

Implementing New Ways of Working: Interventions and their Effect on the Use of an Electronic Medication Record

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ABSTRACT

Successful deployment of information technology (IT) involves implementation of new ways of working. Under-recognition of this organizational element of implementation entails considerable risk of not attaining the benefits that motivated deployment, yet knowledge of how to work systematically with organizational implementation is sparse. This study investigates a set of interventions undertaken to implement one mandated procedure associated with an electronic medication record, namely that all information about medication is recorded in the system. Medical record audits show that the interventions, which were devised and performed as part of the study, significantly lowered the number of records that violated the procedure. This positive effect was, however, not achieved until multiple interventions had been employed, and there is some indication that the effect may be wearing off after the interventions have ended. We discuss the implications of these results for efforts to work systematically with the organizational implementation of IT systems.

Categories and Subject Descriptors

H.5.3 [Information Interfaces and Presentation (e.g., HCI)]: Group and Organization Interfaces – *computer-supported cooperative work, organizational design*. K.6.4 [Management of Computing and Information Systems]: System Management.

General Terms

Experimentation, Human Factors.

Keywords

Organizational implementation, Adoption, Diffusion, Healthcare, Electronic medication record.

1. INTRODUCTION

Information technology (IT) is being introduced at considerable cost in many private and public organizations, yet systematic efforts to ensure the adoption and use of these IT systems are rare

[29, 30, 38]. It is, for example, not uncommon that IT projects end when technical implementation and user training have been completed [30], that system deployment is followed by long-lasting assimilation gaps during which systems remain unused or underused [16, 29], that users overtly or covertly develop workarounds to bypass parts of systems [5, 18], that use practices congeal quickly and users thereafter spend little time exploring systems further [22, 40], and that many systems fail to deliver the improvements that motivated their development and introduction [24]. IT projects in healthcare, the domain we focus on in this study, are no exception to this state of affairs [e.g., 3, 4, 10, 23, 36, 39].

This study investigates the effect of a set of interventions aiming to enhance the adoption of selected work procedures associated with an electronic medication record (EMR). During 2003 to early 2006 the EMR was deployed at all in-patient wards (except acute medical receiving wards) at the hospitals in Region Zealand, one of five healthcare regions in Denmark. The purpose of the EMR is to help ensure that the right medication is given to the right patients at the right time. Physicians use the EMR for ordering medication, and nurses for dispensing and administering medication. Patients' diagnoses, lab tests, treatments, and other non-medication information are not documented in the EMR but in other electronic and paper records. Specifically, the nurses document their observations and care of patients in the nursing kardex, which is presently a paper record. In total, approximately 10000 physicians and nurses use the EMR, and several work procedures involving the EMR are mandated in the region's standard operating procedures for medication. However, a region-wide survey [19] of the use of the EMR showed that by mid 2007 four of eight main EMR facilities were used consistently by only 3-37% of the region's hospital wards, and four of eight mandated work procedures involving the EMR were followed consistently by only 13-28% of wards. No EMR facility or work procedure was consistently adopted by more than 67%, respectively 48%, of wards.

According to the survey respondents, the barriers to consistent adoption of the EMR include a disintegration of information because information about medication is now in the EMR while information about, for example, diagnoses and symptoms is in other records. Moreover, information about medication is at times disintegrated because nurses sometimes record the dispensing and administration of medication in the nursing kardex, rather than in the EMR. This is contrary to mandated procedures, which prescribe that all medication is recorded in the EMR, but may, for example, occur when the physician ordering a medication has not

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yet recorded the order in the EMR, making it impossible for the nurses to record in the EMR that the medication has been dispensed and administered. If such barriers remain unaddressed they decrease the accuracy and completeness with which medication is recorded in the EMR. This may, in turn, have negative effects on clinicians' assessment and treatment of patients and on patients' health. We, therefore, considered the organizational implementation of the EMR and, in particular, the issue of having all medication recorded in the EMR a good case for working with interventions aiming to improve the work practices associated with an IT system.

This study targets the nurses' recording of the dispensing and administration of some medication in the nursing kardex rather than in the EMR. We do this by identifying and addressing the main reasons for this current practice. Reasons were identified through workshops with clinicians at a medical ward. At these workshops we also planned interventions to alleviate the reasons and, in general, promote the use of the EMR for the recording of all medication. The interventions were carried out over a period of two months, and their effect was assessed by means of medical record audits supplemented with observation. In this study we describe the interventions at the medical ward, report their results, and discuss our experiences from working systematically with the organizational implementation of the EMR.

2. RELATED WORK

Below, we first look at studies of clinicians' adoption of healthcare systems, including barriers to adoption, then at researchers' proposals for models of organizational implementation, and finally at previous studies of the effect on organizational implementation of different kinds of intervention.

2.1 Adoption of Healthcare Systems

Gallivan [17] describes organizations' adoption of IT systems as a two-stage process in which a formal, managerial decision to deploy a system is followed by actual adoption by users. This accurately describes many healthcare systems, the adoption of which is often mandated in procedures instituted along with the deployment of the systems. However, the two-stage process creates opportunities for temporary or lasting lags between the formal decision and actual adoption, either because only some of the intended users adopt the system, because only parts of the system are adopted, or because adopted parts are used less or differently than intended [16]. Candidate reasons for such lags include that the formal decision to deploy a system and the decisions about actual adoption are typically made by different people, who may disagree, and that different considerations may be salient to the formal decision and to actual adoption.

Electronic healthcare records are gradually replacing paper records, but the transition is complex, stretched over a period of decades, and unlikely to result in completely paperless hospitals [11, 21]. Moreover, clinicians use healthcare systems for far fewer tasks than the systems support [23]. Lium et al. [27] find increased use of electronic records at a near paperless hospital compared to three years ago when the hospital had just started to phase out paper records. However, the reception of the electronic records among the physicians, nurses, and medical secretaries is mixed. For example, 23% of the physicians report that it is more difficult to review a patient's problems using electronic records

than it was using paper records [27]. Conversely, Cunningham et al. [15] find that medication orders placed using electronic records are significantly more compliant with procedures than paper-based orders. This appears important as about 19% of all medication administered in hospitals contain some level of error in the process from ordering to administration [6]. Aarts et al. [2] emphasize the importance of organizational implementation to the successful introduction of healthcare systems. Differences in organizational implementation may result in the same system yielding different outcomes, even at two hospitals in a geographically confined area [1].

