Publication VI

Johanna Viitanen and Marko Nieminen. 2011. Usability evaluation of digital dictation procedure – An interaction analysis approach. In: Andreas Holzinger and Klaus-Martin Simonic (editors). Information Quality in e-Health. Proceedings of the 7th Conference of the Workgroup Human-Computer Interaction and Usability Engineering of the Austrian Computer Society (USAB 2011). Graz, Austria. 25-26 November 2011. Springer. Lecture Notes in Computer Science, volume 7058, pages 133-149. ISBN 978-3-642-25363-8. ISSN 0302-9743.

Usability Evaluation of Digital Dictation Procedure – An Interaction Analysis Approach

Johanna Viitanen, Marko Nieminen

Strategic Usability Research Group, Department of Computer Science and Engineering,
Aalto University School of Science, P.O. Box 19210, FIN-00076 Aalto, Finland
{Johanna.Viitanen, Marko.Nieminen}@aalto.fi

Abstract. This paper introduces a usability study of digital dictation procedure in which a task-originating modelling method, called interaction sequence illustration (ISI), was used for analysing interaction steps and stages. The analysis was conducted from the physician's viewpoint in a real-life clinical environment. Study results showed that the observed process of digital dictation is inefficient and unnecessarily lengthy. The analysis also revealed a number of interaction design failures and complex interaction sequences. In the study the ISI approach is suitable for providing concrete and detailed information about the steps and stages of interaction, the usability of user interfaces, and the success of interaction design.

Keywords: Usability, interaction sequence illustration analysis, digital dictation, evaluation

1 Introduction

Empirical results regarding the use of current healthcare information technology (IT) systems have pointed out serious challenges to clinicians' abilities to effectively and satisfactory utilise these applications in their everyday work. Recent literature reviews have indicated numerous barriers concerning the uptake of healthcare IT interventions, and few of their results indicate any benefit from the systems [1,2]. Several researchers have reported numerous usability flaws [e.g. 3-6]. Specifically, time taken up by clinical documentation seems to be one of the most challenging bottlenecks of information system use and adaptation [7-10]. These findings raise the question of what makes the design of interactive systems for healthcare purposes especially challenging and vulnerable to shortcomings compared to other domains in which software applications are widely deployed. They also inquire as to what kind of enhancements to methodology approaches have been suggested by researchers in order to overcome these challenges.

This paper focuses on the research of usability and user interfaces of dictation solutions and related IT systems at the level of interaction analysis from the viewpoint of physicians in clinical contexts. Earlier studies have explored the use of documentation systems from other perspectives. For example, Poissant et al. [7] conducted a systematic literature review, whereas Holden [8] and Reuss et al. [9]

applied a qualitative approach and interview methods to study physicians' beliefs and experiences pertaining to electronic documentation. Braun et al. [10] investigated how physicians' information needs can be modelled on a general level. Holzinger et al. [11] explored the use of speech recognition in daily hospital practise from human-computer interaction (HCI) perspective. All these studies provide important findings about the documentation practices and needs of physicians' regarding future applications. However, little information can be found that pertains to judging the success of digital dictation from the viewpoint of physicians in a detailed and practical level. This kind of approach would be beneficial in order to increase the understanding of the current challenges and problems in electronic documentation as experienced by end-users.

2 Background: Usability Evaluation in Health Informatics Field

In HCI field methods for conducting user-centred evaluations fall into two categories: inspection-based evaluation using usability and accessibility guidelines and user-based testing [12].

The advantages of *inspection methods* relate to their abilities to take into account of a wide range of users and tasks and to emphasise obvious usability problems [12]. In contrast to user-based testing methods, these methods are often simpler and quicker to carry out and for these reasons also more cost effective. On the other hand, inspection methods have several weaknesses, which is why they should compliment user-based methods. Results from the inspections tend to be highly influenced by the knowledge and skills of the expert reviewers. Additionally, findings have indicated that the inspection methods might not scale well for complex or novel interfaces [12]. Therefore, they are suggested to be carried out in conjunction with application domain experts [12].

A *user-centred evaluation* is said to be useful at all stages in the project, from the early concept of the design to its long-term usage, which can then provide input for future versions of the system [12]. Variations of user testing involve field validations, i.e. testing design concepts and prototypes in real environments as well as techniques that are more interview- and observation-based [12]. One such technique is contextual inquiry, which is an often-used method for gathering data to support the design of products, systems, and services [13]. In contextual inquiry, a researcher typically conducts field interviews with four to eight users, one at a time, in the working environment and, while observing the user at work, asks about the user's actions in order to understand his or her motivation and strategy [13].

