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# Barriers to the Adoption and Use of an Electronic Medication Record

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**Abstract.** Clinicians' adoption of the information systems deployed at hospitals is crucial to achieving the intended effects of the systems, yet many systems face substantial adoption barriers. In this study we analyse the adoption and use of an electronic medication record (EMR) 2-4 years after its deployment. We investigate mid-and-lower-level managers' perception of (a) the extent to which clinicians have adopted the EMR and the work procedures associated with its use and (b) possible barriers toward adopting the EMR and work procedures, including the managers' perception of the usefulness and ease of use of the EMR. The investigation consists of a questionnaire survey sent to the EMR managers in one Danish healthcare region, followed up with interviews at two hospital wards. The EMR is generally perceived as useful, yet respondents state that adoption of the EMR and related procedures is far from obtained. Eleven categories of barrier are identified with uncertainty about what the barriers concretely are as the prime barrier. This prime barrier is particularly noteworthy because the respondents are formally responsible for the adoption of the EMR. It is apparent that time alone has not led to consistent adoption of the EMR. We discuss implications of this finding for the organizational implementation of systems such as the EMR.

**Keywords:** adoption, technology acceptance, adoption barriers, organizational implementation, electronic medication record, healthcare IT.

## 1. Introduction

To improve the quality and efficiency of healthcare many hospitals are involved in extensive efforts to substitute electronic patient records for paper records. Like the technical development of such technologies, the process of their organizational implementation and adoption is complex and crucial to success (Berg, 1999, Heeks, 2006, Markus, 2004). In this study we analyse the adoption of an electronic medication record (EMR) at the ten hospitals (2525 in-patient beds) in one of Denmark's five healthcare regions. The region started deployment of the EMR in 2003 and finished deployment in early 2006.

The aim of this study is to investigate mid-and-lower-level managers' perception of (a) the extent to which their clinical staff has adopted the EMR and the mandated work procedures associated with it and (b) possible barriers toward adopting the EMR and work procedures, including the managers' perception of the usefulness and ease of use of the EMR. We target managers at the mid and lower levels because these managers, contrary to end-users, can answer on behalf of the entire unit for which they are responsible and because uncertainty in the managers' answers will itself be interesting as the managers are formally responsible for their staff's compliance with mandated work procedures. The study consists of a questionnaire survey and case interviews after the EMR has been in operation for between 2 and 4 years at the region's hospitals. Thus, clinicians have gained considerable experience with the EMR, and work practices involving the system have had time to stabilize.

Our interest in how widely the EMR has been adopted and incorporated in work practices is motivated by a belief that "for a technological innovation to be truly valuable, it must be incorporated within the adopting organization's operational or managerial work systems" (Zmud and Apple, 1992, p. 148). The mandated work procedures prescribe how the EMR is to be incorporated in clinicians' work, making adoption of these procedures an integral part of the implementation and adoption of the EMR. We therefore define a barrier to the adoption of the EMR as any factor perceived (by respondents) to hinder or impede clinicians in using the EMR according to procedures. Such an inclusive definition of

barriers is in line with previous studies (Cabana et al., 1999, Sobol et al., 1999). Barriers are part of respondents' reasoning about the extent to which they consider it meaningful and practicable to work according to the procedures.

## **2. Related work**

According to technology-acceptance research (Davis, 1993, Venkatesh et al., 2003) people's adoption of a technological system depends to a considerable extent on their perception of its usefulness and ease of use, even when adoption is mandated. This emphasizes that the organizational adoption of systems is a two-stage process involving a formal, organizational decision to adopt followed by the actual adoption of the system by users (Gallivan, 2001). Actual adoption may lag behind the formal decision temporally or it may remain partial, 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 (Fichman and Kemerer, 1999).

While economic costs are a primary barrier to the formal, organizational decision to adopt information systems in healthcare (Jha et al., 2009), barriers to actual adoption relate to the clinicians' perception of the use of the systems. These barriers, for example, include that intended users perceive systems as decreasing the quality of records (Alapetite et al., 2009), increasing the time to enter medication orders (Ash et al., 2003), requiring clinicians to compromise their values and ethics to make the system work (Scott et al., 2005), and presenting knowledge barriers (Sobol et al., 1999). Brender et al. (2006) conclude 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, including technical, organizational, and people issues. This emphasizes the need for a socio-technical approach, which involves mutual adjustment of organizational and technical issues (Berg, 1999, Leonard-Barton, 1988).

Sobol et al. (1999) group barriers to the adoption of information technology in healthcare into barriers relating to knowledge, approval, design, and implementation. Studies of barriers to clinicians' adherence to guidelines, including mandated work procedures, point to similar issues. For example, Cabana et al. (1999) identify seven kinds of barriers to guideline adherence: 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. In spite of these barriers mandated procedures for clinical practices such as the use of clinical information systems are important to healthcare because they compile current knowledge, provide a structuring of important work activities, support the coordination of multidisciplinary work, and tend to improve the quality of care (Grol et al., 2004). However, mandated procedures also have limitations. Specifically, mandated procedures may entail a risk of encouraging clinicians to apply procedures rigidly, even in situations that call for clinical discretion (Hurwitz, 1999).

