written or dictated paper notes to templates with fill in boxes [13]. After the information collection, physicians have to work in collaboration with other staff members to summarise, evaluate and enter patient data from paper charts into final assessment reports [13]. Workflow improvements in the information gathering and/or the collaborative final assessment could produce tangible benefits such as productivity increase, reduced paper usage, time saved and quick completion time [14]. Usability improvements in any of these processes could also produce intangible benefits such as increased user satisfaction, e.g., on physician, ease of use and improved institutional image [14].

Materials and Methods

Method

The usability evaluation was carried out as a follow up of the research project *Collaboration without borders*. In the evaluation, end-users performed representative tasks related to dementia assessment. The test included two scenarios: 1) a visit to a patient's home to conduct a dementia assessment using electronic dementia assessment form replicating existing paper forms provided by the National Expertise Service for Ageing and Health (*Aldring og Helse Nasjonalt Kompetansesenter*) and Directorate of Health (*Helsedirektoratet*) [15]; 2) a collaborative writing of the dementia assessment report supported by videoconference with shared document visualisation. A post-evaluation group interview was conducted to qualitatively analyse the output of the test.

Test environment settings

The usability evaluation was run in the Centre for eHealth and Healthcare Technology of the University of Agder, Norway. The facilities were the Usability Laboratory and the Smarthouse. The Usability Laboratory had two rooms: the Test room and the Observation room, connected through one-way mirror (visualisation from the Observation room towards the Test room). The Smarthouse was a large room that simulated firstly a potential patient's home and secondly a municipality office. The test was run in two separated days in May 2014, Day 1 and Day 2.

Participant selection

Four people formed the Dementia team: one nurse coordinator and three nurses. They were one male and three female participants aged from 26 to 58, with a mean of 45 years. They had an average of 10.5 years of experience using clinical systems. All had experience using laptop, and using tablet and videoconference for working purposes.

The patient and patient's relative were healthy elderly people (average age of 79 years), who acted as patient and relative. The acting was merely figurative, meaning that their answers and behaviours were freely decided. The use of actors was based on the recommendations of usability evaluation in clinical settings where the tests were run as role-plays with multiple stakeholders as participants, e.g. physicians, nurses, and patients [16]. Their role was relevant for the simulation process because the Dementia team had somebody similarly aged to a real dementia patient to direct the questions to.

The Research Team

Four members, two with health professional background and two with health and ICT background formed the Research team. All had experience in working in health and technological environments with real patients.

Test procedure

The test plan for the usability evaluation was adapted to the workflow description of an inter-municipality dementia team in Southern Norway collected in a series of workshops in April and May 2013. The usability evaluation was run in three sessions. Each session started giving information to participants about the subsequent test and filling in a pre-test questionnaire (with questions about computer skills, experience with specific technological devices and videoconference systems). Each session followed the same test plan running on an average total duration of 120 minutes. A total of three sessions were run across two days, one session in Day 1 and two sessions in Day 2. For each session, two members of the Dementia team (the coordinator alternating one different nurse at a time) went through the two evaluation scenarios: patient's home dementia team visit and videoconference with shared dementia assessment report. A group interview was conducted at the end of each day as a part of the evaluation method of the two scenarios.

The sequence of the two scenarios, participants involved and the distribution of the rooms used are described in Table 1. Both scenarios were performed in each session of the test and audio-visually recorded in the Observation room. The nurse of the Dementia team was replaced across the sessions and the nurse coordinator participated in all of them. The three rooms were used in a realistic way, replicating the part of the dementia team workflow where they interacted with the patient, relative and technology (i.e., patient's home visit), and the final writing of the dementia assessment report with communication between long-distance municipality offices.

The Scenario 1 represented a home visit by the Dementia team to assess the potential dementia of a patient. The home visit was simulated in the Smarthouse as a dementia patient's home. Two elderly people played the roles, one as the dementia patient and the other as the patient's relative. During the home visit, the Dementia team represented by a nurse coordinator and a nurse alternatively used a laptop and a tablet to fill in the electronic version of the dementia assessment forms (see Materials section for more details on the specific forms).

The Dementia team had not used or seen the electronic version of the dementia assessment forms before.