The significance of evaluation studies has grown during the past decade in the health informatics field as a consequence of IT adoption and use-related problems and contradictory findings. As an illustration of this, several papers have focused on methodology aspects and described how to evaluate the usability of healthcare IT systems. These include approaches and methodologies such as: cognitive and usability engineering methods (e.g. [14,15,16,17,18]), the introduction of formative versus summative evaluation methods [19] remote usability testing [20], cooperative usability testing [21], qualitative usability testing enhanced with data mining techniques [22], and evaluation of mobile in healthcare settings [20,23]. Alongside, several researchers have reported challenges in applying these evaluation methods. According to Jaspers [16], each of the widely known usability evaluation methods (heuristic evaluation, cognitive walkthrough, and think-aloud or usability testing) has its own disadvantages and advantages. This is illustrated by Edwards et al. [4], who stated that several challenges with heuristic walkthrough resulted from the complex nature of the clinical work domain and the limitations of the predictive evaluation method. Therefore, special attention should be paid to reflecting on the realism and concreteness of healthcare contexts [24] and evaluating system usability in collaborative tasks [4]. These findings and experiences from empirical studies have caused researchers to suggest that field study methods are more suitable for informing conceptual problems and developing an understanding of the wider context in which clinical ICT systems are used [23,25].

3 Aim of the Study

This paper has two objectives. First, we investigate the process of conducting digital dictation from a physician's viewpoint. This includes comparing the interaction stages with other dictation techniques and processes: cassette dictation and speech recognition dictation. In addition, we apply task-oriented approach in evaluating the usability of digital dictation procedure and related user interfaces.

Second, this paper aims at contributing to the discussions of usability methods in healthcare. We report an experimental employment of the interaction sequence illustration (ISI) method using the digital dictation study as an example. The motivation for this objective derives from the following observations. Usability evaluation studies in the health informatics field seem to share several characteristics: they focus on a single healthcare information system, apply traditional evaluation methods (user testing, heuristic evaluation, or cognitive walkthrough), are conducted in one specified context, and involve one end-user group perspective. However, challenges in the field as well as worrying findings about the usability of currently used systems demonstrate the need for developing new approaches to evaluating usability and for supporting the redesign and user-centred development of healthcare IT systems.

4 Introduction of Interaction Sequence Illustration (ISI) Method

The widely known methods for conducting inspections in HCI field are *cognitive walkthrough* [26] and *heuristic evaluation* [27]. Variations of these methods include, among others, *low-level interaction walkthrough*, introduced by Ryu and Monk [28], and *interaction walkthrough* for the evaluation of safety-critical interactive systems, described by Thimbleby [29].

Typically, inspection methods emphasise the evaluation of one system or a piece of software in isolation from the system's real-use environment and focus on a selected set of user interfaces. In the HCI research field, these methods have often been criticised for not sufficiently addressing the interaction issues in a real-use context. Additionally, the widely known inspection methods are targeted for designer and evaluator use. Little attention has been paid to considering the advantages or limitations of these methods from the viewpoint of collaborative (usability researcher – software developer) development activities. How well the results and findings from the usability studies can be communicated to developers? Do the study results illustrate the findings in a way that (a) increases the shared understanding of the reasons behind the problems and (b) describes how failures in the interaction design of the user interface design should be improved.

This paper introduces and discusses and experimental task- and context-originating modelling approach, called *interaction sequence illustration (ISI)*, for the analysis of interaction steps and stages in the healthcare context. The idea behind the method is to document and analyse activities–those between a user and computer-based systems–that take place during a predetermined sequence of tasks. The modelling of interaction stages and interaction steps is conducted from the user's viewpoint with an objective to (a) illustrate how the use of information systems appears from the end-user's perspective, (b) identify and report interaction steps and related insufficiencies in the user interface and interaction design, and (c) thereby support the user-centred design and development of healthcare applications. The ISI method focuses on user interface issues and low-level analysis of human-computer interaction. In this paper, we present two types of analysis: analysis of interaction stages and step-by-step illustration of a sequence of tasks.

The approach is different from traditional inspection methods in the following ways: 1) the modelling is conducted in a real-life environment, and 2) the analysis does not focus on one system but instead of those systems that are used to accomplish a set of tasks – in our case to perform digital dictations.

5 Case Study: Evaluation of Digital Dictation Procedure from a Physician's Viewpoint

5.1 Objectives of the Study

The digital dictation study [6] was carried out in the spring of 2008 in a large hospital in Finland. At that time, various dictation techniques, procedures, and equipment were used in the hospital. Three pilot units had already been using a digital dictation solution for several years. From the administration's viewpoint the digital dictation method was seen as the most promising solution for replacing the traditional cassette dictation method in the near future. The hospital also had experiences in using the speech recognition technology for dictation in radiology unit. This emerging technology seemed well suited to the radiology context.

The digital dictation study had three objectives [6]: (1) To describe the digital dictation processes from the physician's viewpoint; (2) To compare the currently used other dictation techniques; (3) To determine physicians' opinions concerning mobile dictation solutions. In our earlier paper [6], we described the process of conducting dictations and the context of use at a general level: we presented the identified needs, wants, and desires of physicians as well as constrains as user requirements for a dictation solution. We also used the described seven requirements as criteria for evaluating the currently used techniques, and describe the physicians' views of future dictation solutions [6]. In this paper, we present complementary analysis and findings: we compare the currently used dictation techniques in interaction stages level and report step-by-step analysis and illustration of digital dictation procedure.

