

# The Gap between Actual and Mandated Use of an Electronic Medication Record Three Years after Deployment

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**Abstract.** Three years after the hospitals in one of Denmark's five healthcare regions deployed an electronic medication record (EMR) four of eight main system facilities are used consistently by only 3%-37% of the hospital wards. Furthermore, four of eight mandated work procedures involving the EMR are followed consistently by only 13%-28% of wards. No system facility or work procedure is consistently adopted by more than 67%, respectively 48%, of wards. Barriers to adoption of the EMR include system factors, such as the EMR being perceived as prohibitively time consuming to use, as well as human factors, such as lack of knowledge, information, and training among clinicians. However, the prime barrier appears to be uncertainty about what the barriers concretely are and about the extent to which system facilities and work procedures are actually adopted. Three years after deployment it is apparent that time alone does not lead to consistent adoption. Rather, interventions are necessary to overcome the barriers.

**Keywords.** EMR, implementation, deployment, diffusion, compliance.

## Introduction

As part of the extensive efforts to substitute electronic patient records for paper records at Danish hospitals, Region Zealand (one of five healthcare regions in Denmark) started deploying an electronic medication record (EMR) at the hospitals in 2003 and finished deployment in early 2006. The EMR is now used on all hospital wards and in some out-patient clinics by approximately 10000 physicians and nurses for maintaining an overview of patients' medication. The physicians also use the EMR for ordering medication and the nurses for dispensing and administering medication. The intention of the EMR is to help ensure that the right medication is given to the right patients at the right time. Several work procedures involving the EMR are mandated in the region's standard operating procedures for medication. The EMR is part of the electronic patient record, and the implementation of the EMR and the associated work processes and clinical guidelines aims to improve patient safety and documentation quality. It is, however, a general impression in Region Zealand that these aims have not been attained and that the EMR is not used as intended. Such gaps between an organizational decision to acquire a system and the actual use of the system by people

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in the organization have been termed assimilation gaps [1]. Assimilation gaps indicate that the actual use of a system is a separate decision, not simply a product of the decision to acquire the system. In this study we analyse the extent to which the different parts of the EMR are used and the extent to which the mandated procedures for using the EMR in the medication process are followed. Our interest in how profoundly the EMR has become incorporated in the practices of the hospital staff 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 system” [2].

The aim of this study is twofold: (a) to assess the actual adoption of the EMR among hospital staff and their compliance with guidelines for its use and (b) to investigate possible barriers toward adopting the EMR and associated work procedures after the hospital staff had gained considerable experience with the system.

## 1. Method

The data for the study were collected by means of an online questionnaire that was developed by the authors and administered with the survey tool SurveyXact®. An email requesting participation was sent to all function managers, department managers, ward managers, and EMR coordinators at the hospitals in Region Zealand, 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%. The targeted clinicians were managers at the mid and lower levels. We targeted these clinicians for two reasons. First, contrary to end-users the targeted clinicians could answer on behalf of the entire unit for which they were responsible. Second, if the targeted clinicians’ answers revealed uncertainty about the actual adoption of the EMR this was itself interesting because these clinicians should according to organizational guidelines be able to answer the questions on behalf of their unit.

Questions in the survey concerned the adoption of the EMR and associated work procedures. 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*. Respondents were also asked to describe, in free text, perceived barriers to using the facilities of the EMR and complying with the work procedures. Moreover, information about the training provided in the use of the system was elicited through a number of questions not analysed in this paper. The questionnaire comprised 59 questions in total and was estimated to take 15 minutes to complete.

Respondents provided 522 free-text comments about barriers to the adoption of the EMR and associated work procedures. These comments were analysed and categorized by the first and third authors through a collaborative process of affinity diagramming [3]. To assess the reliability of the resulting 12 categories, the second author independently assigned each comment to a category. The Kappa value for the level of agreement between the two categorizations of the comments was 0.72, which according to Landis and Koch [4] corresponds to ‘substantial’ agreement. Disagreements were resolved through discussion and a consensus was reached.

## 2. Results

Table 1 shows the extent to which the main facilities of the EMR are used by the wards of the hospitals in Region Zealand. Though the system was designed to support the clinicians' work, none of the facilities are used always or very often by more than two thirds of the wards, and four of the facilities are used always or very often by only 3%-37% of wards. This partial adoption of the system facilities is particularly noteworthy for the three facilities, the use of which is mandated in the region's standard operating procedures for medication. Furthermore, the extent to which one system facility is used at a ward weakly indicates that the other system facilities are used to a similar extent in that the average pair-wise Spearman correlation between system facilities is 0.30 ( $SD = 0.15$ ),  $p < 0.05$  for 24 of the 28 pairs of correlation.

