Measuring Effects on the Clinical Practice from a Configured EHR

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Abstract

The objective of the project was to measure effects related to the clinical usability of an EHR configured by use of participatory design with clinicians from a neurological stroke unit. The project also gave 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 XML-based configuration files were written and deployed. In parallel with this a number of effects related to the clinical practice were identified, specified, and prioritised. 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 The 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, based on the clinician's actual needs, that significantly improves the clinician's overview of the patient's current status in different situations during the clinical process.

Keywords:
Configured EHR, participatory design, strategy, evidence, computerised medical record system, usability, clinical process, effects, measure, vendor, NASA-Task Load Index, XML configuration files.

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. Still it remains to be proven that such specifications can be implemented 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 in Denmark.

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 neurological stroke unit.

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 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 this 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.

Materials and Methods

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.

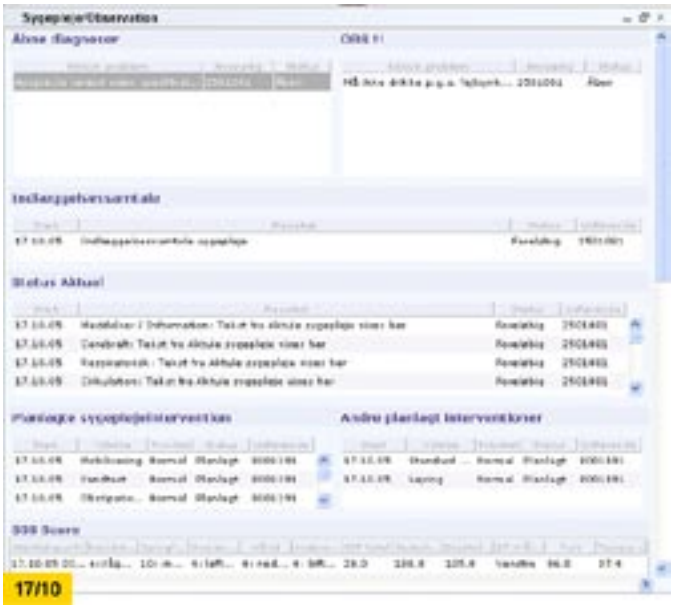
During this process the content of the EHR was elaborated in up to three iterative events. First, mock-ups were drawn on flip-over paper (figure 1).

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

Secondly, a preliminary non-interactive prototype made with MS PowerPoint was discussed (figure 2).

Figur 2 MS PowerPoint illustration of overview for nursing handover used during workshops.

Finally, a running prototype (figure 3) was demonstrated, discussed, and evaluated.



Figur 3 Screen dump from the fifth workshop showing the prototype implementation of overview for nursing handover

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.

Configuration of a clinical framework tool

In the second part of the project (November to December), the EHR was configured. CSC Clinical Suite is not an EHR per se, but a clinical framework tool 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 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). In practise this load is a two step procedure. First the classification used on the templates were loaded into the Enterprise Terminology Service (ETS). Then the XML templates was loaded into the systems template repository.

Clinical Suite is designed to handle a process- and problem-oriented basic structure of concepts built on main concepts of quality of care: Process, Problem, Diagnosis, Goal, Activity, Outcome and Assessment. Clinical Suite is compliant with the Danish Conceptual Model for Communication in Electronic Health Records (G-EPJ) [1, 2]. For instance, during the definition of result- and note templates, the relationship and mandatory registration context for the content in the templates are determinated e.g. it is mandatory for a clinical intervention to have a clinical problem (diagnosis) as an indication.
Standardised use of concepts when defining templates is a central prerequisite if the resultant EHR should be viable across organisatorial units over time. This need for semantic standardisation was accomplished by the ETS in the Clinical Suite. This ETS can handle local and official terminologies e.g. SNOMED CT and cross mappings between these different terminologies. The actual terminology used in the templates was the current official Danish classification codes (SKS[1] and IUPAC[2]), where they were appropriate, while other concepts where coded by use of local codes invented for this study.

Another important issue is capability to control template versions. This concerns the organisatorial scope for the defined templates i.e. which organisatorial units and/or specialities uses the templates. These aspects were however not part of the design of this study.

The XML configuration based on the specifications from the workshops was conducted and loaded into the EHR by the vendor. After the initial load of the templates, the content of the configured EHR was verified by registration of the data from actual paper-based medical records into the EHR and during a subsequent training of 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.

Since Clinical Suites data repository (HTB) is based on the HL7 v 3 Reference Information Model (RIM), the XML-based templates combined with the inherent controlled concept based terminology system in Clinical Suite make it possible to reconfigurate the content of the EHR without corrupting the existing data, and at the same time allows the same concept (data) to be presented or registrated in different templates. This features make it possibly to configurate the EHR to the clinicians/departments present needs and reconfigurate or expand the content in the EHR without compromising semantics and integrations to other systems.

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).

1 A classification system established by the Danish National Board of Health (Sundhedsvæsenets Klassifikations System)

2 IFCC-IUPAC coding schemes for nomenclature, properties and units of laboratory medicine in Danish

- 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 (330.000 patients including 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.

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.

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 an even 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: The configuration was changed back and forth several times during the preparations before the on-line test period. The configuration was even changed during the experiment when the EHR was on-line, 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.

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 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 explicating and measuring desired effects of the EHR system used within a selected clinical practice, the treatment of patients with acute apoplexy.

All partners in the experiment gained valuable experience. 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 and the results will be used as input in the coming strategy process in the county and further experiments supported by 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 cooperation 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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