5.2 Methods and Data Gathering

The study incorporated two usability research methods: contextual inquiry enhanced with interaction sequence illustration (ISI). The *contextual inquiry* followed the established principles of the method [13]. The contextual inquiry was seen as a suitable approach for exploring the currently used dictation techniques in their real context of use (clinical work in wards, clinics, and offices) because the flexible structure of the semi-structured interview would allow the researcher to generate questions during the interview based on what the interviewee had said or done. The aim of the inquiries was to gather data about the users' needs, documenting practices, and procedures as well as users' experiences in using various techniques.

Contextual inquiries were conducted with seven physicians who were accustomed to using a variety of dictating methods and tools in their daily working environments. The physicians were asked to perform a dictation sequence as they normally would and, while working, describe and give reasoning for their actions. In the inquiries, two of the physicians used cassette dictation, three used digital dictation, and two used speech recognition dictation technique. An audio recorder and a digital camera were used to record interviews for later analysis.

The *ISI analysis* focused on interaction steps and stages in digital dictation procedure. For the purposes of low-level interaction analysis, inquiry data was supplemented by documenting all interaction steps in the digital dictation procedure that occurred between a user and the dictating tools. This data was gathered after all seven inquiries were conducted with the physicians. Based on the inquiries, the researchers developed an understanding of the process and main phases of conducting dictations using digital dictation techniques. The collection of data was done in collaboration with a chief physician who daily dictated using digital techniques but who did not participate in the inquiries. While gathering the data, taking screen captures of all the interaction steps that occur in the dictation process, the chief physician was asked to slowly conduct a realistic case (with real patient data) from the very first stages until the end. Meanwhile, the researcher observed the process and captured screenshots after every interaction step.

5.3 Analysis of the Data

Research data consisted of two sets of documented information: 1) typed notes and photographs from the seven contextual inquiry sessions and 2) a set of screenshots from the digital dictation procedure. Based on data from seven inquires, the researchers aimed at providing answers to the first two study objectives: to describe the dictation processes from the physician's viewpoint and to compare the three currently used dictation techniques with each other. The ISI analysis was conducted to outline as well as to describe the stages of interaction specific to each of the three dictation techniques: digital, cassette, and speech recognition dictation.

The interaction analysis of screenshots taken during the digital dictation walkthrough with the chief physician included arranging the screenshots in the right order and removing duplicates and other extraneous data captured. In this work, the researchers utilised their knowledge of the real-life dictation procedures and practices gathered during the seven inquiries. The number of interaction steps in the digital dictation process was counted based on the analysis of the screenshots and the activities performed by the physicians. The screenshot analysis included organising and modifying the pictures as well as highlighting the details of conducted interactions in such a way that the transitions between screenshots would be understandable and reasonable. Individuals' private information was removed from the pictures in order to guarantee both the patients' and the physicians' anonymity. In addition, each of the screenshots was marked with consecutive numbers and enhanced with short descriptive texts.

6 Results

6.1 Comparison of Dictation Techniques: Illustrating Stages of Interaction

The digital dictation procedure consists of nine stages of interaction, whereas cassette dictation process consists of six, and speech recognition consists of four. The stages are presented in Table 1.

Table 1. Stages of interaction during digital, cassette, and speech recognition dictation.

Stage of interaction	***Digital dictation***	***Cassette dictation***	***Speech recognition dictation (radiology)***
1.	Start up the computer, log in, and open electronic health record (EHR) system.	Fill in the dictation paper form (patient identification information).	Open the CRIS radiology information system.
2.	Find the target patient information in the EHR system (using his/her social security number).	Other preparatory actions e.g. stick a note to a cassette and insert the cassette into a recorder.	Select the target patient from the list (→ the patient's pictures will open).
3.	Open up and become familiar with previous documentation using electronic health records and other related systems.	Become familiar with patient documentation using papers and electronic information systems.	Dictate (while modifying the pictures) using a handset. The dictated text appears on screen in almost real time.
4.	Dictate (including identification information and dictated message) using a handset.	Dictation (including identification information and dictated message) using a handset and a recorder.	Edit (using the keyboard) and save the dictation (using the handset).
5.	End and save dictation.	Put cassette and papers into an envelope. (Nurses will deliver the envelope from the physician's desk further.)	
	Dictation is converted from voice to text by transcriptionists and is returned to the physician within several days.		
6.	Find the notification about the transcribed dictation.	Review, and if necessary, make revisions with paper and pen; deliver paper to nurses.	
7.	Search for the dictation using the EHR system.		
8.	Review and, in necessary, make corrections; save the approved dictation.		
9.	Mark the notification as having been checked.		

Digital dictation. The main disparity between the cassette and the digital dictation techniques is the format in which the signal is recorded and transmitted. In brief, the digital dictation procedure consists of nine stages, which are illustrated in Table 1. First, the physician starts up the computer, logs in, and opens the electronic health record (EHR) system. Then, he or she finds the right patient and related information in the system with the help of a social security number. The third stage closely resembles that of cassette dictation: the physician searches for relevant patient information using the paper records, the EHR system, and other electronic resources; opens those; and becomes familiar with patient's earlier health records. After the preparatory stages, the physician is ready to start the dictation using the software. While dictating, the physician mainly operates with the handset and, now and then, searches for relevant information from various sources. At the end, he or she saves the dictation, and thereafter the audio file is automatically sent to a dictation centre (stage 5). After being converted from speech to text by transcriptionists, the dictation is usually returned to the physician for approval within several days. The approval process includes the following activities: finding the notification about the transcribed dictation from the physician's personal checklist (stage 6); based on the patient information in the notification, searching for the dictation in the EHR system (stage 7); reviewing the text, making possible corrections following the text-editing process; saving the approved dictation (stage 8); and marking the notification as having been checked (stage 9).