Table 1 – Usability Testing Settings

Scenario	Task	Participants	Input Device	Room[1]
Dementia team visit to patient's home	Dementia assessment form filling in for patient	Nurse coordinator, Nurse, Patient	Laptop	Patient's Home
Dementia team visit to patient's home	Dementia assessment form filling in for relative	Nurse coordinator, Nurse, Relative	Tablet	Patient's Home
Dementia team Videoconference with shared document visualisation	Dementia assessment report writing	Nurse coordinator and Nurse	Laptop	Municipality offices

A member of the Dementia team interviewed the patient reading the questions of the electronic forms in a tablet, while the other team member filled in the questionnaire answers in a laptop (see Table 2).

Table 2 – Scenario 1 Dementia team interactions during patient's home visit

Electronic Dementia Form	Nurse Coordinator Activity / Device	Nurse Activity / Device	Actor
Mini Mental State Examination (MMSE)	Filling in form answers / Laptop	Reading out loud form questions / Tablet	Patient
Dementia Patient's Relative Questionnaire	Reading out loud form questions / Tablet	Filling in form answers / Tablet	Relative

In the next step of the same scenario, roles were swapped within the Dementia team so a member asked questions to the patient's relative reading from the tablet and the other member was writing the answers in a tablet too. Therefore, two types of input device were used: laptop and tablet. The average time of the Scenario 1 was 45 minutes. There was a moderator present from the Research team whose role was to guide throughout the scenario, reminding the way of proceeding when necessary.

In the Scenario 2, the same two members of the Dementia team from the Scenario 1 wrote a dementia assessment report based on the answers gathered during the patient's home visit. The report writing was performed in a simulated environment, where the participants had a long-distance collaboration, such as between two municipalities. In Scenario 2, the Smarthouse and the Test room represented Dementia team members' offices in different municipalities (see Table 3). A videoconference communication system (see Materials section for further details) was used together with a shared document visualisation of the dementia assessment report simultaneously seen on both offices' screens. The dementia assessment report was written in a MS Word 2010 template provided in advance by the Dementia team. The visualisation of the screen from the Dementia team member in charge of writing the dementia assessment report was directly recorded in the Observation room through the Desktop Presenter software. This screen was also shared with the other Dementia team member office (Smarthouse) via the same software. The average time of the Scenario 2 was 40 minutes. There were moderators in the Smarthouse and in the Test room.

Table 3 – Scenario 2 Dementia team videoconference with shared document visualisation

Participant	Activity	Device	Room
Member 1 of Dementia team	Writing dementia assessment template report	Laptop	Municipality office[2]
Member 2 of Dementia team	Reading dementia assessment template report writing by nurse coordinator	Monitor	Municipality office[3]

In the group interview at the end of Day 1 and Day 2, the Dementia team was asked to give feedback of the two scenarios of each test session: the interaction with the electronic dementia assessment forms and the videoconference with shared document visualisation as a supportive tool for collaboration. The group interview followed the steps defined in an interview guide. The guide included questions relative to the benefits and disadvantages of bringing electronic forms into the home visit stage of the dementia assessment workflow. In addition, questions relative to use of the videoconference with shared document visualisation, as a collaborative tool for writing the dementia assessment report, were included. Finally, questions about usability and graphic User-Interface Design were made during the interview. Suggestions from the Dementia team about further development of the electronic dementia assessment forms were also annotated. Two group interviews were performed with the average time of 35 minutes and moderated by members of the Research team.

Material

For replicability and information purposes, the technological material used during the study is presented below grouped by rooms.

Smarthouse:

- PC: HP Compact Elite 8300 ultra-slim desktop.
- Monitor: 46'' Samsung 460tsn-2.
- Laptop: HP EliteBook 8440p, Intel Core i7 CPU @ 2.67GHz, 4GB RAM, Windows 7 Enterprise SP1 64 bit.

[1] The Smarthouse first simulated a patient and relative's home, afterwards the municipality office and at the end the meeting room for the interview group; the Test room only simulated the municipality office.

[2] The Test room simulated the municipality office for the report writing.

[3] The Smarthouse simulated the municipality office for the report reading.