## **3. The EMR**

The purpose of the EMR investigated in this study is to ensure that the right medication is given to the right patients at the right time. To serve this purpose the EMR consists of facilities for recording and maintaining an overview of the ordering, dispensing, and administration of medication. While ordering is the physicians' responsibility, medication is dispensed and administered by nurses. Thus, the EMR is used by both physicians and nurses, and it is central to the coordination between physicians and nurses.

The EMR is now used on all in-patient wards in the region for all medical specialties, except anaesthesia and acute medical receiving wards. In total, approximately 10000 physicians, nurses, healthcare assistants, secretaries, physiotherapists, and medical social workers use the EMR, and several work procedures involving the EMR are mandated in the region's standard operating procedures.

Patients' diagnoses, lab tests, treatments, and other non-medication information are not documented in the EMR but in other electronic and paper records.

## 4. Method

The data for this study were collected by means of a questionnaire survey and follow-up case interviews. Approval for the study was obtained from the region's director of hospitals and from the management board in the region's quality and development department.

### 4.1 Questionnaire survey

The questionnaire was administered online. An email requesting participation was sent to all function managers, department managers, ward managers, and EMR coordinators at the hospitals in the region, a total of 430 people. Participation in the survey was anonymous and after issuing two reminders we received 232 responses (94 physicians, 129 nurses, 9 others), for a response rate of 54%.

Respondents were asked to what extent different parts of the EMR were used and to what extent different work procedures were followed. The response categories for these questions were *Always*, *Very often*, *Often*, *Rarely*, *Very Rarely*, *Never*, and *Don't know*. Participants were also asked about their agreement to a number of statements about the usefulness and ease of use of the EMR. The response categories for these questions were *Agree completely*, *Agree somewhat*, *Either*, *Disagree somewhat*, and *Disagree completely*. In addition to these fixed-response questions, participants were asked to describe, in free text, perceived barriers to using the facilities of the EMR and complying with the work procedures.

Respondents provided 522 free-text comments about barriers to the adoption of the EMR and associated work procedures. Through a collaborative process of affinity diagramming (Beyer and Holtzblatt, 1998) these comments were analysed and categorized by the first author and a staff member from the region who had a clinical background and thorough knowledge of the EMR. To assess the reliability of the resulting 11 categories, the second author independently assigned each comment to one of the categories. The Kappa value for the level of agreement between the two categorizations of the comments was 0.72, which according to Landis and Koch (1977) corresponds to substantial agreement. Disagreements were resolved through discussion and a consensus was reached.

### 4.2 Case interviews

We interviewed the chief physician and head nurse at a paediatric ward (in the following referred to as ward P) and the chief physician and deputy head nurse at a medical ward on another hospital (referred to as ward M). The two wards were selected because they were recognized within the region as wards that had worked proactively with the implementation of the EMR. The purpose of the interviews was to get a deeper understanding of the barriers to EMR adoption, initiatives and interventions to overcome these barriers, experiences from the process, and effects anticipated from adopting the EMR.

The interviews were semi-structured by an interview guide developed on the basis of the barriers expressed in the survey. This was possible because the interviews were conducted after the survey data had been analysed. The two interviewees at ward P were interviewed together, while the two at ward M were interviewed individually. Each interview lasted 40-60 minutes and was audio recorded and transcribed for analysis. Passages in the text were coded with the barriers from the survey and with issues, initiatives, and interventions specific to the wards.

For both wards, we also conducted a telephone interview with a member of the regional implementation team responsible for the implementation of the EMR at the ward. These two interviews were documented by notes.

## 5. Survey results

### 5.1 Perceived adoption of the EMR and work procedures

Figure 1 shows respondents' perception of the extent to which the main facilities of the EMR are used at the hospital wards in the region. Though the EMR was designed to support clinicians' work, none of the facilities are reported to be used always or very often by more than two thirds of the wards. Four

facilities (items 3 to 6) are used always or very often by only 3-37% of wards. This partial adoption of the EMR facilities is particularly noteworthy for the three facilities, the use of which is mandated in the region's standard operating procedures (items 2, 7, 8). For example, though it is mandated for the nurses to use the dispensing/administration facility when medication is administered to patients, respondents indicate that only 53% of wards always do so.

Figure 2 shows respondents' perception of the extent to which work procedures involving the EMR are followed. Apart from the use of standard medication orders all these work procedures are mandated in the region's standard operating procedures. However, respondents perceive that none of the work procedures are followed always or very often by more than 48% of wards and that four of the nine work procedures are followed always or very often by only 13-28% of wards (items 5, 7, 8, 9). It is, for example, mandated to set the medication status when a patient is transferred from one ward to another but only 28% of wards always or very often do so (item 5).

