Measurement of the Clinical Usability of a Configurable EHR

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Abstract. The objective of the project was to measure the clinical usability of an EHR configured by use of participatory design with clinicians from a neurological stroke unit in order to get input to the County's future strategy for incremental implementation of EHR. The content of the EHR was defined during a series of workshops with the clinicians after which the XML configuration files were written and deployed. In parallel with this, the participants from the University identified, prioritised and further specified a number of effects related to the clinical practice to be measured. The effects requested by the clinicians focused on improving their overview and assessment of patients as well as on more efficient coordination in three specific and highly cooperative situations, viz. nursing handover, ward round and patient conference. All three situations were measured before (using paper-based medical records) as well as during the week where the configured EHR completely replaced the paper-based medical record in order to compare a 'before' and 'after' situation. Measurements were focused on the requested effects and acquired using various techniques including questionnaires, interviews, observations, and Task Load Index (TLX) ratings. In total, 15 nursing handovers, 8 ward rounds, and 11 patient conferences involving a total of 35 patients and more than 20 clinicians were included in the measurements. Data from the project has been comparatively analysed by means of the TLX scores. Our results show several significant results, for example, during ward rounds the physicians experienced a significant improvement of TLX. The experiment has proven it possible to configure the content of an EHR that significantly improves the clinician's overview of the patient's current status in different clinical situations during the clinical process, based on the clinician's actual needs. Furthermore, the configuration process gave the County valuable experience concerning the content and management of a participatory design process as well as documentation of utility value that will be incorporated in future EHR projects.

Keywords: Participatory design, software design, strategy, evidence, computerised medical record system, usage, clinical process, effects, measure, vendor, NASA-Task Load Index, XML configuration files, case study

1. Introduction

In Denmark, the National Board of Health has published a national Conceptual Model for Communication in Electronic Health Records (G-EPJ) for highly structured problem-oriented clinical documentation in EHR systems [1, 2]. After the first tests of G-EPJ it became obvious that it was important to focus more on how such an EHR could be designed in order to make it accepted by the clinicians as a natural day-to-day tool. This insight has founded a national initiative for defining the documentation needed for standard patient workflows, but it has to be proven that such specifications can be im-

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plemented transparently in the clinical setting in order to specifically support the clinician's daily patient-centred routines and practices.

Roskilde County has adopted a bottom-up strategy driven by Participatory Design (PD) experiments to develop and implement their EHR systems in order to give priority to documenting the effects on clinical practice of the use of EHR systems. It has recently been proposed that an experimental strategy is required for PD engagement in large-scale public sector systems [3].

In order to measure the clinical usability of an EHR conformant with the national requirements as well as get input to the County's future strategy for incremental implementation of EHR, an experiment was conducted in the period of August to December 2005 at the Neurological Stroke Unit treating acute apoplexy at Roskilde County Hospital.

During the experiment the clinicians' need for overview and documentation was identified, followed by the configuration of the necessary templates to be implemented in the EHR that completely replaced the present paper-based medical record during a week at the neurology department.

The project group was formed by 3 partners: Clinicians from the neurological stroke unit and project managers from the EHR unit at Roskilde County Hospital, researchers from the Dept. of Computer Science at Roskilde University and business architects from the vendor, CSC Scandihealth A/S. Roskilde County Hospital's interest was to start the deployment of their new PD strategy and assess how to document clinical utility value. CSC Scandihealth's interest was to experience how to configure a clinical process EHR module in participation with clinicians and to test how their solution would work in a real clinical process. The researcher's interest was a research-in-progress project on 'evidence-based IT development' aiming at proposing a new commercial contract model where the customer's payments are dependent on measurable effects of using the vendor's system [4, 5].

The main goal of the experiment was to measure to which degree positive effects on the clinical practice could be obtained by using the configured EHR.

2. Materials and Methods

2.1. Identifying the clinicians' needs

The first part of the project (August to October) started with an initial meeting to scope the initial load of data and use of interfaces to other legacy systems during the test of the EHR. It was followed by five full-day PD workshops where clinicians from the stroke unit in cooperation with business architects from the vendor, project managers from the EPR unit and researchers from Roskilde University specified the content of the EHR.