Studies of barriers that hamper or prevent the adoption of healthcare systems identify barriers relating to knowledge, approval, design, and implementation [39]. In addition, lack of time and resources are identified as important barriers in many studies, including the survey of the adoption of the EMR in Region Zealand [19]. In that survey the top five of the twelve barriers mentioned by respondents are:

1. Don't know: stating that barriers exist but not knowing what they are
2. Time: the system being too slow and time consuming to use
3. Lack of knowledge, information, and training
4. Inadequate support of certain work areas
5. Poor usability and overview

The first and most frequently mentioned of these barriers indicates considerable uncertainty about what constitutes the barriers to adoption of the EMR, and thereby suggests that it might be difficult to launch directed efforts to address the barriers. Apart from the first barrier, the barriers to adoption of the EMR resemble those identified in other studies [e.g., 12, 14, 35]. For example, Cabana et al. [12] identify seven kinds of barrier to guideline adherence among physicians: lack of awareness, lack of familiarity, lack of agreement, lack of outcome expectancy, lack of self-efficacy, lack of motivation, and external factors such as lack of time and resources. This suggests that there is no small set of issues sufficient to ensure the success of healthcare systems; rather, success depends on a host of interdependent issues [11].

2.2 Models of Organizational Implementation

Various socio-technical approaches [e.g., 8, 9, 26, 42] to the development of IT systems have long recognized the central importance of organizational implementation. Yet, it appears that IT projects tend to focus on technical implementation and to approach organizational implementation less systematically, if at all. For example, Markus [30] argues that there is typically little overlap between IT projects, which tend to end when technical implementation has been completed, and organizational-change programs, which tend to pay scant attention to IT. This state of affairs has obvious shortcomings in relation to IT systems, such as EMRs, that must be accompanied by the development and adoption of new work practices to be effective. Markus [30] terms such initiatives technochange and proposes a model for technochange management involving four phases: chartering, solution development, shakedown, and benefit capture. The two last phases concern organizational implementation. While shakedown is where an organization starts working in a new way and troubleshoots problems with the new technology and processes, benefit capture is the phase during which the

organization systematically derives benefits from the new way of working. IT is not a magic bullet that automatically changes organizations and produces benefits [31]. Without a systematic approach to organizational implementation, organizations are likely to experience the problems associated with shakedown but unlikely to capture the benefits of the technology.

The window of opportunity for adapting to a system and reaching benefit capture may be brief. According to Tyre and Orlikowski [40] and Huysman et al. [22] adaptation is more likely to occur immediately after deployment than any time later. The reasons for this include the pressure of production, which discourages people from spending time and resources on adaptation, and the constraining effects of habitual patterns of use. Rather than a lengthy process of gradually adapting to a new system, habitual patterns of use tend to congeal quickly and without much exploration of alternative patterns of use. This suggests that for adaptation to continue – or resume – some time after deployment a disruptive event is generally necessary. The limited adoption of the EMR in Region Zealand appears to support this contention and emphasize the need for knowledge about which kinds of intervention are effective at producing disruptive events.

While Tyre and Orlikowski [40] argue that work practices congeal shortly after a system has been taken into use, Orlikowski and Hofman [34] argue that change to a considerable extent happens over time and is unanticipated. In addition to anticipated change, which is planned ahead and occurs as intended, Orlikowski and Hofman's [34] improvisational model for change management comprises two kinds of change: emergent change and opportunity-based change. Emergent change is local and spontaneous; because it is neither anticipated nor intended, it does not involve deliberate action but grows out of practice. Opportunity-based change is purposefully introduced in response to unexpected opportunities, events, or breakdowns that might arise after the introduction of a system. While emergent change appears to be contrary to the notion of a brief window of opportunity, opportunity-based change reiterates the need for knowledge about how to capitalize on opportunities arising after the initial window of opportunity.

With inspiration from the improvisational model for change management [34], Simonsen and Hertzum [38] propose a process model for a sustained participatory-design approach. The model is iterative, and the starting point of each iteration is the anticipated changes. These changes are specified in terms of the effects that are the intended result of using the system. The system (or a part/prototype of it) is then implemented and tried out for a period of time under conditions as close to a real use as possible. Such periods of real use allow for evaluation of whether planned changes occur as intended, and they allow for emergent changes to surface. Finally, each iteration informs the next iteration by indicating whether further work is required to achieve the effects associated with the anticipated changes and by revealing emergent changes, some of which may be selected and turned into opportunity-based and new anticipated changes. By subjecting the system to real use and iteratively evaluating whether specified effects are achieved, the process model integrates technical and organizational implementation.

2.3 The Effectiveness of Interventions

Working with organizational implementation involves interventions to change the work practices of the intended users of systems. Knowledge of which kinds of intervention are effective is therefore important to models like the sustained participatory-design approach [38]. In a review of interventions used in the healthcare domain, Grimshaw et al. [20] find that: (a) Passive approaches, such as distribution of educational material and clinical practice guidelines, are generally ineffective and unlikely to cause behaviour changes. (b) Providing information in a one-on-one manner by visiting clinicians during work and providing ongoing feedback on clinicians' performance are effective interventions in many situations, including medication ordering. (c) Manual and computerized reminders are also effective in many situations but evidence is mixed for medication ordering. (d) The use of multiple interventions is more likely to be effective than single interventions. Other studies generally support these findings [e.g., 25, 41]. While active approaches and multiple interventions are probably more effective, they are also likely to be more costly. It can also be noted that the interventions covered in these studies are almost exclusively educational. While this appears to fit a two-stage adoption process where adoption is mandated but actual use depends on the staff's individual decisions to change their ways of working, it leaves out for example incentive-based interventions.

3. METHOD

To investigate how interventions and assessment of their effect can be used in working systematically with organizational implementation we conducted an action-research study at a medical ward. The study was approved by the management of the medical department and by the management board of the region's quality and development department.

