End-User Expectations During an Electronic Health Record Implementation: a Case Study in Two Academic Hospitals

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Abstract. Implementing an Electronic Health Record (EHR) is a sociotechnical process. End-users' expectations and attitudes need to be monitored during the implementation of a new EHR. It is not clear what end-users consider the most important determinants (both barriers and enablers for a successful EHR implementation) during this process. Based on the concept mapping method and a literature search we developed a questionnaire to investigate which determinants (future) end-users of an EHR consider important. Additionally we analysed whether there are differences between a centre working with a legacy EHR and one with paper-based patient records before implementation. We identified the following determinants: usability of EHR, availability of facilities, alignment with work processes, support during implementation, training on new EHR, support after implementation, practice with new EHR, internal communication, learning from other centres, reuse of patient data, general IT skills, and patient involvement in decision making. All determinants were perceived important by end-users to successfully work with an EHR directly after its go-live. The only two significant differences between centres were knowledge about the effect of the EHR on work processes, and importance of patient involvement in decision making.

Keywords. Medical Records Systems, Electronic Health Records, Implementation, Health Personnel, Success Factors, Barriers.

Introduction

The implementation of a new Electronic Health Record (EHR) is a sociotechnical process [1]. This means that not only the technicalities of the EHR need to be considered but also the organisational context and social constructs of the organisation. Therefore it is important to take the end-users' expectations and attitudes into account during the implementation process [2]. However, it is not clear what end-users perceive as the most important determinants during an EHR implementation. This makes it difficult to address the determinants that actually matter to the user and can potentially

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influence implementation success. Determinants can be both barriers and enablers for a successful EHR implementation.

In this study we investigated in two university hospitals what (future) end-users of an EHR perceived as the most important determinants during the implementation of a new EHR. One hospital currently works predominantly with paper-based patient records while the other centre currently works with a legacy EHR. The difference in baseline modality (paper records versus legacy EHR) can influence the priorities for implementing an EHR [3]. Therefore, we analysed whether the different baseline modalities of the two centres lead to different results.

1. Methods

We performed our study in two university hospitals in the Netherlands. Most departments in centre A processes patient data with a set of computer programs, together forming the EHR; whereas centre B works predominantly with paper-based records. Employees of both centres work on patient care, research, and education and both centres are jointly implementing a new EHR. At the time of starting this research the majority of the personnel was not familiar with the upcoming implementation process of the new EHR.

Based on the concept mapping method [4] and a literature search (EJ), we developed an online questionnaire to measure what (future) end-users of an EHR perceived as the most important determinants during the implementation of a new EHR. We performed (EJ, RC, MdB, NdK) concept mapping to investigate the possible determinants according to the end-users (centre A n=28, centre B n=18).

Based on the resulting determinants in combination with determinants from the literature we established a list of 12 determinants that can be of importance to successfully work with an EHR directly after its go-live (Figure 1). The questionnaire was used to attain a more detailed insight in the expectations of the end-users.

Our questionnaire consists of three sections: participant characteristics, rating of the determinants, and additional in-depth questions on four specific determinants (internal communication, general IT skills, reuse of patient data, and training on the new EHR). We asked the participants to rate the determinants on a 1 to 10 scale (1= not important, 10= very important). Our questionnaire consists of 32 closed-ended questions and 1 open-ended question. The study design was submitted to the ethics committee of the AMC, and was exempt from review.

The invitation to participate in the online questionnaire was sent to all possible (future) end-users of the new EHR. We expected our target population of (future) end-users to be approximately 10,000 people. To make sure we included our entire target population, email invitations were sent to the 20,071 people who have a working relation to the two centres inviting them to participate in this research. The first question of the questionnaire identified whether employees were in the target population (i.e. future EHR end-users); the questionnaire for all other employees finished after this first question. After three weeks a reminder email was sent to the participants who had not yet responded. Two weeks later the questionnaire was closed.

We used Chi-square and Mann-Whitney U tests to compare distributions between the two organisations (difference in baseline modality). We used Goodman and Kruskal's gamma to calculate the association between ordinal variables and Kruskal–Wallis one-way analysis of variance to compare distribution between participant

groups. We considered p < 0.05 significant, and p < 0.0024 after Bonferroni correction for multiple testing. All responses were analysed in R version 3.1.1 [5].