Cassette dictation. Cassette and digital dictation processes resemble each other closely: the dictation is first recorded and then converted from speech to text. From the physician's point of view, the cassette dictation process is characterised by simplicity and concreteness. The preparatory actions include filling in a dictation form (stage 1), sticking a note to a cassette indicating the patient's social security number, and inserting the cassette into a recorder (stage 2).

Speech recognition dictation. The observed process of speech recognition dictation was in use in the radiology unit and consists of five stages (Table 1). First, the radiology physician starts the computer, logs in, and opens up the radiology information solution (CRIS system). Then, from a list, the physician selects the patient and the related radiological materials to be utilised in dictation. Most often, the procedure can be started from the second stage, since performing dictations is a continuous process and one of the main activities in radiology work. The dictation stage includes looking up and reviewing x-rays as well as dictating with a handset. The speech recognition dictation technique enables the dictated text to appear on a screen almost in real time and thereby supports the physicians in continuously structuring the dictation message. The fourth stage includes making necessary changes using text-editing functionalities, and the last stage consists of saving the dictation and closing the patient information file and pictures using the handset.

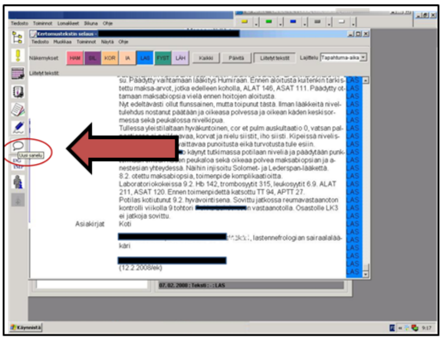
6.2 Step-by-step Illustration of the Digital Dictation Procedure

As described earlier, the low-level analysis of interaction between the user and user interfaces concentrated on examining the digital dictation procedure. The total number of screenshots taken from the digital dictation process was 58. Furthermore, the number of interaction steps was 61. The numbers of screenshots and interaction steps are presented in Table 2. As an example, figures 1-4 illustrate the set of screenshots and interaction steps relating to stages four “Dictate (including identification information and dictated message) using a handset” and five “End and save dictation”.

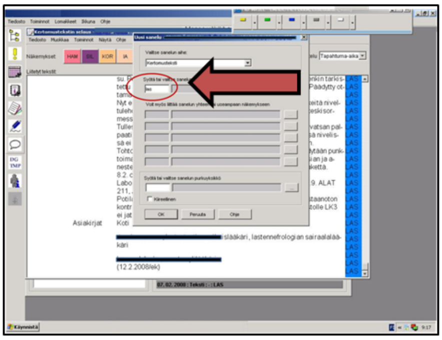
Table 2. Total number of interaction steps in the digital dictation procedure shown together with the stages of interaction and the number of screenshots.

Stage of interaction	Number of screenshots	Number of interaction
1	10	13
2	2	3
3	3	5
4	12	11
5	4	3
6	4	6
7	4	4
8	12	10
9	5	6
Total:	56	61

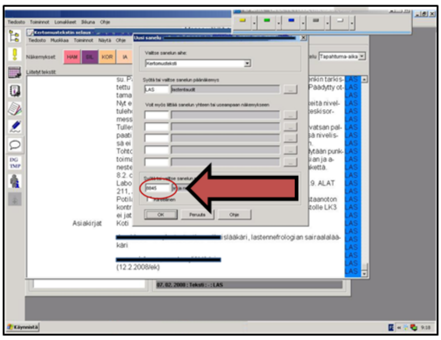
Results from the step-by-step analysis indicate that a high number of steps are required to perform the activities after the dictation is returned for approval (stages six to nine). Analysis of the screenshots reveals the following reasons for this: the notification of a transcribed dictation waiting for confirmation appears in the physician’s “personal checklist”. The notification does not include a link to the dictation text; instead, the physician needs to copy and paste the patient’s social security number when seeking the dictation text from the EHR system. Similarly, several interaction steps need to be taken when marking the notification about the transcribed dictation as having been checked.



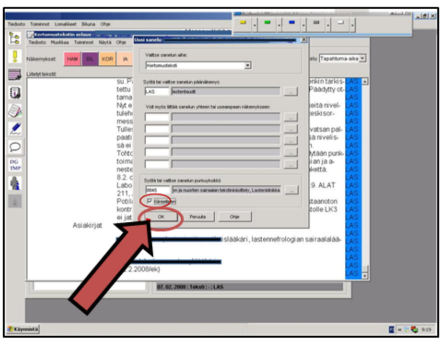
1. User selects ”new dictation” icon.