3.1 The Medical Ward

The medical ward specializes in the treatment of contagious diseases and is one of six specialties at the hospital's medical department. The medical ward also includes the preadmission assessment of all patients who are not admitted directly to one of the five other wards at the medical department. As a consequence, the majority of the patients at the ward are admitted for only one or two days after which they are transferred to another ward or discharged. Approximately 1950 patients are treated at the medical ward each year. To accommodate this number of patients the ward comprises an infection-medicine unit with 10 beds and a preadmission-assessment unit with 12 beds. The ward is staffed with 1 associate chief physician, 19 nurses, and 9 healthcare assistants. To cater for the diversity in patients' diseases, 2-5 physicians from other medical specialties are involved in the treatment of the patients on an ad hoc basis. The staff works in three shifts to be able to admit and treat patients 24 hours a day.

The medication process is central to the work at the medical ward and comprises three main activities: ordering, dispensing, and administration. The ordering of medication is the physicians' responsibility, and they are also responsible for recording the orders in the EMR. Medication orders may be created, adjusted, and cancelled at all times. The dispensing and administration of medication is the nurses' responsibility. Medication is dispensed and administered four times a day, creating a division of the

medication process into four daily timeslots. At the beginning of each timeslot, the nurses consult the EMR to get the list of medication orders for a patient. Each medication on the list is dispensed and signed for individually in the EMR. When the medication has subsequently been administered to the patient, the nurse records the administration of each individual medication in the EMR. Thus, the communication between physicians and nurses about the patients' medication is fully supported by the EMR, but this communication is supplemented with recurrent oral communication. For example, the physicians in most cases inform the nurse responsible for a patient when they make adjustments to the patient's medication, especially if the adjustments are made close to the beginning of a timeslot.

The physicians and nurses at the medical ward have been using the EMR for four years. Thus, work practices have had time to stabilize. All new staff receives a half-day course in the use of the EMR and associated work procedures.

3.2 Interventions

The interventions were devised in collaboration with a nurse, a physician, a quality manager from the medical ward, and two project managers from the Quality and Development Department of Region Zealand. During a full-day workshop, these five healthcare specialists and the first author identified main areas for improving the medication process. For each of these areas they identified possible interventions, methods for assessing the effect of the interventions, barriers to their success, and the targeted group of clinicians. This process was facilitated by a wall-size chart on which workshop participants initially attached post-it notes with their individual thoughts about areas for improvement, interventions and so forth and then collaboratively discussed, refined, and rearranged notes. On the basis of the completed chart, the participants selected one area of improvement as the focus of the study, namely that all information about medication is recorded in the EMR. This area was considered important for several reasons. First, having all information about medication in one place provides for a better overview of patients' medication. Second, the regional medication procedures prescribe that all medication is recorded in the EMR. This has been a main aim of introducing the EMR, but it has neither been consistently attained at the medical ward, nor in the rest of the region. Third, recording information about medication in more than one place introduces a risk of discrepancies between the recordings with maltreatment of patients as a possible result. The occurrence of discrepancies between multiple recordings of medication is well documented [33, 37], but positive effects of redundant recordings have also been reported [13].

In devising interventions to change the clinicians' work practices, the workshop participants had to consider that neither the longstanding presence of the EMR, nor the training in its intended use had led clinicians to record all information about medication in the EMR. Thus, novel initiatives were required. The workshop participants also had to consider the practicability of the interventions and therefore decided to focus on the nurses rather than the physicians. This decision was based on a belief that the nurses would benefit more from having all information about medication in one place and would therefore be more motivated to change their ways of working. The resulting intervention

process followed the sustained participatory-design approach of Simonsen and Hertzum [38] and involved four interventions:

Delegated medication orders. All permanently employed, registered nurses at the ward were allowed to order selected medication such as light painkillers. A list of the selected medication was prepared by a nurse, assigned recommended doses by the chief physician, approved by the pharmacists, and implemented in the EMR. Thus, even when the physicians had not ordered delegated medication or only ordered it by orally informing the nurses, the nurses could record its dispensing and administration in the EMR by first recording the medication order. Previously, the nurses had recorded such medication in the nursing kardex because it was impossible for them to record it in the EMR; only the physicians were allowed to record medication orders in the EMR.

Information and training. Two information sessions were carried out during the nurses' morning break to inform them about the delegated medication orders. During these sessions a physician and a nurse explained the motivation for introducing delegated medication orders and showed how to perform them in the EMR. To ensure that all nurses learned to use the delegated medication orders, the nurse who also participated in the workshop where the interventions were devised trained her colleagues during her shifts. After three weeks all nurses at the ward had received training in the use of delegated medication orders. While it is a rather simple procedure, the labelling of its six steps in the EMR is somewhat unintuitive.

How-to pocket guide. All nurses at the ward received a one-page pocket guide containing two screen dumps annotated with instructions about how to perform delegated medication orders. Also, a copy of the pocket guide was posted next to the computer in the room where nurses dispense medication. The aim of the pocket guide was to alleviate difficulties and reluctance caused by the unintuitiveness of the six-step process involved in making delegated medication orders.

A box of candy. A box of candy containing small bags with wine gums was placed in the staff room. The lid of the box and each individual bag of wine gums carried a label saying: "*The medication out of the nursing kardex and into the EMR*". After a couple of days the box of candy was refilled. While the two previous interventions were educational, the box of candy was purely motivational.

3.3 Medical Record Audits

To determine the effect of the interventions six medical record audits were performed. The first and second audits were performed prior to the interventions to establish a baseline; the third and fourth audits were performed during the period where the interventions took place; and the fifth and sixth audits were performed after the interventions had ended. While the five first audits were performed at one-month intervals, the last audit was performed three months after the fifth audit to assess the long-term effect of the interventions.

An audit spanned a period of seven consecutive days. For each of the seven days we randomly selected four patients among the patients admitted to the ward during that day and audited their record for the first 24 hours of their admission. We chose the first day of patients' admission because critical decisions about

patients' medication are made during this period and because the majority of patients are admitted to the ward for little more than a day. With an average of about 5.3 patients admitted to the ward every day, the 28 patients included in each audit comprise about 75% of the patients admitted during the audit period.