2. Results

In total 4,542 people responded to our invitation of which 2,960 respondents were in our target population. The results in this paper are based on these respondents. Table 1 reports the demographics of our respondents.

Table 1. Respondent demographics

	n (%)		n (%)
Total	2960 (100)	**Function (in both centres)**	
Organisation		Analytical staff	92 (3)
Centre A	1508 (51)	Facilitating staff	37 (1)
Centre B	1439 (49)	Clinical (co-)care provider	222 (8)
Gender		Medical support staff	276 (10)
Male	739 (25)	Management	113 (4)
Female	2213 (75)	Specialists	599 (21)
Age		Staff, administration and secretariat	446 (15)
<29	571 (19)	Nursing	874 (30)
30-39	824 (28)	Scientific research	231 (8)
40-49	625 (21)		
50-59	740 (25)		
>60	192 (7)		

Eleven out of twelve determinants (Figure 1) scored between 8.0 (having general IT skills) and 9.4 (having a user-friendly system). The only outlier was "involving the patient in decision making (on EHR implementation decisions)" (6.3); which also showed a significant difference between the two centres (p<0.0024).

In our in-depth sections of the questionnaire we asked if the users knew what the effects of the new EHR were going to be (Likert-scale 1-5, corresponding to no knowledge to precise knowledge). The mean was 2.7 (ranging from "I know very little about the effects" to "I know approximately what the effects are"). The self-reported knowledge about the effects of the new EHR on the work processes is significantly higher in centre B (p<0.0024).

Of the respondents 84% indicated that they were (very) skilful in working with the current systems they encounter in their daily work processes (no difference between centres). In general the participants said to be comfortable in working with a computer. In participants under 40 years of age more than 95% (strongly) agreed on feeling comfortable. Participants over 40 years of age (strongly) agreed in 89-72%. Age and comfort in computer work are negatively correlated (gamma = -0.36, p<0.0024).

Another in-depth item in our questionnaire is training with the new EHR. All end-users will be trained in using the new system before go-live. Users suggested that training on IT skills is useful (3.9 on a Likert scale 1-5, ranging from "very useless" to "very useful") and important (8.7 out of 10).

We found that older users expected to need more training (p<0.0024) (Figure 2). Users that indicated that they did not feel comfortable in working with a computer showed an increased expectation in number of needed hours for training as well (p<0.0024) (Figure 3). Because of a limited number of participants in specific subgroups and no significant difference between centres the results in figures 2 and 3 are not treated separately per centre.
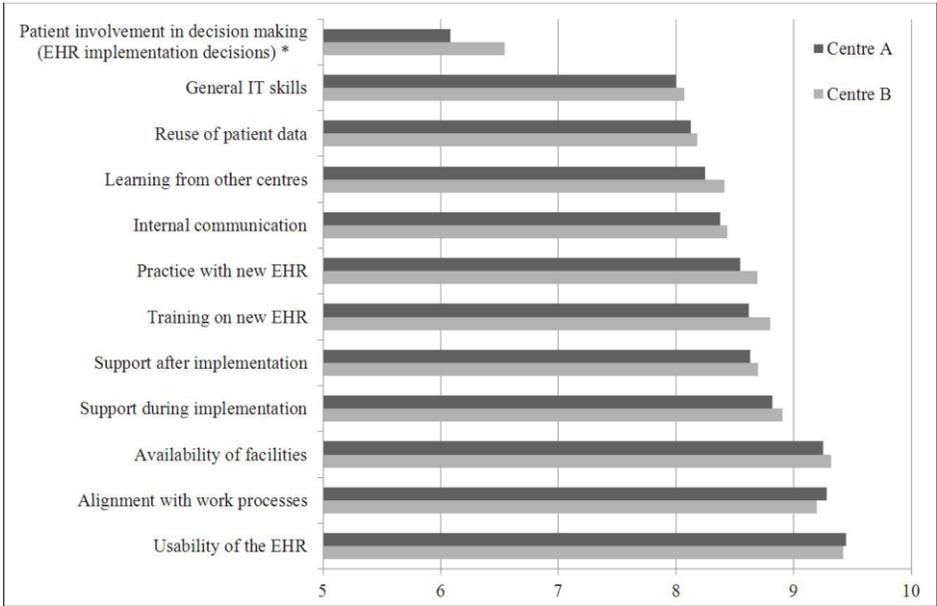
Figure 1. Rating of determinants to successfully work with an EHR directly after its go-live (* indicates a significant difference between centres)
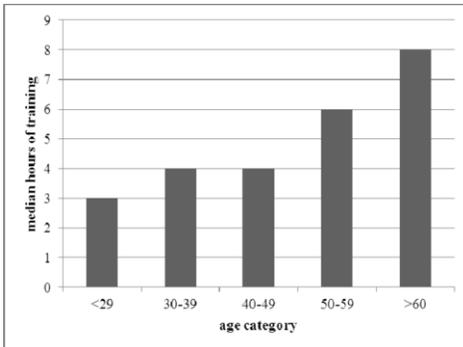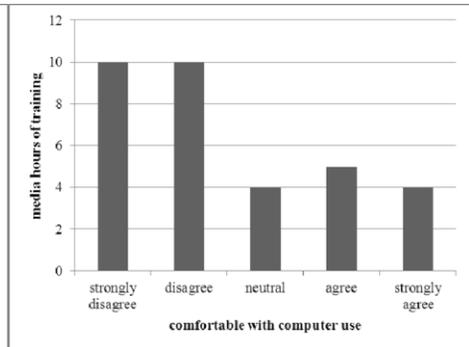

