A Regional PD Strategy for EPR Systems: Evidence-Based IT Development

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ABSTRACT
One of the five regions in Denmark has initiated a remarkable and alternative strategy for the development of Electronic Patient Record (EPR) systems. This strategy is driven by Participatory Design (PD) experiments and based on evidence of positive effects on the clinical practice when using EPR systems. We present this PD strategy and our related research on evidence-based IT development. We report from a newly completed PD experiment with EPR in the region conducted through a close collaboration comprising a neurological stroke unit, the region's EPR unit, the vendor, as well as the authors.

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Participatory design, strategy, evidence, electronic patient record, usage effects, clinical process, measure, vendor.

ACM Classification Keywords
K.6.1 Project and People Management, H.5.3 Group and Organization Interfaces, J.3 [Life and Medical sciences] Medical information systems.

INTRODUCTION

In Denmark, the development and implementation of Electronic Patient Record (EPR) systems is dominated by top-down strategies unfolding around high-priority goals that target issues not directly related to the clinical practice the systems are intended to support.

Denmark is divided into five geographical regions. Each region is responsible for running the hospitals in the region. This includes the development and implementation of each hospital's EPR system. All regions but one have taken a traditional top-down approach in their EPR strategy. In one of these regions the costs of the EPR development (more than 200 billion US$ during 2005-2007) have been covered through loans that are to be repaid by rationalizations, which hence drive the development of the planned EPR systems. It has been announced as a goal to remove 700-900 medical-secretary jobs as EPR systems are deployed over the coming years. Instead the physicians themselves are to record all information directly into the systems. Today, physicians dictate almost all of their patient-record entries on audio tape and medical secretaries subsequently transcribe and code the information.

One region in Denmark, the Zealand Region (in the following referred to as just 'Zealand'), has adopted a very different strategy. They develop and implement their EPR systems through a bottom-up strategy driven by Participatory Design (PD) experiments. Contrary to prioritizing high-level economic issues (as in the top-down strategy mentioned above), Zealand has given priority to documenting the effects on clinical practice of the use of EPR systems. This is done by using a PD strategy for the development and implementation of EPR systems based on so-called 'evidence-based IT development', a research approach further described below.

In the following, we elaborate on the background of the PD strategy applied by Zealand. After that we describe our research within evidence-based IT development. We then present our collaboration with Zealand and a vendor of EPR solutions, CSC Scandihealth (in the following abbreviated to CSC). We elaborate on a large-scale PD experiment, which was conducted during fall 2005, and we end the paper by a conclusion based on our preliminary analysis of the results from this experiment.

A REGIONAL PD STRATEGY FOR EPR SYSTEMS

The background for Zealand's choice of a PD strategy is their recent experiences from implementing a large EPR module for managing the prescription and use of drugs ('OPUS'). OPUS is developed by Zealand and CSC. Researchers from Computer Science, Roskilde University (in the following for short just RUC) have participated in evaluating Zealand's experiences and in initiating the new PD strategy.

OPUS has about 2500 users and runs on almost 1000 PCs, most of which are mobile laptops. OPUS was developed and implemented with a traditional top-down strategy, including a centrally managed requirements specification, development of the module, and implementation of the

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module throughout all hospitals in the region during a relatively short time frame (5 months in 2003-2004). Zealand's EPR unit (in charge of EPR initiatives in the region) was surprised by the high number of problems that arose during the organizational implementation of the system, including the enormous efforts required to change current practices in order to comply with the workflows and procedures related to the new ways of managing drug administration. In order to analyze and evaluate their implementation of OPUS, the EPR unit started to collaborate with RUC in fall 2004. Based on the evaluations of OPUS and the ongoing discussions with RUC, the EPR unit developed a completely new IT strategy. The next EPR module is the so-called clinical process module that supports clinical documentation and decision making and comprises the on-going documentation of medical patient information made by the clinical staff (physicians, nurses, therapists, medical secretaries, etc.). Since the physicians in particular play a vital part in this process (whereas the nurses are the primary users of OPUS), the manager of the EPR unit, who has a background as a physician, decided, that a clinical process EPR module could only be successfully implemented if it gave positive clinical effects – especially with regard to the work of the physicians. The result is a strategy that primarily focuses on the outcome from using the system as seen from the perspective of the clinical staff. This strategy is based on a PD approach and evidence-based IT development.

Zealand's new PD strategy is in some ways the opposite of the traditional top-down strategy. The goal is to conduct a stepwise implementation of EPR in close collaboration with the clinical staff – by experimenting and implementing at one clinical ward at a time. Experiences from each experiment and implementation are to be integrated at the other wards. The absolute success criterion is to document specific positive utility value for the clinical practice. This criterion is the starting point for achieving the overall strategic and political goals of implementing EPR. The strategy reflects an overall process where the development and implementation of EPR is conducted through a PD approach closely tied to a gradual organizational implementation of new clinical work processes.