Questions about the use of five of the system facilities (questions 1, 3, 6, 7, and 8 in Table 1) were also included in a survey in 2004 at the first hospital that deployed the system. A comparison of the responses indicates that the extent to which these five system facilities are used always or very often has increased about 20 percentage points in the three years since 2004.

**Table 1.** Extent to which system facilities are used,  $N = 232$ .

Use of system facilities (tab sheets)	Always + Very often	Often + Rarely	Very rarely + Never	Don't know	Mandated
1. Overview (of ordered medication and its dispensing/administration)	56%	19%	3%	22%	
2. Medication orders	64%	15%	7%	14%	Yes
3. Regimens	37%	39%	13%	11%	
4. Medication history	9%	49%	18%	24%	
5. Prescription history	3%	28%	33%	36%	
6. Prescriptions	21%	37%	25%	17%	
7. Dispensing/administration <sup>a</sup>	67%	4%	11%	19%	Yes
8. Dispensing/administration <sup>b</sup>	63%	8%	10%	18%	Yes

<sup>a</sup> When medicine is dispensed, <sup>b</sup> When medicine is administered.

Table 2 shows 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 for medication. However, none of the work procedures are followed always or very often by more than 48% of wards, and four of the nine work procedures are followed always or very often by at most 28% of wards. The extent to which one work procedure is followed at a ward weakly indicates that the other work procedures are followed to a similar extent in that the average pair-wise Spearman correlation between work procedures is 0.29 ( $SD = 0.22$ ),  $p < 0.05$  for 25 of the 36 pairs of correlation.

Respondents were also asked to indicate the overall extent to which the standard operating procedures for medication were complied with. Though answers to this question correlated significantly with answers to six of the nine questions about the

extent to which specified work procedures were followed the correlations were weak, suggesting limited awareness of the content of the standard operating procedures. Furthermore, 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 all nine work procedures, 31% of function managers ( $N = 35$ ) and 30% of department managers ( $N = 79$ ), the subgroups of respondents formally responsible for their unit's compliance with standard operating procedures, gave *Don't know* answers. Across all 232 respondents the average was 26%. The percentage of respondents uncertain about the extent to which system facilities were used was slightly lower, but still averaged 20% across the eight questions in Table 1.

**Table 2.** Extent to which work procedures are followed,  $N = 232$ .

Work procedures	Always + Very often	Often + Rarely	Very rarely + Never	Don't know	Mandated Compliance assessment <sup>a</sup>	Compliance assessment <sup>a</sup>
1. Use of standard medication orders	43%	38%	8%	11%		0.07
2. Dispensing of each medicine is signed for separately	48%	14%	8%	30%	Yes	0.14 *
3. Administration of medicine is signed for when it is given to patient	34%	25%	10%	31%	Yes	0.15 *
4. Medicine status is set when a patient is admitted	34%	39%	9%	19%	Yes	0.32 ***
5. Medicine status is set when a patient is transferred	28%	42%	9%	21%	Yes	0.27 ***
6. Medicine status is set when a patient is discharged	38%	34%	8%	20%	Yes	0.38 ***
7. Administration status is set when a patient is admitted	27%	36%	8%	29%	Yes	0.22 **
8. Administration status is set when a patient is transferred	13%	31%	15%	41%	Yes	0.10
9. Administration status is set when a patient is discharged	19%	34%	12%	35%	Yes	0.09

<sup>a</sup> Spearman correlation with question 'Standard operating procedures for medication are followed', \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Table 3 shows the five categories of barrier most frequently mentioned by respondents in their free-text comments, totaling 73% of the comments. The categories can be divided into those related to system factors and those related to human factors. System factors include poor usability and overview (e.g., "Difficult to get an overview due to an illogical composition of the interface") and areas inadequately supported by the system (e.g., it is difficult to handle infusion medicine in the EMR because the frequent adjustments of the infusion rate are cumbersome). Time is a system factor in the cases where it refers to the slow response times of the EMR or when inferior design is the reason for the system being time consuming to use. While most of the comments about time refer to system factors, time can also be a human factor. This is, for example,

the case when insufficient computer skills and lack of training are the reasons why system use takes a lot of time. The categories related to human factors include lack of knowledge, information, and training, but the largest human-factors category is uncertainty about what constitutes the barriers to using different parts of the EMR.