2. The user enters the code indicating the area of clinical speciality (required information).

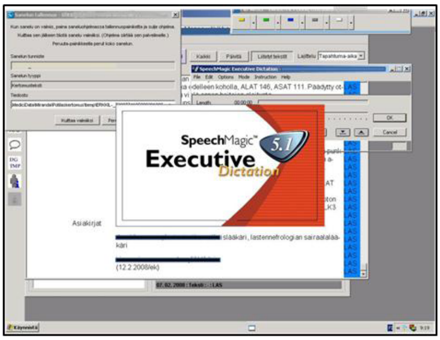


3. The user types the number of the dictation centre (required information) .

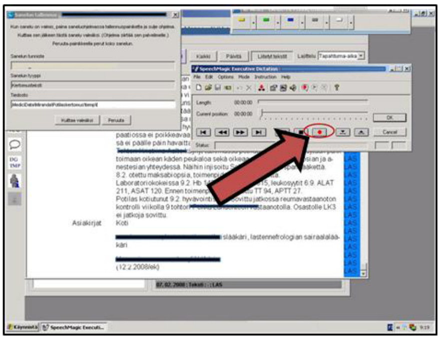


4. The user selects “urgent” and continues the process.

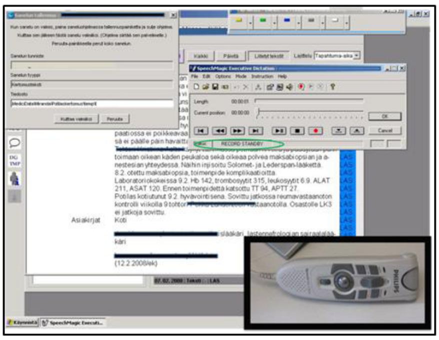
Fig. 1. An example of the interaction steps illustration (steps one to four, i.e. stage 4 of the digital process in Table 1). First four screenshots and descriptions of action from the digital dictation process.



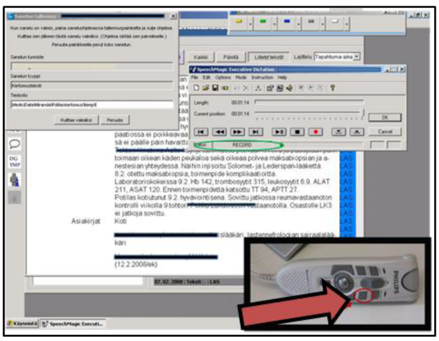
5. Dictation software starts up.



6. The user selects “record”.

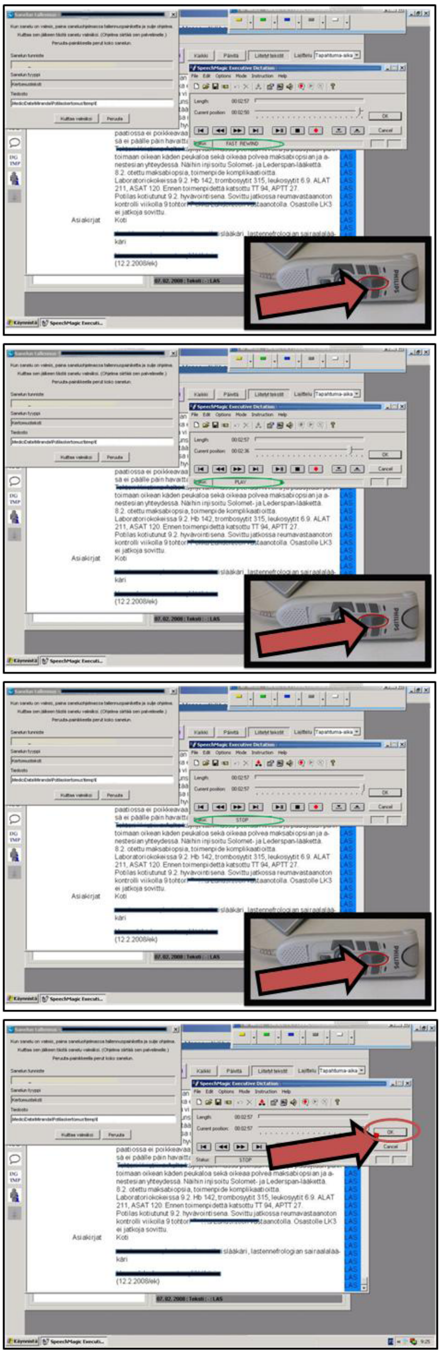


7. Before the recording starts, the user needs to utilize the handset.



8. The user pushes the “record” button to start the recording.

Fig. 2. An example of the interaction steps illustration (steps five to eight). Four screenshots and descriptions of action from the digital dictation process enhanced with pictures of actions performed using a handset.