The audits were performed by an experienced nurse with clerical assistance from the first author and consisted of reading through all nursing-kardex entries in the selected records to identify any instances of medication that was recorded in the nursing kardex. Each such instance was compared to the recordings in the EMR, and if any discrepancy existed it was considered a violation of the requirement to record all medication information in the EMR. Each violation was documented by recording:

The kind of medication (delegated or undelegated). We distinguished between two kinds of medication because delegated medication was the specific target of the interventions. Delegated medication can (after it has been implemented in the EMR) be documented correctly by nurses independently of other staff groups. Undelegated medication can only be documented correctly by nurses if physicians have ordered it in the EMR.

The shift during which the violation occurred (day, evening, or night). We recorded the shift because we expected that between-shift differences in tasks, workload, and staffing might have an impact on when violations occur.

The documentation of the audits contained no information about the identity of patients or clinicians. Across the six audits a total of 168 records were audited.

3.4 Observation

Before the intervention period, the first author explored the medication process at the medical ward by means of observation. A nurse and a physician were "shadowed" for two days each. The shadowing consisted of following the nurse or physician throughout a shift, observing their activities and, when possible, asking questions to clarify what they were doing, why it was done, and how it related to other activities. These observations served to familiarize the authors with the medical ward and the medication process. During the intervention period, the nurse was shadowed one more day, and about ten hours of additional observation were made by "hanging out" at the ward to get an impression of how the interventions were received by the staff. These observations complemented the audits and provided input about why delegated medication orders were or were not adopted. The periods of observation were documented in written notes.

After the intervention period, the nurse who had conducted the medical record audits was interviewed about her assessment and experience of the effect of the interventions. This interview lasted an hour and was audio recorded and transcribed.

4. THE INTERVENTION PROCESS

Below, we analyze the data from the medical record audits and present findings from the observations of the intervention process.

4.1 The Results of the Interventions

The medical record audits identified 45 (27%) records that contained violations of the requirement that all information about medication is recorded in the EMR. Some records contained

multiple violations; the total number of violations was 58. The numbers reported in the following analysis are exclusively the numbers of records containing violations for each kind of medication (i.e., a record is counted only once, even if it contains multiple violations for the same kind of medication) because these numbers can be directly related to the 28 records in an audit, or the total of 168 audited records.

We initially performed a multivariate analysis of variance of the data from the medical record audits with kind of medication and shift as within-groups measures and audit as a between-groups measure. This analysis showed a significant effect of audit, $F(5, 163) = 3.38, p < .01$, indicating that the interventions affected the number of violations. With the study-wide error thus protected, we proceeded with analyses of the individual kinds of medication.

Figure 1 shows the number of records violating the requirement that all information about delegated and undelegated medication is recorded in the EMR. A total of 22 violations occurred for delegated medication (13% of the 168 audited records), and 29 (17%) for undelegated medication. These numbers include six records that contained violations for both kinds of medication.

For delegated medication, the number of violations varied significantly across audits, $F(5, 163) = 2.87, p < .05$. Using reverse Helmert contrasts, we found that the numbers of violations identified at the May and June audits were lower than the average number of violations at earlier audits (both $ps < .05$). This indicates a positive effect of the interventions. At the September audit the number of violations was, however, not different from the average number of violations at the five earlier audits ($p = .6$), suggesting that the positive effect of the interventions may not be lasting. Dividing the violations into those occurring during the first three audits and during the last three audits, we get an indication of whether the interventions differentially affected the number of violations occurring at different shifts, see the right-hand side of Figure 1. While it appears that the interventions have mostly reduced the number of violations occurring during night shifts, the interaction between shift and audit was not significant, $F(10, 158) = 1.08, p = .4$.

For undelegated medication, the number of violations did not vary significantly across audits, $F(5, 163) = 2.05, p = .07$. Reverse Helmert contrasts revealed that fewer violations were identified at the May audit, compared to the average number of violations at earlier audits ($p < .05$). For all other audits there was no difference between the number of violation identified at that audit and the average number of violations at earlier audits (all $ps > .05$). This indicates that for the medication not targeted by the interventions, the number of violations remained stable across the six audits. As for delegated medication there was no interaction between shift and audit, $F(10, 158) = 1.67, p = .09$. Thus, the absence of an overall difference across audits in the number of violations for undelegated medication was not masking a difference across shifts.

The absence of differences for undelegated medication provides some evidence that the medication process at the ward was not affected by other factors in parallel with the interventions. This strengthens the link between the interventions and the differences in the number of violations for delegated medication.

