Medical Informatics in a United and Healthy Europe
K.-P. Adlassnig et al. (Eds.)
IOS Press, 2009

doi:10.3233/978-1-60750-044-5-404

Usability Laboratory as the Last Outpost before Implementation – Lessons Learnt from Testing New Patient Record Functionality

Gry SELAND [1], Inger Dybdahl SØRBY
Department of Computer and Information Science,
Norwegian University of Science and Technology (NTNU), Trondheim, Norway

Abstract. The implementation of clinical IT systems is resource-demanding and difficult. In this paper we show how laboratory-based usability tests can be used as a last checkpoint before a system is rolled out, and share lessons learnt on how to conduct such tests in order to obtain valid results. The recommendations are based on experiences from two usability tests of a new medication module conducted in the spring 2008, where two nurses and two physicians simulated a pre round meeting, ward round, and administration of medication in a usability lab furnished as a hospital ward. The results show that details around the test situation are important for testing of implementation ready clinical IT systems. Patient cases must be adapted to the clinical specialties of the test participants, the patient data in the system must be complete, and persons holding the roles as patients have to understand the patient histories and the medical problem.

Keywords. electronic patient records, human-computer interaction, usability testing, clinical information systems, medication

1. Introduction

Clinical information systems such as electronic patient record (EPR) systems are used in a highly collaborative and information intensive practice. Designing and implementing new EPR functionality into this conglomerate of existing human, paper-based and electronic information and communication systems is challenging and demands thorough testing and planning. Having clinicians to enact realistic clinical scenarios in a laboratory environment prior to implementation in the hospital can serve as a useful approach for identifying problematic issues.

Several large Norwegian hospitals are in the process of implementing new medication modules to be integrated with their existing electronic patient record (EPR) systems. The new modules will replace current paper-based systems used for prescription and administration of medications. Implementation of the new functionality into existing systems and clinical practices is an expensive, high risk process. Errors in the medication process might jeopardize patient safety, and usability

[1] Corresponding Author: Gry Seland, Department of Computer and Information Science, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway; E-mail: gry.seland@idi.ntnu.no.

problems of the system might lead to a disproportionate use of health care provider time on the system [1]. Revealing and understanding potential risks and problems are therefore crucial when designing the system and planning the implementation process.

This paper briefly presents two usability tests conducted in order to elucidate some of the aspects that might be problematic when implementing such new functionality in an existing hospital EPR system. The study was performed as part of the POCMAP (Point-of-care multi-aware clinical pilot) research project. The paper focuses on the methodological aspects related to usability testing of clinical information systems. The main objective of the paper is to provide recommendations on how to conduct valid and reliable results from usability laboratory tests of implementation ready clinical systems.

2. Usability Laboratory Testing

Usability testing is a well established human-computer interaction method for obtaining feedback on user interfaces, and can be defined as "the evaluation of information systems that involve testing of participants (i.e., subjects) who are *representative* of the target user population, as they perform *representative* tasks using an information technology" [2]. Usability tests can be conducted in a laboratory or in the field, and will usually involve a video recording of the test situation and the system in use. In usability testing, the participants might be instructed to "think aloud" by verbalizing their thoughts while carrying out the tests [3]. Alternatively, two or more participants might work together to encourage a natural conversation about the system [4].

In health informatics there has been an increased focus on methodological aspects related to usability testing during the last decade. Jaspers describes how to use think-aloud protocols for testing health technologies [5]. Svanæs et al. argue that mobile EPR systems should be tested in laboratories with a high degree of realism, and with a number of users working together [6]. Alsos and Dahl claim that it is sufficient to create a moderate degree of realism as regards the physical environment, the test scenarios, and the prototypes when testing prototypes of mobile hospital ICT. They also describe how usability testing can be extended to encourage reflections among test participants [7].

According to Kushniruk and Patel, there are five major types of usability tests in the development of new technology [2]: 1) exploratory test of preliminary design concepts, 2) testing of prototypes during requirements gathering, 3) assessment test to provide feedback into evolving design process, 4) validation test of completed software, and 5) comparison test at any stage to compare design alternatives.