- Tablet: 2x Elite Pad 900, Intel Atom @1.80GHz, 2GB RAM, Windows 8 32 bits.
- Tablet keyboard: HP ElitePad Case H4R88AA.
- Camera: SONY BRCZ330 HD 1/3 1CMOS P/T/Z 18x Optical Zoom (72x with Digital Zoom) Colour Video Camera.

Observation room:

- PC: HP Z220 CMT Workstation, Intel Core i7-3770. CPU@3.4 GHZ, 24GB RAM, Windows 7 Professional SP1 64 bit.
- Monitor: 3x HP Compaq LA2405x.
- Remote controller: SONY IP Remote Controller RM-IP10.
- Streaming: 2x Teradek RX Cube-455 TCP/IP 1080p H.264.
- Software Wirecast 4.3.1.

Test room:

- Laptop: HP EliteBook 8460p, Intel Core i7 CPU @ 2.70GHz, 4GB RAM, Windows 7 Enterprise SP1 64 bit.
- Monitor: 19'' Dell 1908 FPT.
- Tablet: Elite Pad 900, Intel Atom @1.80GHz, 2GB RAM, Windows 8 32 bits.
- Camera: SONY BRCZ330 HD 1/3 1CMOS P/T/Z 18x Optical Zoom (72x with Digital Zoom) Colour Video Camera.
- Software Cisco Jabber v9.7.1.
- Software Telestream Desktop presenter v2.0.4.

For the electronic dementia assessment forms creation, the software packages Adobe Acrobat X Pro 10.0.1 and Adobe InDesign CS6 8.0.2 were used. These electronic forms replicated the standardized dementia's assessment A4 paper-based form versions from standardized dementia's assessment A4 paper-based form versions [15]: Mini Mental State Examination (MMSE) (*Mini Mental Status Evaluering*) and Dementia Patient's Relative Questionnaire (*Spørsmål Til Pårørende*). The electronic forms were designed and electronically made at the University of Agder, Norway.

Data collection

Scenarios 1 and 2 (3 sessions x 2 scenarios) and the two group interviews were all audio-visually recorded in the Observation room of the Usability Laboratory, resulting in 8 data recordings in total. Annotations of the recording visualizations by the Research team were included in the analysis. The group interview recordings were transcribed verbatim. Pre-test questionnaire participants' answers and notes from the Research team were also included. The analysis was based on qualitative content analysis [17] and made with the software QSR NVIVO 10 [18].

Ethical considerations

This study was approved by the Norwegian Social Science Data Services [19] (NSD), project number 37920. All participants received oral and written information about the project, informed that participation was voluntary and the data collection, storage and access was confidential. All participants signed a written informed consent before the evaluation.

Results

The results were obtained from the annotations, observations and transcripts of the audio-visually recorded data. To ease the reading, the results of each scenario are separately presented.

Scenario 1: Dementia team visit to Patient's Home

The Dementia team argued that the use of electronic forms did not substantially save time for the dementia assessment form filling. The time consumed in information input to the devices (via physical keyboard or touch screen), based on the Dementia team answers, did not improve when compared with the traditional pen and paper.

The use of a device with a vertical screen and physical keyboard (e.g., laptop or tablet with external keyboard) resulted in a physical barrier that interfered in the communication between Dementia team members and the patient. When filling in the questions, it was found more appealing by the Dementia team to have the tablet in the lap covered by the table they were sitting around, removing any technological device from the visual field of the interviewed and reducing distractions. This resulted in a unanimous preference for tablet built-in keyboard input than through an external one.

The primary outcome of the electronic form evaluation was the immediate paper load reduction of the process. Instead of having to carry out and store the dementia assessment forms, the answers were electronically kept in the tablet, occupying no extra physical space nor introducing potential problems related with data loss or uncontrolled access.

The most highlighted benefit of the electronic form use was its impact in the Dementia team workflow after the home visit. It allowed repeated access to the forms for retrospective amendments and reviews. In addition, it introduced the possibility of electronically sharing the form answers with other professional colleagues, with a potential systematic treatment of the data.

The usability of the electronic assessment forms was subjectively evaluated as "clear, self-explained and little need for user training". The text size was sufficient in term of legibility, although there were some problems with the page scrolling.