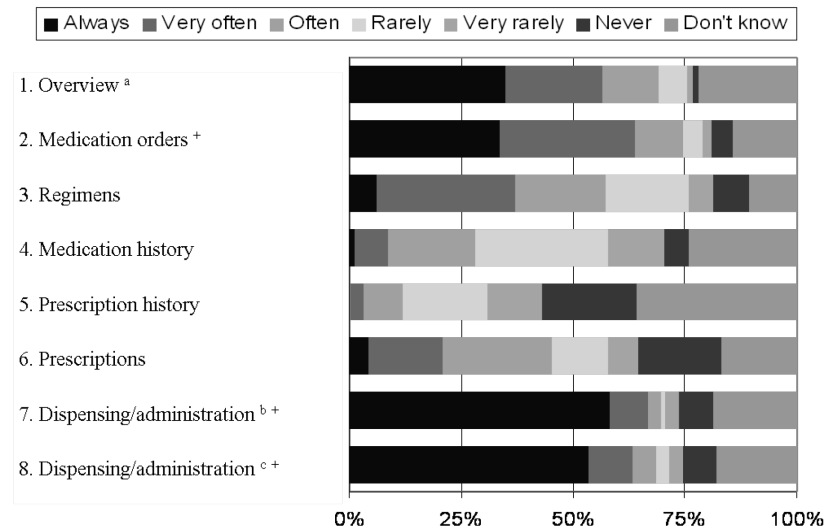


Figure 1: Perceived use of EMR facilities, N = 232 respondents

Notes: <sup>a</sup> Overview of ordered medication and its dispensing/administration. <sup>b</sup> When medication is dispensed. <sup>c</sup> When medication is administered. <sup>+</sup> The use of the facility is mandated.

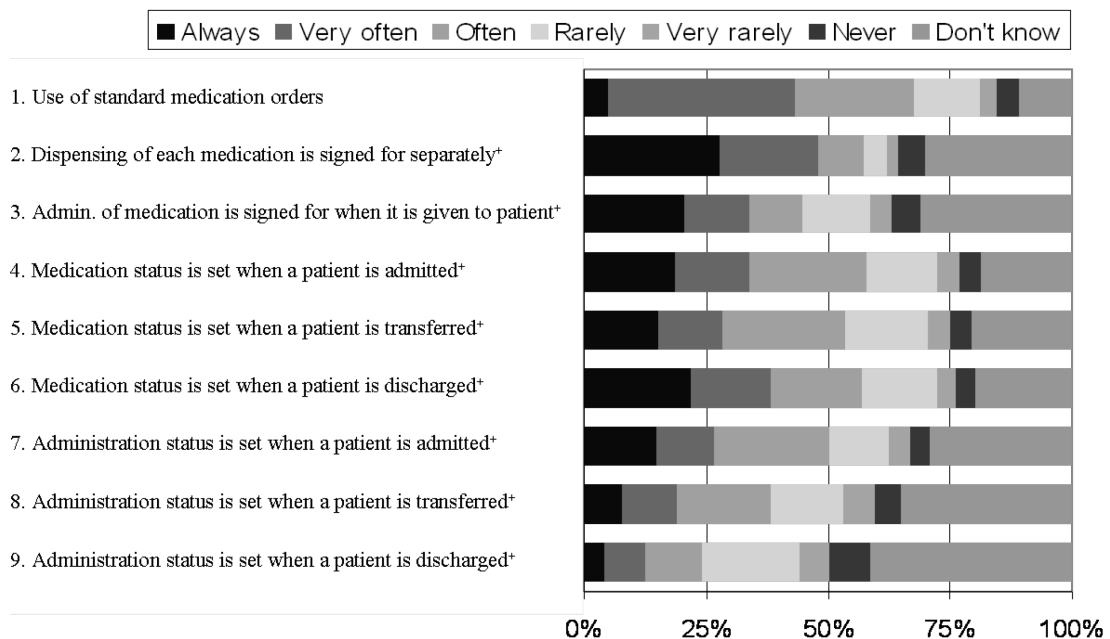


Figure 2: Perceived compliance with work procedures, N = 232 respondents

Note: <sup>+</sup> The work procedure is mandated.

Many respondents lacked knowledge of the extent to which specified work procedures were followed, as indicated by the high percentages of *Don't know* answers. Averaged over the nine work procedures in Figure 2, 26% of respondents gave *Don't know* answers. The percentage of respondents uncertain about the extent to which system facilities were used was slightly lower, but still averaged 20% *Don't know* answers across the eight EMR facilities in Figure 1.

## 5.2 Barriers to EMR use

Table 1 shows the eleven categories of barrier mentioned by respondents in their 522 free-text comments (each respondent had the opportunity to make multiple comments). Notably, the category most frequently mentioned is uncertainty about what constitutes the barriers to adopting the EMR facilities and associated work procedures. Time, the second-most-frequent category, refers mainly to technical issues such as slow response times and inferior system design making it time consuming to use the EMR. However, in some cases time refers to social issues, such as when insufficient computer skills and lack of training make the EMR time consuming to use. Additional categories related to social issues include lack of knowledge, information, and training (e.g., "Unaware of the facility") and barriers resulting from non-compliance with work procedures earlier in the medication process (e.g., "Medication orders are incomplete" making it difficult for nurses to record the medication when they subsequently dispense/administer it). Collectively the categories that mainly refer to social issues (categories 1, 3, 6, 7, 9) account for 52% of the comments. The categories mainly about technical issues include time, inadequate support for certain work areas (e.g., difficulties handling infusion medicine in the EMR), poor usability and overview, and inadequate hardware.