In order to pinpoint the required effects on the clinical practice during the treatment of acute apoplexy patients, the clinicians were asked at the first workshop to identify the most critical 'information bottlenecks' during the clinical pathway of acute stroke patients. This was done in order to identify the objectives for the critical overviews that had to be configured during the experiment. Three specific and highly cooperative clinical situations were identified at the first workshop, viz. nursing handover, ward round and patient conference.

From this starting point the remaining content of the EHR was identified during the following three workshops, i.e. the structure, content and placement of clinical notes and result templates, standard plans, concept lists etc. At the final workshop the complete specification was presented and reviewed before the actual configuration of the XML-based templates and load of the templates to the EHR.

During this process the content of the EHR was elaborated in up to three iterative events. First, mock-ups were drawn on flip-over paper (figure 1). Secondly, a preliminary non-interactive prototype made with MS PowerPoint was discussed. Finally, a running prototype (figure 2) was demonstrated, discussed, and evaluated.
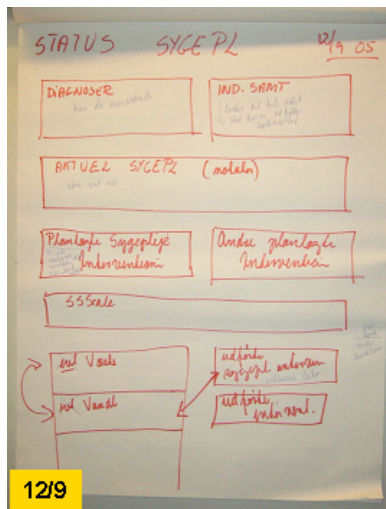

Figure 1. Photo of flip-over from the first workshop with input to overview for nursing handover

Figure 2. Screen dump from the fifth workshop showing the prototype implementation of overview for nursing handover

2.2. Identification of effect measurements

The effects requested by the clinicians focused on supporting coordinative aspects [6]. They requested an improvement of their overview and assessment of patients as well as on more efficient coordination in three specific and highly cooperative situations, viz. nursing handover, ward round and patient conference.

Nursing handover, which happens three times a day at the beginning of each nursing shift (7am, 3pm, and 11pm) and last about an hour. There is no time for the nurses that leave the ward to discuss patients with the nurses on the next shift. During the nursing handover, one nurse is designated as the team leader and provides an overview of the patients at the ward and manages the necessary coordination and exchange of information.

Ward round, which happens once every weekday and lasts for three to six hours. It includes evaluation, reviewing, and discharging of patients. The chief physician visits all patients and reviews the plans for their treatment. Usually there is no time for nurses to follow the physician during the ward round. Information exchange and coordination is obtained through the patient record and by ad hoc communication with the nurses on shift.

Patient conference, which takes place once every weekday, lasts approximately 15 minutes, and includes all clinical staff members (physicians, nurses, and therapists). An interdisciplinary assessment of each patient is carried out and plans are revised.

In parallel with defining and configuring the content of the EHR, the university researchers identified, prioritised, and further specified a number of effects related to the clinical practice that could be measured by various techniques, including questionnaires, interviews, observations, and NASA Task Load Index (TLX) ratings [7].

All three situations above were measured before the test of the EHR and during the test week.

2.3. Configuration of a clinical framework tool

In the second part of the project (November to December), the required content was configured as XML-based templates that were loaded into the clinical framework tool, CSC Clinical Suite, based on the Oracle Healthcare Transaction Base (HTB).

CSC Clinical Suite is not an EHR per se, but a clinical frame that can contain and present the clinical content as specified by the clinicians by use of XML-based templates for overviews, clinical notes, results, standard plans, work situations and structure of the patient's medical record. This makes it possible to configure a complete medical record in accordance with the clinician's requirements and is able to evolve dynamically as new requirements emerge.

The XML configuration based on the specifications from the workshops was conducted by the vendor and loaded into the EHR. After the initial load of the EHR templates, the content of the configured EHR was verified by registration of the data from actual paper-based medical records into the EHR before training the clinical staff in the use of the EHR. The need for adjustment of the content was identified during these sessions and implemented before the actual clinical test of the EHR.