EVIDENCE-BASED IT DEVELOPMENT

Evidence-based IT development is our research-in-progress project [2, 4]. Our ultimate goal is to 'commercialize' PD [3] by developing a new commercial contract model where the customer's payments are dependent on measurable effects of using the vendor's system. The basis of this idea is to establish a strategic partnership where customer and IT vendors share the responsibility of providing IT solutions that meet agreed-upon measurable effects as experienced by the clinical staff using EPR. The identification and measurement of the effects are determined in collaboration with the clinical staff at the ward in question.

The idea of evidence-based IT development is generally applicable to all large-scale IT projects but will in our collaboration with Zealand and CSC be investigated in the context of EPR systems. Measurable effects are defined in relation to clinical work practices and include for example:

- The physician can complete the daily medical ward round as a "one-man show" (without an escorting nurse), and all information and coordination with other clinical staff is done using the EPR system.
- Mental workload is reduced when clinical staff assesses the status of a patient during the daily team conference.
- The amount of information missing during the nursing handover, initiating every nursing shift, is reduced by 90% and nurses experience an unambiguous patient plan.

Evidence-based IT development seems promising especially for complex and business-critical projects that require establishment of strategic, long-term, and mutually beneficial relationships characterized by user participation, trust, mutual learning, and cooperation between vendor and customer.

In our research, we address the following general research questions:

- How can desirable effects be identified, specified, and quantified in collaboration with the clinical staff and how can methods for measuring those effects be developed?
- How can realistic experiments be conducted in order to measure effects of using EPR systems during real clinical work processes?
- How can effects specific to the clinical work processes be related to overall strategic and political goals?
- How can an overall collaboration between customer and vendor be established for an evidence-based approach?
- How can IT projects be based on evidence-based contracts and what are the conditions and consequences?

Dan Shapiro [3] has recently proposed that an experimental strategy is required in order to get a breakthrough for PD engagement in large-scale public sector systems. We regard evidence-based IT development as a promising candidate for such an approach.

THE OVERALL COLLABORATION

In order to make a large-scale experiment with evidence-based IT development as well as to initiate the deployment of the regional PD strategy a close collaboration was formed between CSC, Zealand, and RUC:

CSC constitutes the vendor organization in charge of developing, implementing, and testing EPR solutions in terms of IT infrastructure and applications as well as critical clinical processes. CSC provided – free of charge – Zealand with access to their newly released EPR platform. The platform is based on the Oracle® Healthcare Transaction Base which is highly configurable and well-suited for prototyping. CSC was responsible for system development, installation, configuration, data migration, and extensive support during the experiment where the system was in use. CSC's interest

was to experience how to configure a clinical process EPR module in participation with clinicians and to test how their solution would work in a real clinical process.

Zealand was providing the experimental field for the project. Zealand had the role of the customer organization defining the needs and desired outcomes in terms of specific effects as well as testing and evaluating CSC's EPR solution. Zealand was responsible for preparing the clinical department for participation in the experiment. Zealand was also responsible for providing the clinical staff with introduction, training, and support needed for participating in the experiment. Zealand's interest was to start the deployment of their new PD strategy and assess how to document clinical utility value.

RUC was responsible for formulating and maintaining the experiment's focus on evidence-based IT development. RUC acted as the research organization facilitating the collaboration, developing and refining approaches to evidence-based IT development, and investigating their trial use. RUC was responsible for identifying and specifying the desired effects in participation with the clinicians, for developing methods measuring the effects, and for designing, managing, and facilitating the experiment in order for the effects to be measured and evaluated.

CSC, Zealand, and RUC collaboratively shared the responsibility for knowledge sharing and for documenting evaluations and results from the experiment.

THE PD EXPERIMENT

The evidence-based PD experiment was completed during fall 2005. It involved a neurological stroke unit treating patients with acute apoplexy.

The experiment went 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 effects from real clinical processes supported by a fully functional EPR module with complete patient records.

The experiment in the stroke unit required that all paper-based patient records were replaced with a prototype EPR system for a period of one week. The experiment thus required thorough planning involving development of new EPR-supported patient trajectories, specification of desired effects from using the EPR solution, configuration and implementation of the EPR system, simulated as well as real-time integration with other systems, migration of patient data, and training of the clinical staff in using the system and working according to the revised patient trajectories.

The first part of the project (August through October) included five full-day PD workshops where clinical personnel in cooperation with the designers from the vendor, project managers from the EPR unit, and researchers from RUC designed and configured a prototype of the system. Main parts of the prototype were designed through up to three iterative events: During one workshop, mock-ups were drawn on flip-over charts. During a following workshop, a preliminary non-interactive prototype made with MS-PowerPoint was discussed. During a third workshop, a running prototype was demonstrated, discussed, and evaluated.

In the second part of the project (November through December), CSC undertook the technical development of the prototype, along with interfaces to various systems currently used at the hospital (laboratory systems, patient administrative system, OPUS, etc.). A number of tests and reconfigurations of the system were made in parallel with training the clinical staff in using the prototype.