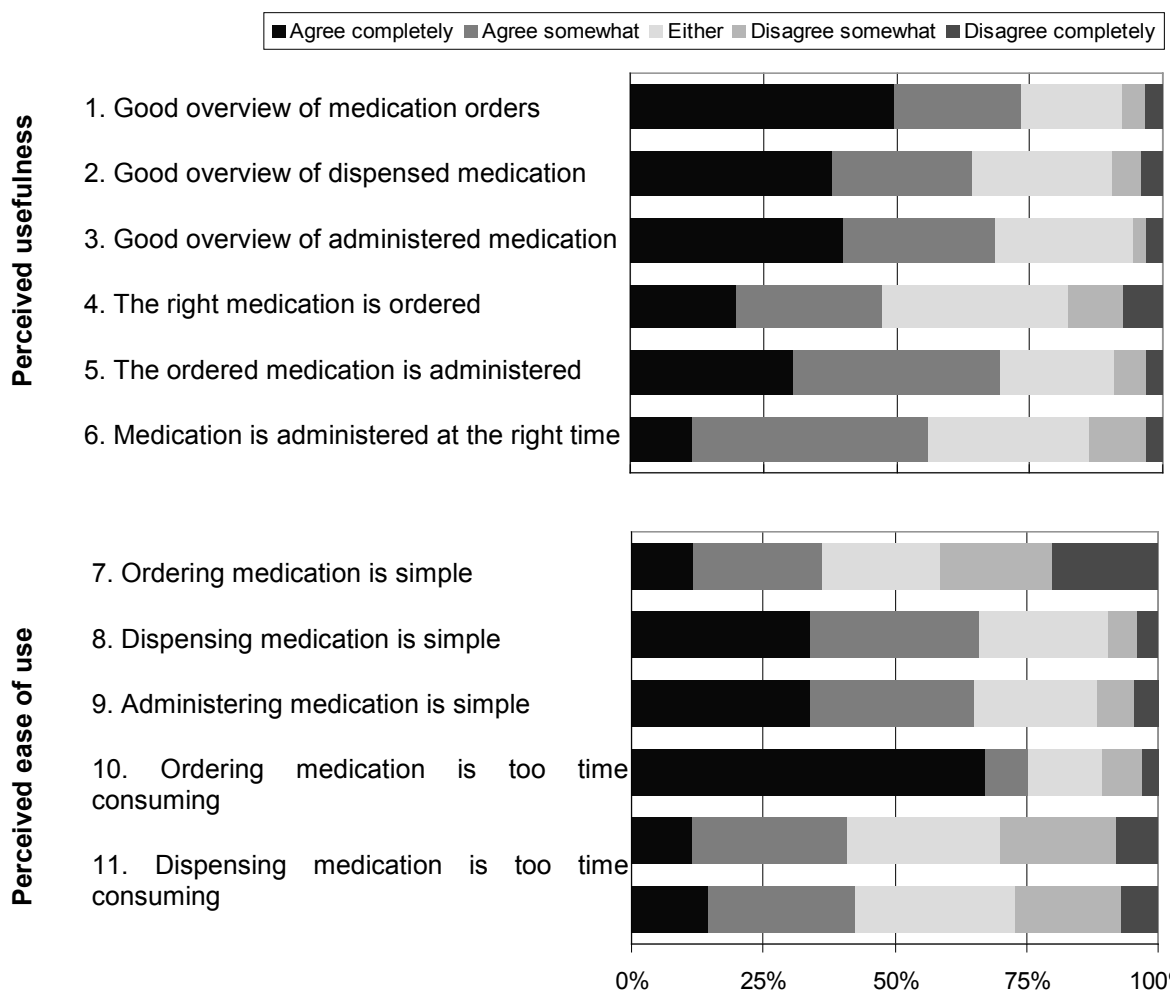
Table 1: The eleven categories of barrier,  $N = 522$  comments

Category	Number of comments
1. Don't know: stating that barriers exist but not knowing what they are	132 (25%)
2. Time: the system being too slow and time consuming to use	85 (16%)
3. Lack of knowledge, information, and training	60 (11%)
4. Inadequate support of certain work areas	55 (11%)
5. Poor usability and overview	50 (10%)
6. Non-compliance with work procedures earlier in the medication process	42 (8%)
7. Cumbersome work procedures	20 (4%)
8. Inadequate hardware	19 (4%)
9. General operating procedures experienced as in conflict with EMR	9 (2%)
10. Requests for extension or revision of EMR functionality	7 (1%)
11. Other	43 (8%)

## 5.3 Perceived usefulness and ease of use

The respondents' perception of the usefulness and ease of use of the EMR may, if negative, be an important barrier to EMR adoption. Figure 3 shows respondents' perception of the usefulness and ease of use of the EMR. Below, we collapse *Agree completely* and *Agree somewhat* answers into a combined percentage of agreeing answers. Regarding perceived usefulness, 64-73% of respondents agree that the EMR provides a good overview of the different parts of the medication process (items 1, 2, 3). The three remaining items about perceived usefulness concern the quality of

the medication process and yield slightly less positive results. Notably, the median response for the item concerning whether the right medication is ordered is neutral, that is neither agreement nor disagreement (item 4). Several respondents comment that the EMR has not reduced the number of medication errors but merely changed the types of medication error. Regarding perceived ease of use, the results show a difference between physicians and nurses. Medication ordering, which is the physicians' responsibility, is perceived as simple by only 36% of the 94 physicians among respondents (item 7) and as too time consuming by 76% of them (item 10). Conversely, dispensing and administering medication, which is the nurses' responsibility, are perceived as simple by 65-66% of the 129 nurses among respondents (items 8, 9) and as too time consuming by 41-43% of them (items 11, 12). For both simplicity and time consumption nurses rate their parts of EMR use more positively than physicians rate theirs.