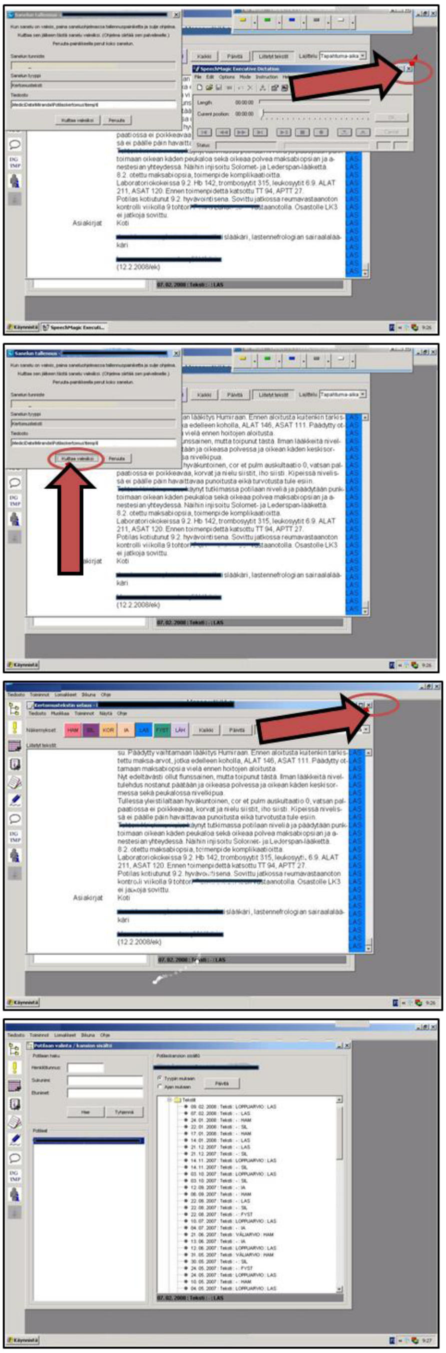
9. The user wants to hear what she or he has dictated. The user rewinds the dictation recording using the handset.

10. The user operates the handset (pushing play).

11. The user stops the recording.

12. The user is satisfied with the recorded message and selects “OK”.

Fig. 3. An example of the interaction steps illustration (steps 9 to 12). Four screenshots and descriptions of action from the digital dictation process enhanced with pictures of actions performed using a handset.



13. The user closes the recording window.

14. The user confirms that the recording is ready to be sent to the dictation centre.

15. The user closes the patient documentation window.

16. The user is ready to start a new dictation by typing a new patient's social security number.

Fig. 4. An example of the interaction steps illustration (steps 13 to 16). Four screenshots and descriptions of action from the digital dictation process.

7 Discussion

7.1 On the Results of the Study

This paper continued the earlier research concerning user-centred evaluation of digital dictation solution [6]. The outcomes of the interaction analysis consisted of two sets of data and documentation: 1) illustrations of interaction stages in three dictation procedures that utilise digital, analogue, and speech recognition recording techniques, and 2) step-by-step illustrations of user-computer interaction focusing on the sequence of events in the digital dictation process.

The outcomes of the ISI method and related analysis provide practical and hands-on data about the interaction stages and steps. The observed process of digital dictation consists of nine stages of interaction and involves several complicated steps. Compared to both conventional cassette dictation and advanced speech recognition techniques, the number of steps and stages is considerably higher. Findings from the step-by-step analysis showed that in total, the amount of required interaction steps in a simplified digital dictation process was found to be 61. What is more, this does not include steps involved in searching for patient information from various resources or dictating lengthy messages, during which interruptions are common and considerably complicate the continuity of dictation.

The observed digital dictation software was closely integrated into the EHR system. Thus, any problems related to the information system were also attributed to the dictation process. The interaction analysis indicated dozens of apparent usability problems, including unnecessary codes and verifications, ambiguous terminology, and additional but superfluous clicking, to mention only a few examples. The detailed evaluation of the user interface characteristics was not the focus of this study; however, these findings partly explain the high number of interaction stages and steps.

Based on the study results, one can easily argue that the problems found in the digital dictation process and procedure derive from poor usability and insufficiencies in the interaction design. The number of unnecessary clicks required, and thus resources wasted, considerably hinder clinical work. Earlier studies have shown challenges in documenting and retrieving patient information using electronic systems [7-10]. Our findings are consistent with these. In addition, our study provided concrete and detailed findings that can be utilised in the further development of digital dictation application.

Dictation is a time-consuming tasks of physicians within modern hospitals, but a necessary task. The study findings suggest for choosing speech recognition dictation due to the reported benefits, e.g. less interaction stages. However, it should be noted that the in the target hospital, the speech recognition solutions had been developed and tested for radiology purposes in close collaboration with the physicians and software provider for about three years. Experience had indicated that there were many challenges to overcome, before similar solution could be utilised in other clinical contexts.

7.2 Experiences with the ISI Analysis

In the clinical context, the technology environment consists of many IT applications, of which several are used simultaneously. From the viewpoint of clinicians, research on the usability of a single system can be claimed as contradictory, perhaps irrelevant, when their daily work environment and the nature of their jobs are taken into account. Traditional usability inspection methods concentrate on the evaluation of a single system with little emphasis on context of use considerations. The introduced task- and context-originated analysis aimed at addressing the challenges of evaluating healthcare IT systems in clinical contexts and thereby contributing to ongoing discussions about methodology challenges in health informatics field. Our work with interaction analysis, continued the earlier work and the development of HCI inspection methods established by Ruy and Monk [28] and Thimbleby [29].