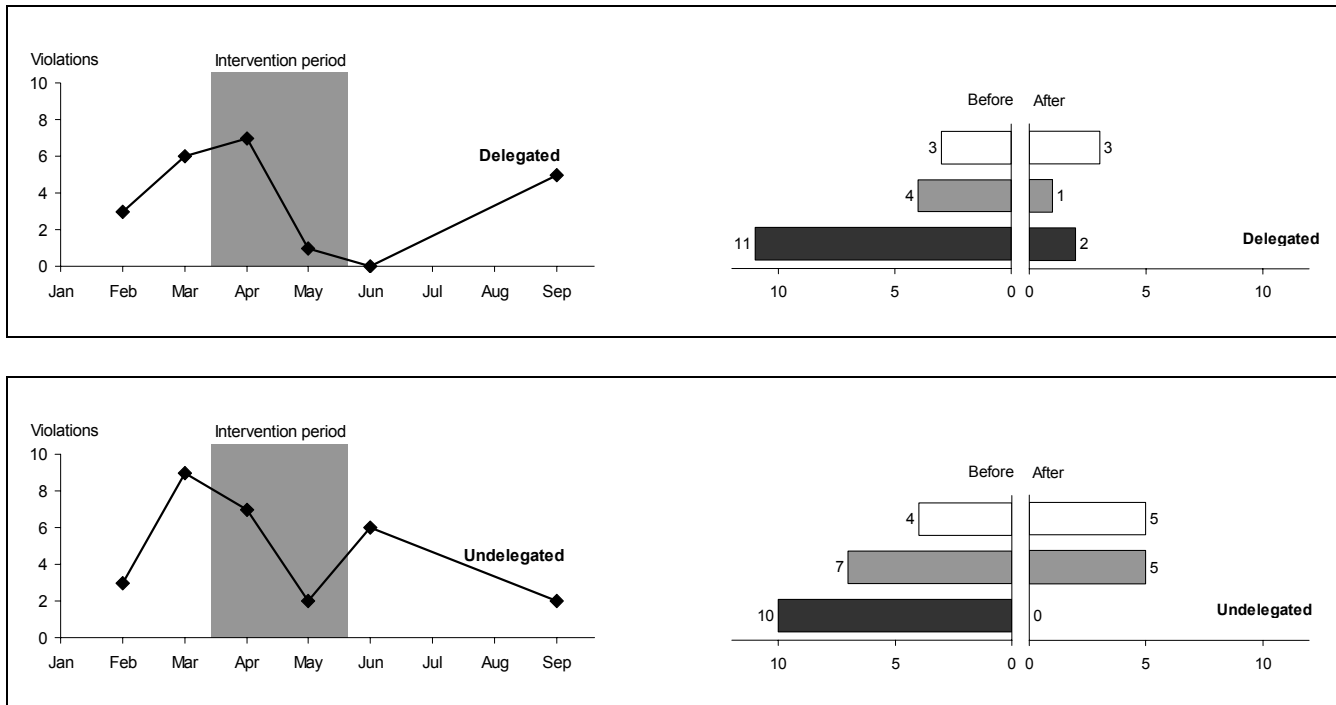


Figure 1. The number of audited records containing violations of the requirement that all information about delegated medication (top panel) and undelegated medication (bottom panel) is recorded in the EMR, $N = 168$ records. The curves on the left show the distribution of violations across the six audits. The bar graphs on the right show the same data distributed onto day shifts (upper, white bar), evening shifts (middle, grey bar), and night shifts (bottom, black bar); ‘Before’ is the sum of the three first audits, ‘After’ of the three last audits.

4.2 Adoption of Delegated Medication Orders

The intervention period started when the nurses were enabled to make delegated medication orders. On the first day of the intervention period, in mid March, the first information session was also performed; information and training activities continued in the following weeks. Thus, the intervention period began with the first two interventions. The nurses at the ward were very positive about the possibility of making delegated medication orders. One nurse said: *“This is exactly what we need”*. Observations at the ward confirmed the nurses’ positive attitude and awareness of the interventions. Nurses also started sharing insights about how to use delegated medication orders among each other. No observations suggested that nurses were reluctant to adopt delegated medication orders because they, for example, perceived the ordering of medication as the physicians’ job.

At the medical record audit in April it was, therefore, surprising to learn that the number of violations concerning delegated medication had not decreased (see Figure 1). A possible explanation is that delegated medication orders was just one of several initiatives being implemented at the ward. Other simultaneous initiatives included nutrition screening and registration of contact persons. While these initiatives were not targeting the medication process, they were competing for the nurses’ attention. It appeared as though some nurses forgot about the possibility of using delegated medication orders and simply continued documenting in the nursing kardex as they were used to do. The simultaneous presence of multiple initiatives competing for the clinicians’ attention is, however, not exceptional, and the

organizational implementation of one change in clinicians’ work practices must be able to go on in parallel with other initiatives. Another possible explanation picked up during the observations was that some of the nurses had trouble remembering how to use the EMR functionality that supported delegated medication orders. This functionality was located in a part of the EMR not normally used by nurses, and the labelling of the steps involved in making delegated medication orders was not intuitive. For example, in choosing a delegated medication the nurse is presented with two options, labelled “Use” and “Approve”. The nurse must select “Approve” to continue with a delegated medication order; selecting “Use” implies that a physician must approve the order before proceeding.

As the medical record audit in April showed that the desired effect was not being achieved after the first two interventions, additional interventions were necessary. It was unfortunately not possible to implement quick revisions of the interface of the EMR. Based on the observations of nurses forgetting about delegated medication and of their difficulties making delegated medication orders, we instead devised the third and fourth interventions: the how-to pocket guide and the box of candy. The box of candy was particularly well received. The nurses appeared to appreciate not just the wine gums but also the humorous twist and distinctly different nature of this intervention compared to the other interventions. In spite of a refill the box of candy was quickly emptied and during an observation session a week after it was initially introduced a nurse asked: *“When are we going to have candy again?”*

With respect to delegated medication, the medical record audits in May and June showed one and zero violations, respectively. The single violation at the May audit consisted of a delegated medication recorded in the nursing kardex rather than in the EMR. The recording in the nursing kardex was, however, annotated with a note saying: *"I have tried ordering in the EMR but without luck"*. Upon investigating this violation, it turned out that the nurse in question knew how to make delegated medication orders, but that she was, incorrectly, listed in the EMR as a nursing student, though she had for years been employed at the ward as a registered nurse. Consequently, she could not make delegated medication orders, because the possibility of making such orders was restricted to permanently employed, registered nurses.

Apart from this violation, all delegated medication was recorded in the EMR. This made sense to the nurses and made their work easier, as explained by one nurse: *"Now I can stay in the medication room and look in the EMR. I do not have to go back to the office, find the patient's paper record, and look in the kardex"*. This implies that the nurses benefited from their change of work practice. Consequently, the better overview of medication orders was not restricted to the physicians, who do not consult the nursing kardex.

In the period between the medical record audits in June and September neither interventions nor observations were performed at the ward. When the participating nurse was interviewed after the September audit and was presented with the results of the audits she remarked: *"We just did it so well, but now..."* She could not think of any obvious reason for the somewhat disappointing results of the September audit for delegated medication. The week covered by the audit had not been unusually busy, and no new nurses had been employed after the intervention period had ended; thus, all nurses at the ward had been exposed to the interventions. A possible, though more indirect, reason suggested by the interviewed nurse was that the charge nurse had not committed to the use of delegated medication orders. The charge nurse was not against the use of delegated medication orders, but she neither supported the interventions, which promoted the use of delegated medication orders. This absence of managerial support subtly affected the nurses' attitude toward the entire initiative, as stated by the participating nurse at the end of the project: *"I do not think they [i.e., the nurses] felt it was 'a ward project'; it was more of an EMR project"*. Thus, the nurses may not have assumed full ownership of the project but rather felt that it was to some extent imposed on them by those responsible for the organizational implementation of the EMR.

5. DISCUSSION

The main focus of this study is our iterative, intervention-based approach to organizational implementation, not the nature of the concrete interventions. Below we discuss our approach to organizational implementation and the implications of our empirical findings.