**Figure 3:** Perception of the EMR and the work procedures involved in using it.

*Note: For items 1-6, all 232 respondents are included; for items 7 and 10, only the 94 physicians are included; and for items 8, 9, 11, and 12, only the 129 nurses are included.*

## 6. Case-interview analysis

At ward P the EMR was deployed in May 2005, after all staff had received half a day of training in its use and been offered an optional course in basic IT skills. The ward management appointed a person to receive extra training and follow the adoption process to identify needs for adjusting work practices. A member of the implementation team points out that ward P has shown extraordinary commitment toward the EMR and undertaken various initiatives to ensure consistent use of it. Ward M deployed the EMR in October 2005 after the staff had received training similar to that at ward P. Also, an EMR coordinator was appointed to support the clinicians and ward management in dealing with any



problems that emerged when clinicians started to use the EMR. Though the clinicians at wards M and P have learned to use the EMR, they still experience barriers that make it difficult to use the system as mandated. Other barriers have, however, been overcome through organizational initiatives or by establishing workarounds.

As in the survey, time appears a prime barrier to the consistent use of the EMR according to procedures: "It takes too long. You have to open and close so many windows." Thus, one reason for the perceived slowness of the EMR is that its use involves many operations that are merely navigational. Another reason mentioned by the interviewees is that the computers and network are slow. As a consequence the nurses at ward M have given up bringing portable computers to the patients' bedside to record the administration of medication in real time. Instead, they record the administration of medication either before or after they have administered it to the patients. This practice is contrary to procedures but considered necessary to avoid delay and frustration. At ward P, they found that they spent too much time logging on to the computers. To minimize this problem, the nurses have established a practice of marking a computer with their name at the beginning of their shift and thereby claiming this computer for the duration of their shift. This way they circumvent repeatedly logging on and starting over on a new computer. Contrary to the other interviewees, the chief physician at ward M thinks unrealistic expectations about the time savings to be achieved with the EMR is a larger barrier than the actual time needed to use the system.

The most frequent problem relating to non-compliance with procedures earlier in the medication process is that nurses cannot record the dispensing and administration of medication in the EMR if the physician has not ordered it properly. For example, if the physician initially orders the medication orally but forgets to later order it through the EMR, then the nurses cannot document the administration of the medication in the EMR, as mandated by the procedures. To alleviate such problems, the nurses at ward M have been enabled to make 24-hour orders of selected drugs such as light painkillers. This way the nurses can complete some of the physicians' incomplete medication orders and thereby also provide the basis for recording their own dispensing and administration of medication according to procedures. As the head nurse states: "It is a fact, that if the nurses do it, it gets done", implying that the physicians do not always do everything the way they ought to do it.

In the survey, lack of knowledge, information, and training was a prime barrier. The interviewees remark that though new staff completes the half day of EMR training, they cannot remember much of it when they get back to the ward. All interviewees emphasize the importance of the more informal and ad hoc training that is hardly perceived as training but often consists simply of explaining or showing a colleague how something is done. In getting clinicians to adopt procedures, it also seems effective to supplement explanations of how to do things with explanations of why it is important: "If you explain the reason to them, they are more motivated to do it. People need to be able to see the sense in it, if they are to spend time doing it." The chief physician at ward M argues that proper use of the EMR is a matter of good habits, and he sees it as part of his responsibility to instill good habits in the clinicians at his ward.

A possible barrier to the adoption of procedures could be disagreement as to whether the procedures are sensible. It is, therefore, worth noting that all four interviewees were in support of the procedures associated with the EMR. When specifically asked whether they found the procedures sensible, the interviewees gave answers such as "I find it very sensible to gather the documentation in the EMR – all in one place" and "It is, as a matter of fact, the best way to do it." In the interviewees' experience, adjustments of procedures and work practices have resolved issues that would otherwise have been barriers to the use of the EMR. The head nurse of ward P adds that though a lot can be accomplished by adjusting work practices it may take considerable time to make such adjustments: "When you introduce a new technology then people have to learn new ways of working. That is not something you do from one day to the next." While it is well known that it takes time to change habits, it is notable that this utterance is made after ward P has been using the EMR for two years, implying that learning new ways of working may take considerable time.