Findings from the experimental study indicated that the analysis approach that was introduced and the ISI method that was used are suitable for providing concrete and detailed information about the steps of interaction, the usability of user interface, the effectiveness of use, and the success of interaction design. Such a remote analysis enables thorough walkthroughs that can be conducted not only by usability specialists and by developers but also by the users of the system. The possibility for remote analysis is especially important in the healthcare domain because: 1) conducting on-site analyses may be difficult due to sensitive topics being discussed between the physicians and the patients, 2) the evaluation of information systems that include real patient data is not usually possible, and 3) involving end-users into intensive data capturing sessions might be difficult due to the hectic and critical nature of clinical work. When working with user interface screenshots, modifications to the visible data in screenshots can be made with authorised personnel so that patient privacy will not be compromised.

Based on our experiences, however, determining the criteria for defining stages of interaction is not a straightforward or strictly guided process. In our case, stages were defined based on the number of user actions and interaction steps between the user and the system as well as on time taken up by performing these in a realistic work context. Such a methodology approach was seen as useful when comparing dictation techniques to each other from the end-user's viewpoint. When applied for these kinds of purposes, it is important throughout the study to follow the agreed-upon principles or criteria. It is worth noticing that for the sake of simplicity, issues of complex medical details in dictated messages and contents of patient documentation were intentionally reduced as being minimal (depending on the patient situation, the contents of the dictation may be complex and the physician may use numerous information systems and applications during dictation). Often, physicians seek patient information from several information systems (e.g. laboratory system) and from numerous entries documented in EHR systems. Therefore, the described step-by-step process only accounted for those steps that users are required to perform in each and every digital dictation process.

Furthermore, our study pointed out that considering issues of patient privacy is essential when applying methods like ISI in healthcare contexts. Access to real environments in which clinical systems are used is crucial in order to gather reliable and rich data for research and development purposes. Nevertheless, getting access and permission to record audio data might not be easy. At the very least pictures and other data need to be carefully modified in the analysis phase in such a way that the anonymity of both the patient and healthcare professionals is guaranteed.

7.3 Future Work

It seems that healthcare technology failures often derive from misunderstandings and poor collaboration between developers, users, administrators, and other stakeholders. The approach introduced for analysing human-computer interaction in healthcare may provide new opportunities and concrete tools for supporting collaborative activities during technology development. Future research should address the questions of how this data and these illustrations of stages and steps could be utilised in development work and how software developers perceive the usefulness of such a method. In addition, more work needs to be conducted to understand and to evaluate the ISI method. Such an assessment should describe its advantages and disadvantages when employed in usability evaluations, in user interface design, and for interaction design purposes.

8 Conclusion

This paper introduced an analysis approach, interaction sequence illustration (ISI), for documenting and analysing users' actions with interactive systems – a method thereby studying the successfulness and failures of interaction design and user interface aspects. The study showed that at present, the process of digital dictation is inefficient and unnecessarily lengthy from the physician's viewpoint. The analysis of digital dictation procedure revealed a number of interaction design failures and complex interaction sequences, the improvement of which is essential.

References

1. Khangura, S., Grimsha, J., Mohe, D.: Evidence Summary: Electronic Health Records (EHRs). Ottawa Hospital Research Institute. Available from: http://www.ohri.ca/kta/docs/KTA-EHR-Evidence-Review.pdf [accessed 01/07/2011]
2. Black AD, Car J, Pagliari C, Anandan C, Cresswell K, Bokun T, McKinstry B, Procter R, Majeed A, Sheikh A.: The Impact of eHealth on the Quality and Safety of Health Care: A Systematic Overview. PLoS Med 2011;18. Available from: http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1000387 [accessed 01/07/2011].
3. Kjeldskov, J., Skov, M.B., Stage, J.A.: Longitudinal Study of Usability in Health Care: Does Time Heal? Studies in Health Technology and Informatics, 130, 181-191 (2007).
4. Edwards, P.J., Moloney, K.P., Jacko, J.A., Sainfort, F.: Evaluating Usability of a Commercial Electronic Health Record: A Case Study. International Journal of Human-Computer Studies, 66, 718-728 (2008).