Several errors were found during the test relative to the form filling. Initially, the arrow keys were used to navigate through the questions. However, once a question was answered, the arrow keys changed their functionality for question answer navigation, which impeded the normal navigation across questions and could potentially affect the final answer of a question (e.g., changing from *Yes* to *No*, instead of jumping to the next question). Another critical error was the miscalculation of the summarisation of the form answers, making the Dementia team members to manually summarise the question answers. The last main error was an occasional problem with storing the electronic form after filling in. This required having the tablet permanently switched on until the dementia assessment report was filled in.

The disadvantages were referred to the amount of visualisation of information on the form. It was stated that in the device, the information at one glance was smaller than when compared to the paper version form. The navigation through the document also presented some problems. For the Dementia team members, it was easier to physically navigate through the document pages than to scroll one by one the pages in the device. This also affected the notion of where the user was in the document at a given time, point especially relevant when they wanted to

check out answers or information from other questions than the one currently visualised. It was expressed a fear of unexpected technology failure (e.g., device run out of battery before or in the middle of the form fill in, fatal error of device Operative System or unable to open/save document form), which reinforced the idea of having the paper-based form at hand as a back up. In the hypothetical scenario of technology failure and having to fill in the paper-based form, the presumed benefit of paper load reduction would not apply.

The Dementia team members suggested that an automatic summarisation and result transfer into the dementia assessment report in order to reduce human errors in manually calculating and transferring the data from the forms to the report. In addition, the possibility of making comments for each question (e.g., in a text box beside the answer options), instead of only in one section at the end of the form, would help to refine the assessment and reflect the nuances of the answers (e.g., if a potential patient wrongly answers to the question of "What is today's date?" with years of difference instead of days, then it would worsen the evaluation of that answer compared with the current case where the only accepted answers are *right* or *wrong*). In this context, one nurse of the Dementia team asked for the possibility of using a stylus to insert the answer by hand in the device using text boxes.

Other suggestions were made related to link the filled form with patient's health history; the document should be seamlessly stored in the patient's electronic Health Record (EHR) directly from the device, and allowing temporary and final versions of the document. This interoperability feature will ensure the long-term impact in the Dementia team workflow.

Scenario 2: Collaborative Dementia Assessment Report Writing

The use of a videoconference system with a shared document visualisation was evaluated as positive way of collaborative work by the Dementia team. In terms of work efficiency, sharing the report document visualisation allowed to see and collaboratively work on the same document by Dementia team members working from long-distance municipalities. The ability of finishing the document in one session, instead of requiring several sessions that would require additional tasks such as physically printing out the report, sending it by post or communicating the information through phone call to the other colleague, as it was stated in one of the group interviews:

> *The videoconference with shared document was a positive experience today. It functioned quite well. My colleague sees what I write at once, instead of me having to read aloud what I have written*

In addition, a good sound quality was found more important for communication than the on-screen visualisation of the other Dementia team member. The average duration of the Scenario 2 was 40 minutes.

Several potential disadvantages were described by the participants that might affect the collaborative work, such as bad sound quality or difficulties to establish the communication between the two remote systems.

Discussion

Use of electronic dementia assessment forms

The use of electronic dementia assessment forms generally received favourable comments from the Dementia team members in all the sessions. When comparing the electronic functionality of the form in the tablet with the traditional paper form filling in, the result was evenly ranked. However, the digital form offered several features that the paper form lacked. For instance, the electronic form gave the opportunity to retrospectively amend the results filled in by the professionals, which sometimes needed to be revisited. In addition, they reduced the amount of paper produced in each visit and the wide availability of the electronic format (i.e., PDF), made potentially easier to digitally interoperate with other electronic systems (e.g., EHR). These advantages confirmed the findings of the project *Collaboration without borders* that revealed a need for improving communication processes, especially those paper-based. The use of electronically stored data improves the availability of the data, reduces the hand-made transference of data between sources (e.g., from paper to EHR) and can automatically summarise the results. In addition, the use of devices with external keyboard was unanimously seen as a non-optimal, because the Dementia team members argued that the device's vertical screen could create a physical barrier in the communication with the patient and relative.