2.4. Implementation and deployment of the EHR

Interfaces and initial load of data from the scoped legacy systems currently used at the hospital were established in parallel with the configuration of the EHR.

The test setup with the configured EHR included:

- All acute admitted patients in the 9-bed acute apoplexy unit within five days with a total of 15 patients
- 16 staff members used the EHR (10 received training prior to the test)
- Data included all production data, both bedside and in real work situation, 24 hours for five weekdays
- The technical setup included screens projected on the wall during nursing handover and patient conferences, stationary and portable PCs, and PDAs used for obtaining measurements at the patient's bedside
- In the weeks before the test five years of patient data from the County (a total of more than 26 million data records) were migrated to the prototype from the ADT system, laboratory system and Medication Module, and interfaces established to these legacy systems in order to receive updated data in the EHR during the test period

3. Results

Though one week of using an EHR is too short a period to establish routine use of the system, some results yield statistically significant positive effects of the EHR for each of the above clinical situations.

All participants at the nursing handover (except for the team leader) experienced a significant improved nursing plan. The number of missing information as well as the number of messages to hand over to other clinicians were significant lower during the nursing handover.

The chief physician experienced a significant reduction in mental workload on all six scales of the TLX ratings with regard to his ward round.

During the patient conference, the physicians experienced a significant reduction in their mental workload on all six scales of the TLX ratings. The nurses experienced a significant improvement on one of the TLX scales (own performance). The chief physician in charge of the conference experienced a significant better priority of tasks and division of work/responsibility for the tasks.

4. Discussion

It was of great importance that the stroke unit already had implemented detailed standard clinical guidelines for acute apoplexy patients. Everybody knew exactly what to do and when to do it, thus no data chart in the configured EHR was unknown to the clinicians.

Clinical framework-based EHRs such as CSC Clinical Suite demand heavy clinical involvement in the configuration process in order to make the system provide the expected effects, and the vendor will not be able to do this on their own.

The nurses found it easy to use the customised documentation model that was chosen and they quickly asked for a more problem-oriented model, which the EHR was able to provide to the users. CSC Clinical Suite could "follow" the user demands as the process evolved.

CSC Clinical Suite was perceived as easy to learn, to navigate and to write in and it was easy to use the standard plans of interventions defined according to the standard patient guidelines. It is also a highly flexible system that is very configurable: The configuration was changed back and forth several times during the preparations before the on-line test period. The configuration was even changed after the EHR went live, which impressed the clinicians.

Several users stated after the experiment that
- They missed the system in the days after the experiment.
- They found the juxtaposed clinical data from several systems to be very helpful in getting the desired overview of the patient.
- They had delivered better quality care but they had also spent more time recording and interpreting data.

5. Conclusion

The experiment go beyond classic IT prototyping experiments focusing on evaluations of user interfaces and interaction based on prototypes with limited functionality and small data samples. Our experiment aimed at measuring the effects of real clinical processes supported by fully functional EHR modules with complete patient records.
The authors has not been able to identify description of studies similar to this study in PubMed and there are only a few references in the literature to configurable EHR´s e.g. [8] based upon a future-proof EHR architecture [9].

The participatory design case study experiment has been a success in so far as it has demonstrated a realistic evaluation of a fully functional EHR solution that supports clinical work processes. The configured EHR was the result of a participatory design effort focusing on formulating and measuring desired effects of an EHR system on a selected clinical practice, the treatment of patients with acute apoplexy.

All parties in the experiment gained valuable experience from the study. The experiment has encouraged Roskilde to retain its participatory design strategy as an alternative to mainstream top-down approaches. Effects have been identified, specified, quantified and measured by the clinical staff involved that will be used as input in the coming strategy process in the county and the experiment supported the University's work on evidence-based IT development.

The clinical framework, CSC Clinical Suite, proved to be an effective tool for configuration of state-of-the-art clinical content in an EHR solution that is well received by healthcare professionals. The experiment proved that it is possible to configure an EHR dictated by the clinician's requirements for clinical overview and documentation, supporting the corporation between different healthcare professionals during the clinical pathways of critically ill patients.

Finally, the clinicians were inspired to further structure their present documentation in the paper-based medical record as a result of the experiences of the project.

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