5. Peute, L.W.P., Jaspers, M.W.M.: The Significance of a Usability Evaluation of an Emerging Laboratory Order Entry System. International Journal of Medical Informatics, 76, 157-168 (2007).
6. Viitanen, J.: Redesigning Digital Dictation for Physicians: A User-centred Approach. Health Informatics Journal, 15, 179-190 (2009).
7. Poissant, L., Pereira, J., Tamblyn, R., Kawasumi, Y.: The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review. Journal of the American Medical Information Association, 12 (5), 505-516 (2005).
8. Holden, R.J.: Physicians' Beliefs about Using EMR and CPOE: In Pursuit of a Contextual Understanding of Health IT Use Behavior. International Journal of Medical Informatics, 79, 71-80 (2010).
9. Reuss, E., Naef, P., Keller, R., Norrie, M.: Physicians' and Nurses' Documenting Practices and Implications for Electronic Patient Record Design. In Holzinger A. (eds.): USAB 2007, LNCS 4799, Springer-Verlag Berlin Heidelberg; 2007, 113-118.
10. Braun, L.M.M., Wiesman, F., van der Herik, H.J., Hasman, A., Korsten, E.: Towards Patient-related Information Needs. International Journal of Medical Informatics, 76, 246-251 (2007).
11. Holzinger, A., Ackerl, S., Searle, G., Sorantin, E.: Speech Recognition in Daily Hospital Practice: Human-computer Interaction Lessons Learned. In Lanyi S. (eds.): Central European Multimedia and Virtual Reality Conference CEMVRC 2004, 125-134. University of Veszprém Press (2004).
12. ISO 9241-210. International standard: Ergonomics of human-system interaction, Part 210: Human-centred design for interactive systems. First edition 2010-03-15. Reference number ISO 9241-210:2010(E).
13. Beyer, H., Holzblatt, K. Contextual Design: Defining Customer-centered Systems. San Diego: Academic Press (1998).
14. Beuscart-Zéphir, M.C., Brender, J., Beuscart, R., Ménager-Depriester, I.: Cognitive Evaluation: How to Assess the Usability of Information Technology in Healthcare. Computer Methods and Programs in Biomedicine, 54, 19-28 (1997).
15. Kushniruk, A.W., Patel, V.L.: Cognitive and Usability Engineering Methods for the Evaluation of Clinical Information Systems. Journal of Biomedical Informatics, 37, 56-76 (2004).
16. Jaspers, M.W.M.: A Comparison of Usability Methods for Testing Interactive Technologies: Methodological Aspects and Empirical Evidence. International Journal of Medical Informatics, 78, 340-353 (2009).
17. Janß, A., Lauer, W., Radermacher, R.: Cognitive Task Analysis for Prospective Usability Evaluation in Computer-assisted Surgery. Proceedings of the HCI and Usability for Medicine and Health Care. In third Symposium of the Workgroup Human-Computer Interaction and Usability Engineering of the Austrian Computer Society USAB 2007, Graz, Austria, 349-356.
18. Horsky, J., Kaufman, D.R., Oppenheim, M.I., Patel, V.L.: A Framework for Analyzing the Cognitive Complexity of Computer-assisted Clinical Ordering. Journal of Biomedical Informatics 4, 4-22 (2003).
19. Belden, J.L., Grayson, R., Barnes, J.: Defining and Testing EMR Usability: Principles and Proposed Methods of EMR Usability Evaluation and Rating. Healthcare Information and Management Systems Society (HIMSS) EHR Task Force (June 2009). Available from: http://www.himss.org/content/files/HIMSS_DefiningandTestingEMRUsability.pdf [accessed 01/07/2011].
20. Bastien, J.M.C.: Usability Testing: A Review of Some Methodological and Technical Aspects of the Method. International Journal of Medical Informatics, 79, e18-e23 (2010).

21. Følstad, A., Hornbæk, K.: Work-domain Knowledge in Usability Evaluation: Experiences with Cooperative Usability Testing. The Journal of Systems and Software, 83, 2019-2030 (2010).
22. González, M.P., Lorés, J., Granollers, A.: Enhancing Usability Testing through Datamining Techniques: A Novel Approach to Detecting Usability Problem Patterns for a Context of Use. Information and Software Technology, 50, 547-568 (2008).
23. Alsos, O.A., Dahl, Y.: Towards a Best Practice for Laboratory-based Usability Evaluations of Mobile ICT for Hospitals. In NordiHCI 2008, Lund, Sweden, 3-12. ACM Press (2008).
24. Svanæs, D., Alsos, O.A., Dahl, Y.: Usability Testing of Mobile ICT for Clinical Settings: Methodological and Practical Challenges. International Journal of Medical Informatics, 79, e24-e34 (2010).
25. Horsky, J., McColgan, K., Pang, J.E., Melnikas, A.J., Linder, J.-A., Schinipper, J.L., Middleton, B.: Complementary Methods of System Usability Evaluation: Surveys and Observations During Software Design and Development Cycles. Journal of Biomedical Informatics, 43, 782-90 (2010).
26. Wharton, C., Rieman, J., Lewis, C., Polson, P.: The Cognitive Walkthrough Method: A Practitioner's Guide. In: Nielsen, J., Mack, R. (eds.): Usability Inspection Methods. John Wiley & Sons, Inc, New York, NY (1994).
27. Nielsen, J.: Usability Engineering. Academic Press, Inc, San Diego (1993).
28. Ryu, H., Monk, A.: Analysing Interaction Problems with Cyclic Interaction Theory: Low-level Interaction Walkthrough. PsychNology Journal, 2, 304-330 (2004).
29. Thimbleby, H.: Interaction Walkthrough: Evaluation of Safety Critical Interaction Systems. In Doherty, G., Blandford, A. (eds.): Proc. DSVIS 2006, Berlin, Heidelberg. Springler-Verlag (2007).