There were some additional non-tested features that were suggested by the Dementia team members and could easily be incorporated in the electronic form fill in that could enhance the interaction and the home visit outcome. For instance, the possibility of writing comments for each question would help to refine the information used for the dementia assessment outcome. The use of a stylus was also suggested for handwriting device input, as a more natural way of interacting with the technology.

In conclusion, the use of electronic dementia assessment forms could impact the workflow home-visit stage of an inter-municipality team when compared with traditional paper-based procedures. The main impact are benefits after the home visit, where added functionalities such as paper-load reduction, retrospective access for amendments and reviews and electronic availability and storage, are now included.

Videoconference with shared document visualisation

The videoconference with shared dementia assessment report visualisation also received positive evaluations from the Dementia team members. The tested system no longer relied on manual procedures that lacked optimal visualisation and sound quality for the collaboration. It allowed collaboratively completing the dementia assessment report in one operation in contrast with the paper-based workflow where printed forms sent by post and/or physical meetings are used for mutual agreement between the Dementia team members in the dementia assessment report writing. This collaborative component can save time to the team members involved in the report writing and provide information at earlier stage to the other professionals included in the next step of the workflow, such as General Practitioner.

Limitations of the study are related with the reduced number of participants (one nurse coordinator, three nurses and two actors), which might influence the generalisability of the findings. However, in qualitative usability studies a small number of participants can be sufficient for having valid results (e.g., 3 users from each category if testing three or more groups of users [20]). Another limitation could be that the electronic assessment forms were not completely operative which impeded the full exploration of the form functionalities. However, their operativeness provided a satisfactory simulation of how they could work in a real scenario.

Conclusions

The study presented is a follow up of the project *Collaboration without borders*, which specified user requirements and proposed the use of electronic tools that could support access and exchange of medical information of inter-municipality care teams. Two electronic tools have been usability tested, in order to evaluate their impact in an inter-municipality workflow of dementia assessment. The evaluation was carried out in realistic clinical settings: patient's home for the interaction with the electronic version of dementia assessment paper-based forms; municipalities' offices for collaborative writing of a dementia assessment report; and role-play with multiple stakeholders such as nurse coordinator, nurse, potential dementia patient and patient's relative.

The main findings reported several benefits of the use of electronic forms, such as digital storage that allowed a later access for reviewing the written information and reduced paper load. These results are congruent with the use of electronic tools to facilitate efficient, accurate and controlled information flow, in a wide range of scenarios such as emergency care [21], medical homes [22] and for sharing data with patients, professionals, providers and government [23]. Research evidence shows that identified communication process gaps can be partly or fully covered by the use of effective electronic tools [22] and workflow operational improvements [24]. The potential of electronic forms for data collection has been demonstrated in data sharing and reporting quality measures between multiple actors [23].

The evaluation of a videoconference system with shared document visualisation provided a synchronization component to the workflow, where both professionals of the Dementia team could collaboratively work on the same dementia assessment report. Based on the findings of this simulation, a new dementia assessment workflow is proposed below as an alternative for the current paper-based one (se Fig. 2).

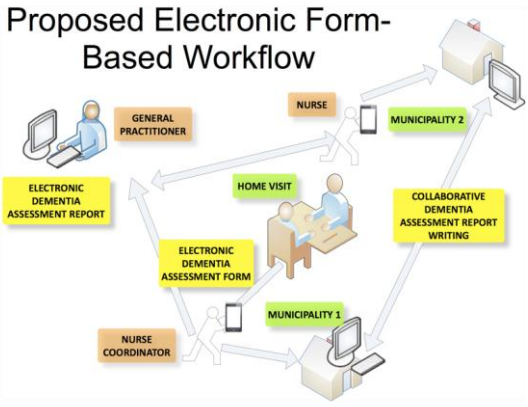

Figure 2 – Scheme of the proposed electronic form-based workflow for an inter-municipality dementia team

Future work would include usability evaluation of the implementation of fully operative electronic dementia assessment form and its interoperability with other electronic health services, such as the Electronic Health Record within simulated and real clinical settings.

Acknowledgments

We thank all participants for their contributions in the study. Financial support was provided by the Regional Research Fund, Agder, Norway (Grant number 204119-2011). We thank Katrine Breievne Torp for contribution in the graphic design of the electronic dementia assessment forms.

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