## 7. Discussion

### 7.1 Barriers to adoption

Respondents find that the EMR provides a good overview of medication orders, dispensed medication, and administered medication. They are also positive, though less so, about the quality of the medication process. Yet, there is a considerable gap between mandated and actual adoption of the EMR and associated work procedures. This gap persists 2-4 years after deployment in spite of training, information programmes, efforts to speed up the EMR, and improvements to the design of its user interface. In a survey of Norwegian hospitals, Lærum et al. (2001) report the related finding that physicians used electronic medical records for far fewer tasks than the systems supported. Though it is unclear whether it was mandatory to use the systems they surveyed, this suggests that substantial under-use of clinical systems is not uncommon. The respondents in our survey are the managers formally responsible for their units' consistent use of the EMR and compliance with associated work procedures. Hence, respondents ought to know the extent to which the EMR and work procedures are adopted, the barriers that impede consistent adoption, and how to address these barriers. There is, however, considerable uncertainty among respondents about the actual level of adoption and the concrete character of the barriers, complicating directed efforts to address the barriers. Stating that barriers exist but not knowing what they are is the barrier most frequently mentioned by respondents. While this barrier reflects a lack of knowledge, the lacking kind of knowledge is not included in common definitions of knowledge barriers. These definitions focus, instead, on a lack of knowledge about the system or procedure being introduced (Cabana et al., 1999, Sobol et al., 1999).

The barriers mentioned by respondents are about evenly divided between barriers that mainly refer to social issues and to technical issues, emphasizing the need for a socio-technical approach. For example, barriers relating to time persist in spite of several efforts to speed up the EMR and provide extra training, emphasizing that this barrier has to be addressed in a more effective and systematic manner to achieve adoption. At ward P, they have successfully lowered the time spent logging on to the EMR by adopting a practice where each nurse claims a computer for her or his entire shift. This workaround reduces flexibility by giving each nurse access to the EMR from one rather than all computers, but it is considered an improvement of the usability of the EMR. Such examples illustrate that pragmatic social, as opposed to technical, solutions are frequently employed to work around barriers.

As a planned effect of the EMR, the associated work procedures have shifted work from nurses to physicians. Physicians have to specify medication orders in more detail, while nurses are relieved of work – though some nurses consider it a barrier to their work that physicians still make some incomplete medication orders. This might explain why the physicians among respondents perceive the ease of use of the EMR more negatively than the nurses, a difference similar to the one reported by Lium et al. (2006). Thus, while physicians and nurses are highly interdependent in their use of the EMR, they have reasons to perceive its usefulness and ease of use from different perspectives. A result of this is barriers specific to either physicians or nurses.

A further barrier may arise from the simultaneous presence of several interrelated records, of which the EMR is only one. For years hospitals have been and will continue to be in a transitional state where some records have become electronic and others have not. A possible consequence of this transitional state is a disintegration of information, as stated by one survey respondent in a free-text comment:

*Nothing has been achieved, except that data are now recorded in [the EMR]. Medication is no longer in the patient record; that is, the unified overview of medication and symptoms is lost, which is a clinical disaster.*

This quote captures an adoption barrier that is easily dismissed as merely transitional, but such transitional states have become an almost permanent characteristic of work in many complex domains. As a consequence, the alignment of systems appears to be a key concern in achieving acceptance and adoption of individual systems.

## 7.2 Limited adoption of mandated procedures

The implementation of mandated procedures is often equated with improvement in clinical practice (Grol et al., 2004) but mandated procedures may under-recognize the contingencies of clinical practice. Respondents perceived the EMR as useful, and the interviewees at wards M and P explicitly stated that they considered the mandated work procedures reasonable. This makes the gap between procedures and practice more notable. The magnitude of the gap suggests, however, that there may be good practical reasons for not complying fully with the mandated procedures. For example, the nurses at ward M have given up documenting the administration of medication in real time, as prescribed in the procedures, because the wireless network is too unstable and the EMR too slow to enable that the administration of medication is documented at the bedside on a portable computer. The head nurse describes that the nurses continually balance compliance with procedures against what is practically feasible in the situation to get their work done. This situated use of procedures is consistent with Suchman's finding that "plans are resources for situated action, but do not in any strong sense determine its course" (Suchman, 1987, p. 52). Suchman's analysis shows that plans are underspecified and depend on users to match the plans to the practicalities of the situation and thereby make *competent* use of the plans.

If barriers such as an EMR that is too slow prevent clinicians from following procedures and, at the same time, getting their work done, then the conditions for following the procedures are not present. This suggests that management may have failed either in taking effective action against barriers or in adjusting procedures so they support clinicians rather than present unattainable ideals. In the survey, a lack of managerial support was not mentioned as a barrier to adoption. While this is contrary to several previous studies (Carroll et al., 1997, Hommelstad and Ruland, 2004), it should be remembered that the survey respondents and interviewees were managers. Lack of managerial support might have surfaced as a barrier to adoption if the survey had targeted clinicians in general.

## 7.3 Windows of opportunity

Partial adoption of mandated technologies is often explained as lags in the adoption process, suggesting that given more time adoption will occur (Gallivan, 2001). Similarly, studies performed shortly after a technology has been introduced often account for partial adoption by emphasizing that insufficient time has passed for users to gain experience with the system and for new work practices to stabilize (La Cour and Hellstern-Hauerslev, 2007). The EMR was deployed 2-4 years before this study, yet no system facility and no mandated work procedure is fully adopted by all wards. The persistence of this adoption gap suggests that it may be misconstrued to expect that a long period of use will gradually lead to more complete adoption. Rather than being gradual, the adoption process may be discontinuous and characterized by a relatively brief period for exploring and developing new work practices, which thereafter tend to stick (Huysman et al., 2003, Tyre and Orlikowski, 1994).