In this paper we describe another approach: Usability laboratory tests as a guide to the implementation process. The approach is described and exemplified in the next section, which briefly presents two usability tests with subsequent focus group discussions. The study was conducted five months prior to the planned implementation of a new medication module in a Norwegian hospital.

3. Example Study: Testing New EPR Functionality

The test of the medication module was conducted during two days in May 2008, and took place in the Usability Laboratory at the Norwegian EHR Research Centre (NSEP). The usability laboratory at NSEP is 80 m^2 and has configurable walls. During the tests, the area was furnished as a section of a ward with two patient rooms, one office, and a hospital corridor (see Figure 1). Video recordings of the participants and the system in use during the tests were done from the adjacent control room.

The medication system consists of a prescription module and an administration module, which are fully integrated with the current EPR system. The medication system is intended for use with laptops on trolleys in the patient rooms. The system is integrated with bar code readers to identify patients and medications during drug administration.

Two nurses and two physicians were recruited as test participants. The participants (one nurse excepted) work at the hospital where the new functionality was to be implemented. Researchers from NSEP and two nurses from a local hospital acted as patients during the tests. Researchers from NSEP functioned as facilitators, and one representative from the EPR system vendor was present at the second workshop. The vendor representative remained in the control room during the usability test, but took part in the discussion following the test. Some data from two patient cases (personal, medication, physician and nurses' notes) was entered into the system prior to the tests, and the "patients" were instructed in their medical history.

During the tests, the physicians and nurses worked in pairs as they would do in a real hospital ward. They were instructed to perform their usual tasks during a pre-round meeting, a ward round, and medication administration, by means of the new EPR module. The instructions were deliberately of little detail, in order to drive the scenarios by the medical problems in the patient cases. Prior to the test the participants were given a short introduction to the system, and after the tests there was a focus group discussion where the participants (including the "patients") summarized and discussed their experiences. The discussions were led by the facilitators. The tests and the discussions were captured on video for later analysis. After the focus group discussion of the second test, the participants could explore the system more informally, without "patients" present.

During the tests, several important and critical problems of the system were identified. The findings spanned from user interface problems to architectural issues

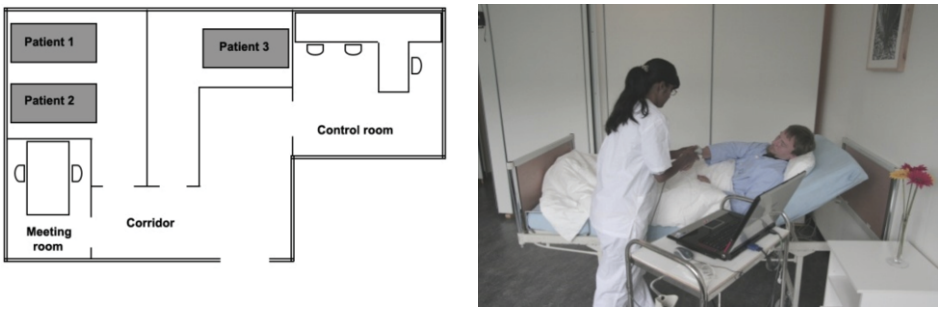

Figure 1. Left: Usability laboratory configuration. Right: Nurse scanning patient bracelet (from simulated medication administration situation)

and resulted in five suggestions for improvement on the system and six recommendations related to the implementation process. Our summary of the results was perceived as useful by both participating nurses and physicians, hospital employees working with the implementation process, and by the system vendor.

4. Usability Testing as a Guide in the Implementation Process

The tests identified several important aspects of how the new module would affect clinical practice and workflow. Although usability testing at this stage is performed too late to influence the design, knowledge about design weaknesses and other issues that appear when the system is used in context is useful when planning the implementation and the organized training program in the hospital.

The tests revealed for example that using a bar code reader in the patient room to prescribe or administer medication was perceived as difficult. Based on the observation we recommended the hospital to organize practical training in using the system. Furthermore, we observed that unexpected events during the test were difficult to handle (i.e., one of the patients was instructed to "throw up" a pill after it had been registered in the system), and on that basis the hospital was recommended to provide training in rare events in addition to basic use of the system.