In parallel with the design and configuration of the prototype, a number of effects related to the clinical practice were identified, prioritized, and further specified. The effects requested by the clinical staff focused on improving their overview and assessment of patients as well as on more efficient coordination in three specific and highly co-operative situations:

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. This nurse reviews the patient records and orally informs the others about status and plans for the shift.

Medical 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.

Team 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. The current status of each patient is given orally by a nurse and an overview of current plans is available by means of a table on a large whiteboard or, in the prototype EPR system, a full screen projected on the wall.

All three situations above were measured before (with normal paper-based practices) as well as during the week in which the EPR prototype was used in order to compare a 'before' and 'after' situation. Measurements were focused on the requested effects and acquired by using various techniques including questionnaires, interviews, observations, and Task Load Index (TLX) ratings [1]. In total, 15 nursing handovers, 8 ward rounds, and 11 team conferences

involving a total of 35 patients and more than 20 clinical staff members were included in the measurements.

In the final part of the experiment, the prototype was online 24 hours a day and replaced the paper-based records for all patients during one week in December 2005. Five years of patient data (in total more than 26 million data records from more than 300.000 patients) had been migrated to the prototype. The prototype included screens projected on the wall during nursing handovers and team conferences, stationary and portable PCs, and PDAs used for obtaining measurements at the patients' bedside (temperature, blood pressure, etc.) All clinicians used the EPR system during this week. Each clinician had a 'shadow' (a CSC employee with a clinical background or a person from Zealand's EPR unit) that could instantly be consulted in case of questions about how to use the system and in face of emergency situations.

The prototype simulated a fully integrated EPR system. The prototype thereby simulates an EPR solution that is not expected to be in operational use in Denmark until 2007 or later. In order to simulate a fully integrated EPR system, a 'back office' was established and staffed 24 hours a day. Patient-record entries that involved paper-based transactions were initiated in the prototype. The back office identified such entries and mailed them in the conventional fashion. When results were received, they were immediately typed into the prototype EPR system. Thus the clinical staff experienced the prototype as if all transactions were fully IT supported.

CONCLUSION

The PD experiment has been a success in so far as it has demonstrated that it is possible to design, configure, and evaluate a fully functional large-scale EPR solution in close collaboration with the clinical staff. The prototype was the result of a PD effort focusing on formulating and measuring desired effects of an EPR system on a selected clinical practice, the treatment of stroke patients with acute apoplexy. The experiment documents evidence for a number of positive effects on the clinical practice. It has encouraged Zealand to retain its PD strategy as an alternative to mainstream top-down approaches. During the experiment CSC has managed to develop a state-of-the-art clinical process EPR solution that was received well by the clinical staff.

We have identified, specified, quantified, and measured at least some of the effects the clinical staff wanted from an EPR system. Though one week of using a prototype is too short a period to establish routine use of the system, some of our data yield statistically significant effects.

During the team 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). For the therapists however there was no significant improvement with any of the TLX scales. This result reflects two observations: First, the team conference is mainly an activity providing the physicians with multidisciplinary views on the patients. Second, the physicians were the prime participants in configuring the patient status screens used during the team conference. The nurses commented on the screen design, while the therapists as a clinical group were not involved in the participatory design and configuration of the prototype. We conclude that this result also reflects the level of user participation from the physicians, nurses, and therapists respectively.

Unforeseen yet desirable effects were also observed as described below. During the nursing handovers and the team conferences, the use of large projected screens led to collective inspections of the patient record. The nurses also managed to change the screen for the team conference in order to make their observations more visible.

During our 'before' measurements of the nursing handovers we observed that the patient record was seldom seen by others than the team leader, except in cases for example where the handwriting was unreadable. During the experiment the patient record (projected on the wall) was repeatedly inspected by all nurses present at the handovers, and they collectively participated in interpreting the immediate status of the patient.

Halfway through the experiment the nurses initiated a change in the team conference screen – adding a panel specifying their observations relevant for the conference. In this way, the nurses' observations became more salient to the clinicians as they were forming their overview of the status of the patients. The nurses themselves were also in charge of which of their observations were sufficiently important to be communicated to the other clinicians present at the team conferences.

We conclude that evidence-based IT development succeeded in supporting the PD experiment. It has confirmed our expectations that this approach can support EPR projects with a high degree of user participation as well as a PD strategy based on experiments and step-wise implementation.

REFERENCES

1. Hart, S.G. and Staveland L.E. Development of NASA-TLX (task load index): Results of empirical and theoretical research. *Human Mental Workload*. Elsevier, Amsterdam (1988), 139-183.
2. Hertzum, M. and Simonsen J. Evidence-based development: A viable approach? *Proc. NordiCHI 2004*. ACM Press (2004), 385-388.
3. Shapiro, D. Participatory design: The will to succeed. *Proc. Critical Computing*. ACM Press (2005), 29-38.
4. Simonsen, J. and Hertzum M. Evidence-based IT development: Toward a new contract model for EPR projects. *Proc. SHI 2005*. Virtual Centre for Health Informatics, Aalborg University, Denmark (2005), 66-70.