Tyre and Orlikowski (1994) argue that adaptation is most likely to occur immediately after deployment than any time later. For adaptation to occur sometime after deployment a disruptive event is generally necessary, and it has to be actively exploited. In explaining the brevity of this window of opportunity, Tyre and Orlikowski provide four reasons: First, the pressure of production discourages people from spending time and resources on adaptation. Second, habitual patterns of use constrain practice because they tend to congeal without much exploration of alternatives. Third, expectations are adjusted to fit experience, thereby reducing or removing the perceived need for adaptation. Fourth, the teams responsible for adaptation lose momentum or dissolve before adaptation is accomplished. All four reasons appear relevant to an understanding of the use of the EMR. For example, the forums of coordinators and super users disintegrated soon after deployment, and they were not replaced by another forum for driving the adoption process.

If the exploration of new systems and the accompanying adaptation of work practices are confined to a brief window of opportunity, after which routinization takes over, then periodic interventions become a key element of organizational implementation. Periodic interventions are necessary to provide new opportunities for modifying work practices and technology. Abstaining from such interventions entails considerable risk of only partially capturing the benefit of deploying a system (Markus, 2004).

## **7.4 Limitations**

Four limitations should be remembered in interpreting the results of this study. First, the response rate of the survey is moderate. While respondents were evenly distributed across the region's hospitals, non-respondents may differ from respondents in their perception of the EMR. The absolute number of wards at which EMR facilities and work procedures are not consistently used is, however, substantial among the respondents alone; non-respondents cannot subtract from but only add to this number. Second, survey respondents and case interviewees were managers at mid and lower levels. A management position may involve increased focus on procedures and less exposure to the practicalities of using the EMR in the day-to-day treatment of patients. Third, we do not assess the appropriateness of the mandated procedures. No respondent has, however, criticized the mandated procedures, except by commenting that they were cumbersome. Fourth, the EMR cannot be dissociated from the network, the hardware, and the other applications used along with it. Respondents' perception of the EMR incorporates their frustrations over, for example, slow network connections and this, in turn, affects how they use the EMR. Thus, the limited adoption of the EMR and work procedures cannot, based on this study, be attributed to the clinicians, the EMR, or any other single cause.

## **7.5 Implications for practice**

The EMR survey has three main implications for the region's hospitals. Keeping the above-mentioned limitations in mind, we feel that these implications are also more broadly applicable.

First, the managers formally responsible for the adoption of systems and work procedures may often be insufficiently aware of the actual level of adoption and the concrete barriers to adoption. This makes it likely that limited adoption will go unnoticed and difficult to address barriers in an effective manner. Practitioners should consider to support managers in working systematically with organizational implementation. It appears that support in realizing the issue and assuming responsibility for it may be under-recognized first steps.

Second, the gap between actual and intended use may be large. Various barriers and practical reasons may obstruct users' adoption of a system, even if they perceive the system as useful and agree that consistent use is in principle a good idea. Supporting clinicians in making the transition to a new system requires considerably more than providing a useful system, mandated procedures, and training.

Third, the window of opportunity during which clinicians explore a new system and adapt their ways of working appears to be brief. We suggest a sustained focus on organizational implementation with periodic interventions to open new windows of opportunity. Interventions should target selected barriers and be accompanied by activities to monitor whether the interventions have the intended effect.

## **8. Conclusion**

EMR systems are an important element in hospitals' shift toward electronic patient records. In one of the five healthcare regions in Denmark, managers at the mid and lower levels perceive that the main EMR facilities are used always or very often by 3-67% of the hospital wards and that the mandated work procedures associated with the EMR are followed always or very often by 13-48% of wards. These findings are not a result of limited experience with the EMR but the state of affairs after using it for at least 2 years. The EMR is fully diffused at the organizational level, but at the level of clinicians the adoption of the EMR and its incorporation into clinical work practices are far from the goals that motivated the acquisition of the EMR.

Respondents to our survey find that the EMR provides a good overview of the medication process, and they display a division between physicians and nurses in their perception of whether the process is simple and too time consuming. Apart from differences between physicians and nurses, eleven adoption barriers are mentioned by respondents as reasons for the gap between actual and mandated use. These barriers include the EMR being too slow and time consuming to use, lack of knowledge, information, and training, and inadequate support of certain work areas. The prime barrier

appears, however, to be uncertainty about what the barriers concretely are. This suggests a need for interventions at the managerial level to heighten managers' awareness of concrete barriers and have them assume responsibility for the low levels of adoption.

This study indicates that time alone will not lead to consistent adoption. First, clinicians cannot be expected to use the EMR as mandated unless the main barriers to its adoption are addressed. Second, clinicians appear to explore new systems and adapt their work practices for a brief period of time, after which work practices congeal and routinization takes over. Third, routinized work practices tend to stick until challenged. Hence, consistent adoption of technologies such as the EMR requires periodic interventions to target selected barriers and provide opportunities for renewed exploration and modification of work practices. Such a systematic approach to organizational implementation is, at present, beyond the scope of most efforts to introduce electronic patient records.