5.1 Iterative Organizational Implementation

The organizational implementation of systems such as the EMR is not accomplished by specifying and mandating procedures for their use. Neither, is it sufficient to provide information and

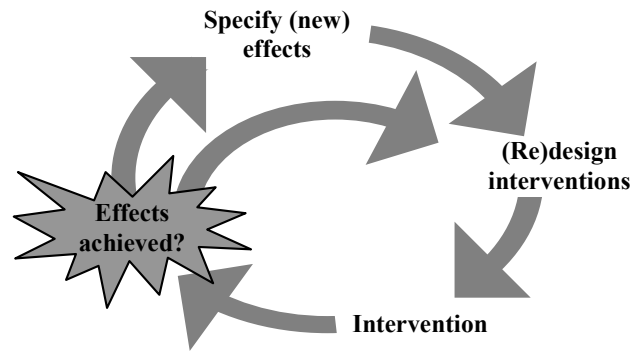


Figure 2. An iterative process for working systematically with organizational implementation.

training, as illustrated by the ineffectiveness of the two first interventions in our study. Many organizational-implementation efforts are, however, considered complete when work procedures have been specified and training provided, especially when the procedures are well received by users – such as in our case.

We approach organizational implementation as an iterative process inspired by participatory design [38] and, more generally, action research [7]. In each iteration, interventions are performed to achieve effects that are specified and assessed as part of the process, see Figure 2. In this study the desired effect, the first interventions for achieving it, and the audits assessing whether it was in fact achieved were specified during the workshop that preceded the interventions. The early audits revealed that the two first interventions did not produce the desired effect in that a considerable number of orders of delegated medication were still recorded in the nursing kardex rather than in the EMR. This was surprising given the nurses' positive reception of the introduction of delegated medication orders and shows the value of assessing whether desired effects are achieved.

As the first interventions failed to produce the desired effect, another iteration was necessary. This was a first-order iteration in the sense that additional interventions were performed to achieve an unchanged effect. The additional interventions had the desired effect, at least temporarily, as evidenced by the May and June audits. In complex settings where technology and work practices are highly interrelated, an iteration may also lead to reflection on whether the pursued effect should be abandoned, amended, or complemented with additional effects. Also, opportunities may emerge and suggest new effects [34]. This can produce second-order iterations, which aim to achieve new or changed effects.

In the healthcare region's original plan (from 2002) for the organizational implementation of the EMR, the first success criterion was that *"99.5% of all medication orders are documented by a physician"*. This was seen as a necessary and important step toward accomplishing a high-quality medication process where all information about medication was recorded in one place, namely in the EMR. Relative to that success criterion, this study constitutes a second-order iteration by replacing the aim of having physicians record all medication orders with delegated orders permitting nurses to order selected medication. The clinicians involved in devising the present study considered it more realistic to achieve this effect, and it was consistent with the overall goal of recording all information about medication in the

EMR. What seems to have changed over time is the clinicians' perception of how this overall goal is best attained. This emphasizes that effects specified ahead of organizational implementation will not remain static and that a mix of first-order and second-order iterations will, therefore, be required to match changes in context and organizational goals as well as to exploit emergent opportunities. For both kinds of iteration, interventions and assessment are necessary to instil change and ascertain how work practices are affected.

Obviously, overall goals can also be questioned and modified. Mabeck [28] finds that recording of medication in both an EMR and a paper record may serve as an informal quality control. In her study, clinicians generally relied on the paper record in cases of discrepancy, because the paper record gave information about medication in the context of other patient information whereas the EMR contained medication information only. This particularly suggests that the separation of medication information from other patient information by recording all medication in an EMR may make it easier to get an overview of a patient's medication but at the expense of making it more difficult to get an overview of a patient's condition. Cabitza et al. [13] discuss the roles of redundancy in clinical work and provide a very useful distinction between redundancy of data and redundancy of effort. While the same information is often relevant in multiple situations and in combination with a variety of other pieces of information, redundancy of effort often consumes scarce resources and consists of mere copying of information. One of the conclusions of Cabitza et al. [13] is that electronic records, in contrast to paper records, make it possible to obtain redundancy of data without redundancy of effort. This suggests that recording all medication in the EMR may decrease redundancy of effort and risk of discrepancy and improve possibilities of useful data redundancy. These possibilities will, however, only become available as the EMR is gradually extended, so for a considerable period of time the recording of all medication in the EMR will involve extra effort to adapt to the system and few immediate benefits compared to paper records. In our study, the clinicians considered it an important and worthwhile goal to record all information about medication in the EMR and to avoid such information in the nursing kardex. One pragmatic reason for their point of view was that the physicians do not consult the nursing kardex. Thus, a third-order iteration, involving a change of overall goal, was not considered relevant.

While this study shows that the work procedures associated with an EMR are receptive to organizational and motivational interventions, we are not arguing that work with the organizational implementation of such systems should exclude technical changes of the system. Rather, it is a limitation of this study that it was restricted to organizational and motivational interventions. We would, for example, have preferred to combine the how-to pocket guide with a redesign of the interface of the EMR to make delegated medication orders easier to complete. It is, however, quite common that technical changes cannot be made during organizational implementation, at least not until the scheduled release of the next version. Often, this forces a choice between short iterations that are restricted to organizational and motivational interventions and long iterations that may include technical changes of the system but risk losing momentum. An integrated approach to technical and organizational implementation, as proposed by for example Markus [30], may be

required to avoid that organizational implementation is unduly reduced to the adoption of a system that is no longer considered malleable.

5.2 Implications

This study has four implications for systematic work with organizational implementation of IT systems. First, it is encouraging that an iterative process consisting of interventions and assessments of progress can affect clinicians' ways of working. Some previous work have found that work practices tend to congeal soon after a new system has been introduced and that a disruptive event is necessary to resume adaptation [40]. Collectively, the introduction of delegated medication orders, the training in their use, the how-to pocket guide, and the box of candy appear to be an example of such an event. It is critical to the success of interventions that the involved clinicians are positive toward the change promoted by the interventions. This suggests that the effects pursued in the interventions must be specified in collaboration with the involved clinicians, but at the same time a survey of the adoption of the EMR finds that the most frequently mentioned barrier to adoption of the EMR is uncertainty about what constitute the barriers to adoption of the EMR [19]. Thus, it may be difficult for local managers to identify effective effects and interventions, and the work with organizational implementation may benefit from an external facilitator, who could be part of the EMR project team or of a more permanent organizational-implementation group.