**Table 3.** The five most frequent categories of barrier,  $N = 522$ .

	<b>Category</b>	<b>Number of comments</b>
1	Don't know: stating that barriers exist but not knowing what they are	132
2	Time: the system being too slow and time consuming to use	85
3	Lack of knowledge, information, and training	60
4	Inadequate support of certain work areas	55
5	Poor usability and overview	50

### 3. Discussion

Three years after deployment there is a considerable gap between mandated and actual adoption of the EMR and associated work procedures. This gap exists in spite of several attempts during the past three years to address some of the barriers toward using the system and complying with standard operation procedures for medication. Both Region Zealand and the EMR vendor have been aware of the slowness of the system and have tried to improve the network, the computers, and the design of the EMR itself. Furthermore, the regional implementation organization has established a standard training program for new staff, and continuously throughout the last three years extra information and training have been provided.

Function and department managers (49% of the survey respondents) are formally responsible for their unit's consistent use of the EMR and compliance with medication procedures. Hence, these 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. The responsible managers are, however, to a considerable extent uncertain about what the barriers concretely are, complicating directed efforts to address the barriers. The remaining respondents display a similar uncertainty.

Several concrete barriers are, however, mentioned frequently by respondents. Though it may in some situations be difficult to determine whether time barriers are due to insufficient hardware, inefficient EMR software, or inadequately trained staff it is unquestionable that time is perceived and pointed out as a vast barrier by the respondents. It therefore has to be addressed. Similarly, the lack of knowledge, information, and training needs to be addressed. The previous attempts at increasing knowledge and information through training serve to emphasize that this barrier has to be addressed in a more targeted, effective, and systematic manner to achieve adoption. A recent study of another EMR implementation in Denmark showed that three months after deployment the actual level of use was far below the desired level of use. This assimilation gap was partly explained by the short period of use [5]. In our study we find a similar gap after three years of use, suggesting that it may be overly optimistic to

expect that a long period of use will lead to a gradual closing of such gaps. A candidate explanation for the persistence of assimilation gaps is the concept of media stickiness [6]. Huysman et al. [6] found that the patterns of use for a new system are developed shortly after the system is deployed and tend to persist over time.

We see a need for an increased focus, by the responsible clinical managers as well as by the EMR implementation organization, on the barriers toward using the EMR and on ways of addressing these barriers. To overcome the barriers, this focus must be accompanied by activities to monitor whether the interventions that are undertaken have any effects and, if not, by the launching of new interventions. It would also be desirable with a more in depth ethnographic study to unveil unidentified barriers.

#### **4. Conclusion**

In this study we have found a considerable gap between mandated and actual use of an EMR and a lack of compliance with the work procedures associated with the EMR. These findings are not a result of limited experience with the EMR but the state of affairs after three years of use. The EMR is fully diffused at the organizational level but at the level of clinicians the adoption of the EMR and its incorporation into clinicians' work practices are far from the level necessary to attain the goals that motivated the acquisition of the EMR. A number of barriers related to both human and system factors enter into explaining the gap, but considerable uncertainty also exists about what the concrete barriers actually are. We therefore suggest further investigation of the barriers and experiments exploring what kinds of intervention can counteract the barriers. This study indicates that time alone will not lead to consistent adoption; hence, we cannot expect the EMR to be used as mandated unless the barriers are addressed. Hence, better knowledge of existing barriers and effective interventions are required.

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#### **References**

- [1] Fichman, R., G. and C. Kemerer, F. , *The Illusory Diffusion of Innovation: An Examination of Assimilation Gaps*. Information Systems Research, 1999. **10**(3): p. 255-275.
- [2] Zmud, R.W. and L.E. Apple, *Measuring Technology Incorporation/Infusion*. Journal of Product Innovation Management, 1992. **9**(2): p. 148-155.
- [3] Beyer, H. and K. Holtzblatt, *Contextual design : Defining Customer-Centered Systems*. Morgan Kaufmann series in Interactive Technologies, ed. S. Card, Grudin, J., Linton, M., Nielsen, J., Skelly, T. 1998, San Francisco: Morgan Kaufmann.
- [4] Landis, J.R. and G.G. Koch, *The measurement of observer agreement for categorical data*. Biometrics, 1977. **33**(1): p. 159-174.
- [5] La Cour, V. and C. Hellstern-Hauerslev, *Evaluating the implementation and use of a computerized physician order entry system: a case study*. Stud Health Technol Inform, 2007. **130**: p. 75-9.
- [6] Huysman, M., et al., *Virtual Teams and the Appropriation of Communication Technology: Exploring the Concept of Media Stickiness*. Computer Supported Cooperative Work: The Journal of Collaborative Computing, 2003. **12**(4): p. 411-436