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## **References**

- Alapetite, A., Andersen, H. B. & Hertzum, M. 2009. Acceptance of speech recognition by physicians: A survey of expectations, experiences, and social influence. *International Journal of Human-Computer Studies*, 67, 36-49.
- Ash, J. S., Gorman, P. N., Lavelle, M., Stavri, P. Z., Lyman, J., Fournier, L. & Carpenter, J. 2003. Perceptions of physician order entry: Results of a cross-site qualitative study. *Methods of Information in Medicine*, 42, 313-323.
- Berg, M. 1999. Patient care information systems and health care work: A sociotechnical approach. *International Journal of Medical Informatics*, 55, 87-101.
- Beyer, H. & Holtzblatt, K. 1998. *Contextual design: Defining customer-centered systems*, San Francisco, CA, Morgan Kaufmann.
- Brender, J., Ammenwerth, E., Nykänen, P. & Talmon, J. 2006. Factors influencing success and failure of health informatics systems: A pilot delphi study. *Methods of Information in Medicine*, 45, 125-136.
- Cabana, M. D., Rand, C. S., Powe, N. R., Wu, A. W., Wilson, M. H., Abboud, P.-a. C. & Rubin, H. R. 1999. Why don't physicians follow clinical practice guidelines? A framework for improvement. *Journal of the American Medical Association*, 282, 1458-1465.
- Carroll, D. L., Greenwood, R., Lynch, K. E., Sullivan, J. K., Ready, C. H. & Fitzmaurice, J. B. 1997. Barriers and facilitators to the utilization of nursing research. *Clinical Nurse Specialist*, 11, 207-212.
- Davis, F. D. 1993. User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International Journal of Human-Computer Studies*, 38, 475-487.
- Fichman, R. G. & Kemerer, C. F. 1999. The illusory diffusion of innovation: An examination of assimilation gaps. *Information Systems Research*, 10, 255-275.
- 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, 51-85.
- Grol, R., Wensing, M. & Eccles, M. (eds.) 2004. *Improving patient care: The implementation of change in clinical practice*, Burlington, MA: Butterworth-Heinemann.
- Heeks, R. 2006. Health information systems: Failure, success and improvisation. *International Journal of Medical Informatics*, 75, 125-137.
- Hommelstad, J. & Ruland, C. M. 2004. Norwegian nurses' perceived barriers and facilitators to research use. *AORN Journal*, 79, 621-634.

- Hurwitz, B. 1999. Legal and political considerations of clinical practice guidelines. *British Medical Journal*, 318, 661-664.
- Huysman, M., Steinfield, C., Jang, C.-Y., David, K., Veld, M. H. I. T., Poot, J. & Mulder, I. 2003. Virtual teams and the appropriation of communication technology: Exploring the concept of media stickiness. *Computer Supported Cooperative Work*, 12, 411-436.
- Jha, A. K., Desroches, C. M., Campbell, E. G., Donelan, K., Rao, S. R., Ferris, T. G., Shields, A., Rosenbaum, S. & Blumenthal, D. 2009. Use of electronic health records in U.S. hospitals. *New England Journal of Medicine*, 360, 1628-1638.
- La Cour, V. & Hellstern-Hauerslev, C. 2007. Evaluating the implementation and use of a computerized physician order entry system: A case study. In: Westbrook, J. L., Coiera, E., Callen, J. L. & Aarts, J. (eds.) *Proceedings of the Third International Conference on Information Technology in Health Care*. Amsterdam: IOS Press.
- Landis, J. R. & Koch, G. G. 1977. The measurement of observer agreement for categorical data. *Biometrics*, 33, 159-174.
- Leonard-Barton, D. 1988. Implementation as mutual adaptation of technology and organization. *Research Policy*, 17, 251-267.
- Lium, J.-T., Lærum, H., Schulz, T. & 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, 668-675.
- Lærum, H., Ellingsen, G. & Faxvaag, A. 2001. Doctors' use of electronic medical records systems in hospitals: Cross sectional survey. *British Medical Journal*, 323, 1344-1348.
- Markus, M. L. 2004. Technochange management: Using IT to drive organizational change. *Journal of Information Technology*, 19, 4-20.
- Scott, J. T., Rundall, T. G., Vogt, T. M. & Hsu, J. 2005. Kaiser Permanente's experience of implementing an electronic medical record: A qualitative study. *British Medical Journal*, 331, 1313-1316.
- Sobol, M. G., Alverson, M. & Lei, D. 1999. Barriers to the adoption of computerized technology in health care systems. *Topics in Health Information Management*, 19, 1-19.
- Suchman, L. 1987. *Plans and situated action: The problem of human-machine interaction*, Cambridge, UK, Cambridge University Press.
- Tyre, M. J. & Orlikowski, W. J. 1994. Windows of opportunity: Temporal patterns of technological adaptation in organizations. *Organization Science*, 5, 98-118.
- Venkatesh, V., Morris, M. G., Davis, G. B. & Davis, F. D. 2003. User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27, 425-478.
- Zmud, R. W. & Apple, L. E. 1992. Measuring technology incorporation/infusion. *Journal of Product Innovation Management*, 9, 148-155.