Second, to work systematically with organizational implementation it is important to assess whether the specified effects are achieved. Clinicians are busy with their day-to-day responsibilities, and multiple extra activities typically compete for their remaining attention. Thus, even though the nurses welcomed delegated medication orders, initiatives such as delegated medication orders may be forgotten unless their adoption is monitored. Assessments of whether effects are achieved may reveal that additional interventions are needed to, for example, increase motivation among clinicians or align a new work practice better with other mandated procedures. The assessments are, however, also an opportunity to reflect on whether the specified effects match overall goals and to exploit possibilities that have emerged during the interventions [34, 38].

Third, models of organizational implementation must address the risk that the effect of interventions wears off after the interventions have ended. One interpretation of the results of the September audit in our study is that they suggest the presence of a Hawthorne effect [32]. If so, the nurses were mainly affected by the attention that was devoted to their work during the interventions, whereas the content of the interventions was secondary; consequently, the reason for the nurses' changed behaviour disappeared when the intervention period ended. More research is needed to clarify not just the immediate but also the long-term effect of different kinds of intervention. Without such knowledge, periodic reassessment of previously achieved effects may be a necessary element of organizational implementation. From a practical point of view, this points toward a tension between a wish for brief organizational-implementation projects with clear completion criteria and a need for ongoing organizational-implementation processes to sustain long-term achievement of effects.

Fourth, it may be tempting to abstain from educational, motivational, and other organizational interventions in cases where technical changes of the system appear to be a better solution. Technical changes of systems are, however, outside the scope of much work with organizational implementation, at least in the short term. We do not consider unavailability of the best solution a legitimate excuse for not working with organizational interventions, which appear to have some effect [20]. In the healthcare domain, clinicians are morally obliged to improve their practices for the benefit of patients' health and safety by either intervening in system design, implementing new ways of working, or both. We believe that a combination of technical changes and organizational interventions will yield the best results. Future work should explore a tighter integration between technical and organizational implementation.

6. CONCLUSION

Deployment of information technology involves implementation of new ways of working to attain planned as well as emergent benefits. It is well known that new work practices do not follow automatically from the introduction of new systems or training in the new ways of working; instead, a systematic approach to organizational implementation is necessary. We have investigated an iterative, intervention-based approach to the organizational implementation of an EMR at a medical ward. The interventions focused on the nurses, who were permitted to make delegated orders of selected medication. While medical record audits indicated that the interventions led to a decrease in the instances of medication not recorded in the EMR, the audits also suggested that this positive effect might not be lasting. The three primary conclusions from this study are that interventions directed at achieving specified effects must be combined with assessment of whether these effects are in fact achieved; that although specification, assessment, and possibly revision of effects are important activities, they are rather straightforward compared to performing effective interventions; and that a sustained organizational-implementation process may be necessary to work systematically with the implementation of new ways of working.

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8. REFERENCES

- [1] Aarts, J., and Berg, M. 2006. Same systems, different outcomes: Comparing the implementation of computerized physician order entry in two Dutch hospitals. *Methods of Information in Medicine*, 45, 1, 53-61.
- [2] Aarts, J., Doorewaard, H., and Berg, M. 2004. Understanding implementation: The case of a computerized physician order entry system in a large Dutch university medical center. *Journal of the American Medical Association*, 11, 3, 207-216.
- [3] Alapetite, A., Andersen, H.B., and Hertzum, M. 2009. Acceptance of speech recognition by physicians: A survey of expectations, experiences, and social influence. *International Journal of Human-Computer Studies*, 67, 1, 36-49.
- [4] Ash, J.S., Gorman, P.N., Lavelle, M., Stavri, P.Z., Lyman, J., Fournier, L., and Carpenter, J. 2003. Perceptions of physician order entry: Results of a cross-site qualitative study. *Methods of Information in Medicine*, 42, 4, 313-323.
- [5] Azad, B., and King, N. 2008. Enacting computer workaround practices within a medication dispensing system. *European Journal of Information Systems*, 17, 3, 264-278.
- [6] Barker, K.N., Flynn, E.A., Pepper, G.A., Bates, D.W., and Mikeal, R.L. 2002. Medication errors observed in 36 health care facilities. *Archives of Internal Medicine*, 162, 16, 1897-1903.
- [7] Baskerville, R., and Pries-Heje, J. 1999. Grounded action research: A method for understanding IT in practice. *Accounting, Management and Information Technologies*, 9, 1, 1-23.
- [8] Berg, M. 1999. Patient care information systems and health care work: A sociotechnical approach. *International Journal of Medical Informatics*, 55, 2, 87-101.
- [9] Bødker, K., Kensing, F., and Simonsen, J. 2004. *Participatory IT design: Designing for business and workplace realities*. MIT Press, Cambridge, MA.
- [10] Bossen, C. 2007. Test the artefact - develop the organization. The implementation of an electronic medication plan. *International Journal of Medical Informatics*, 76, 1, 13-21.
- [11] Brender, J., Ammenwerth, E., Nykänen, P., and Talmon, J. 2006. Factors influencing success and failure of health informatics systems. *Methods of Information in Medicine*, 45, 1, 125-136.
- [12] Cabana, M.D., Rand, C.S., Powe, N.R., Wu, A.W., Wilson, M.H., Abboud, P.-A.C., and Rubin, H.R. 1999. Why don't physicians follow clinical practice guidelines? *Journal of the American Medical Association*, 282, 15, 1458-1465.
- [13] Cabitza, F., Sarini, M., Simone, C., and Telaro, M. 2005. When once is not enough: The role of redundancy in a hospital ward setting. In K. Schmidt, M. Pendergast, M. Ackerman and G. Mark (Eds.), *Proceedings of the GROUP '05 Conference on Supporting Group Work*. ACM Press, New York, 158-167.
- [14] Colón-Emeric, C.S., Lekan, D., Utley-Smith, Q., Ammarell, N., Bailey, D., Corazzini, K., Piven, M.L., and Anderson, R.A. 2007. Barriers to and facilitators of clinical practice guideline use in nursing homes. *Journal of the American Geriatrics Society*, 55, 9, 1404-1409.
- [15] Cunningham, T.R., Geller, E.S., and Clarke, S.W. 2008. Impact of electronic prescribing in a hospital setting: A process-focused evaluation. *International Journal of Medical Informatics*, 77, 8, 546-554.
- [16] Fichman, R.G., and Kemerer, C.F. 1999. The illusory diffusion of innovation: An examination of assimilation gaps. *Information Systems Research*, 10, 3, 255-275.