The focus group discussions after the tests revealed several important issues. For example, the participants feared that the new process of administering medications might become too automated, thus loosing the redundant checks they perform today. Thus, the hospital was recommended to pay attention to these issues prior to the implementation in the hospital.

5. Recommendations on Usability Testing of Implementation Ready Systems

In addition to the specific results of problematic aspects of the user interface and the system in use at the bedside, we learnt a number of lessons on how to conduct usability tests of implementation-ready clinical information systems:

- **The patient cases must be realistic and complete, and they must be tailored to the medical specialties of the participants.** We discovered that incomplete data reduced the realism of the scenarios and made it hard for the participants to pretend that they were in a real hospital ward. Several studies emphasize the importance of providing as sufficient degree of realism in the test situations [6, 7]. For a test where the participants are asked to play themselves, they expect the medical problems to be in the field of their medical specialization.
- **The people acting patients must understand their illness history to be able to give the test users realistic feedback**. We experienced that it is not only important to provide real persons to act patients in usability tests of clinical systems [7]; the actors must be knowledgeable about the reason for admittance to be credible. Preferably, age and gender should match the biographical data of the "patient". Good "patient" candidates are health care providers with knowledge on the patient history in focus, or actors who are directed in the role by a physician or a nurse.

- **The system including integrated devices such as bar code readers must work reliably.** In a usability test of a prototype the participants may have a higher tolerance for incompleteness [7]. However, an implementation-ready system is expected to work properly, and we experienced that the participants became unfocused when unexpected technical problems occurred.
- **The education of the participants before the test must be tailored to the specific work expected to be done in the usability test.** To enable the participants to carry out their tasks in the test, especially when it comes to implementation-ready systems, requires a well-designed training program.
- **Letting the participants try the system once more in the debriefing session after the test proved useful.** Extending the test with a focus group discussion proved useful in order to understand problems and possibilities of the new system and work processes. After the second test the participants were allowed to try the system without "patients" present, and this fostered a valuable discussion. Extending the usability test to provide reflections are in line with previous research on best practises for usability testing [7], and should be done as part of this type of testing. After the test the participants had obtained valuable insight on how the system could work in a physical context.

6. Conclusions

Conducting a usability test in a laboratory is a relatively inexpensive way of preparing an implementation process. However, to obtain valid results it is important to pay attention to details in the research design due to the characteristics of hospital work and the complexity of implementation ready clinical IT systems.

Acknowledgements. Thanks to Ole A. Alsos and Arild Faxvaag for valuable comments. This work was supported by the Norwegian Research Council by grant 176761 (Point of Care Multi-aware Clinical Pilot) of the VerdIKT program, DIPS ASA, The Industrial Research Fund for NTNU, St. Olav University Hospital, Akershus University Hospital, and NTNU.

References

[1] Kushniruk, A.W., Triola, M.M., Borycki, E.M., Stein, B., Kannry, J.L. (2005) Technology induced error and usability: The relationship between usability problems and prescription errors when using a handheld application. *International Journal of Medical Informatics* 74:519–526.

[2] Kushniruk, A.W., Patel, V.L. (2004) Cognitive and usability engineering methods for the evaluation of clinical information systems. *Journal of Biomedical Informatics* 37:56–76.

[3] Peute, L.W.P., Jaspers, M.W.M. (2007) The significance of a usability evaluation of an emerging laboratory order entry system. *International Journal of Medical Informatics* 76:157–168.

[4] Buur, J., Bagger, K. (1999) Replacing usability testing with user dialogue. *Communications of the ACM* 42(5), 63–66.

[5] Jaspers, M.W.M. (2009) A comparison of usability methods for testing interactive health technologies: Methodological aspects and empirical evidence. *International Journal of Medical Informatics* 78:340–353.

[6] Svanæs, D., Alsos, O.A., Dahl, Y. (2009) Usability testing of mobile ICT for clinical settings: Methodological and practical challenges. *International Journal of Medical Informatics*, http://dx.doi.org/10.1016/j.ijmedinf.2008.06.014.

[7] Alsos, A.O., Dahl, Y. (2008) Toward a best practice for laboratory-based usability evaluations of mobile ICT for hospitals. In *Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges*, ACM, New York, 3–12.