- [17] Gallivan, M.J. 2001. Organizational adoption and assimilation of complex technological innovations: Development and application of a new framework. *The Data Base for Advances in Information Systems*, 32, 3, 51-85.
- [18] Gasser, L. 1986. The integration of computing and routine work. *ACM Transactions on Office Information Systems*, 4, 3, 205-225.
- [19] Granlien, M.F., Hertzum, M., and Gudmundsen, J. 2008. The gap between actual and mandated use of an electronic medication record three years after deployment. In S.K. Andersen, G.O. Klein, S. Schulz, J. Arts, and M.C. Mazzoleni (Eds.), *MIE2008: Proceedings of the XXIst International Congress of the European Federation for Medical Informatics*. IOS Press, Amsterdam, 419-424.
- [20] Grimshaw, J.M., Shirran, L., Thomas, R., Mowatt, G., Fraser, C., Bero, L., Grilli, R., Harvey, E., Oxman, A., and O'Brien, M.A. 2001. Changing provider behavior: An overview of systematic reviews of interventions. *Medical Care*, 39, 8, Supplement 2, 2-45.
- [21] Haux, R., Ammenwerth, E., Herzog, W., and Knaup, P. 2002. Health care in the information society. A prognosis for the year 2013. *International Journal of Medical Informatics*, 66, 1-3, 3-21.
- [22] Huysman, M., Steinfield, C., Jang, C.-Y., David, K., Veld, M.H.I.T., Poot, J., and Mulder, I. 2003. Virtual teams and the appropriation of communication technology: Exploring the concept of media stickiness. *Computer Supported Cooperative Work*, 12, 4, 411-436.
- [23] Lærum, H., Ellingsen, G., and Faxvaag, A. 2001. Doctors' use of electronic medical records systems in hospitals: Cross sectional survey. *BMJ*, 323, 7325, 1344-1348.
- [24] Landauer, T.K. 1995. *The trouble with computers: Usefulness, usability, and productivity*. MIT Press, Cambridge, MA.
- [25] Landry, M.D., and Sibbald, W.J. 2002. Changing physician behavior: A review of patient safety in critical care medicine. *Journal of Critical Care*, 17, 2, 138-145.
- [26] Leonard-Barton, D. 1988. Implementation as mutual adaptation of technology and organization. *Research Policy*, 17, 5, 251-267.
- [27] Lium, J.-T., Lærum, H., Schulz, T., and Faxvaag, A. 2006. From the front line, report from a near paperless hospital: Mixed reception among health care professionals. *Journal of the American Medical Informatics Association*, 13, 6, 668-675.
- [28] Mabeck, H. 2008. Implementation of an electronic medication system and disregarded power of the record. In S.K. Andersen, G.O. Klein, S. Schulz, J. Aarts, and M.C. Mazzoleni (Eds.), *MIE2008: Proceedings of the XXIst International Congress of the European Federation for Medical Informatics*. IOS Press, Amsterdam, 443-448.
- [29] Mark, G., and Poltrock, S. 2003. Shaping technology across social worlds: Groupware adoption in a distributed organization. In *Proceedings of the GROUP '03 Conference on Supporting Group Work*. ACM Press, New York, 284-293.
- [30] Markus, M.L. 2004. Technochange management: Using IT to drive organizational change. *Journal of Information Technology*, 19, 1, 4-20.
- [31] Markus, M.L., and Benjamin, R.I. 1997. The magic bullet theory in IT-enabled transformation. *Sloan Management Review*, 38, 2, 55-68.
- [32] Mayo, E. 1933. *The human problems of an industrial civilization*. MacMillan, New York.
- [33] Mikkelsen, G., and Aasly, J. 2001. Concordance of information in parallel electronic and paper based patient records. *International Journal of Medical Informatics*, 63, 3, 123-131.
- [34] Orlikowski, W.J., and Hofman, J.D. 1997. An improvisational model for change management: The case of groupware technologies. *Sloan Management Review*, 38, 2, 11-22.
- [35] Paré, G., and Trudel, M.-C. 2007. Knowledge barriers to PACS adoption and implementation in hospitals. *International Journal of Medical Informatics*, 76, 1, 22-33.
- [36] Scott, J.T., Rundall, T.G., Vogt, T.M., and Hsu, J. 2005. Kaiser Permanente's experience of implementing an electronic medical record: A qualitative study. *BMJ*, 331, 7528, 1313-1316.
- [37] Senderovitz, T., Christophersen, A.B., Christensen, H.R., and Kampmann, J.P. 1998. Discrepancies between medical records and dispensing records in two large hospital departments in Copenhagen. *Ugeskrift for Læger*, 160, 27, 4055-4058.
- [38] Simonsen, J., and Hertzum, M. 2008. Participative design and the challenges of large-scale systems: Extending the iterative PD approach. In J. Simonsen, T. Robertson and D. Hakken (Eds.), *PDC2008: Proceedings of the Tenth Anniversary Conference on Participatory Design*. ACM Press, New York, 1-10.
- [39] Sobol, M.G., Alverson, M., and Lei, D. 1999. Barriers to the adoption of computerized technology in health care systems. *Topics in Health Information Management*, 19, 4, 1-19.
- [40] Tyre, M.J., and Orlikowski, W.J. 1994. Windows of opportunity: Temporal patterns of technological adaptation in organizations. *Organization Science*, 5, 1, 98-118.
- [41] Wensing, M., van der Weijden, T., and Grol, R. 1998. Implementing guidelines and innovations in general practice: Which interventions are effective? *British Journal of General Practice*, 48, 427, 991-997.
- [42] Wulf, V., and Rohde, M. 1995. Towards an integrated organization and technology development. In *Proceedings of the DIS '95 Symposium on Designing Interactive Systems*. ACM Press, New York, 55-64.