Figure 2. Age vs. median hours of training

Figure 3. Comfortable with computer use vs. median hours of training

3. Discussion

End-users consider a wide range of determinants important to them to successfully start working with an EHR directly after its go-live. The participants found all 12 determinants from our questionnaire important. The determinant "patient involvement in (EHR implementation) decision making" was the least important. This indicates that the participants will probably still make decisions based on the needs of the patients but do not want to include the patients themselves in that specific decision making process.

The baseline modality (paper versus EHR) of the centre did not significantly influence most of the outcomes. Only two results differed between the two centres:

importance of patient involvement in decision making, and knowledge about the effects of the EHR on the work processes. The personnel of the two centres responded comparably, although the current situation in the centres before the implementation of the new EHR is substantially different. Centre A works with computerised health records whereas centre B is predominantly working with paper-based records. The personnel of centre B have a higher self-reported knowledge about the effects of the EHR on work processes. Given the shared and similar processes of communication and implementation in both centres this might indicate an overestimation by the participants from centre B who are not familiar with working with an EHR or an underestimation by the participants from centre A because of their experience with an existing EHR.

Training is an important prerequisite to the implementation of an EHR. However, the available time to train the end-users is usually limited because of limitations in staff, patient care, and willingness of the end-user. Our results show that the end-users underestimate the necessary hours of training and expect to need less training than is needed to become proficient in working with the new EHR. Additionally, we found that not all users expect the same amount of training. Age and comfort in computer work are negatively correlated (gamma = -0.36, $p<0.0024$) and older users feel less comfortable in working with a computer than younger employees. The older users expect to need more training. It would be advisable for implementation teams to adjust the hours of training for individuals based on the characteristics of the users.

This study is limited by the number of participating hospitals. Two hospitals participated in this study (n=2), one working with paper records and one working with a legacy EHR. To ensure we did not miss any users of the EHR we sent the questionnaire to every employee of the two centres (n=20,071), our target population of EHR users is approximately half of this group (n=10,000). The response of 2.960 people in our target population therefore resulted in a relevant response of 30%.

Our results differ from the conclusion by Zandieh et al. [3] who found that there is a difference in prioritization for implementing a new EHR between organisations using paper- or electronic patient records. A possible explanation for this difference is the different target population. Zandieh et al. [3] interviewed a small selection of practice managers and medical directors whereas we used a large group of the end-users.

Based on concept mapping we found a set of 12 determinants, which were all perceived important to successfully work with an EHR directly after its go-live by end-users. We found no substantial difference between the two centres despite their different baseline modality. Therefore we conclude that centres implementing a new EHR need to take all determinants into account during the implementation.

References

[1] Aarts J, Doorewaard H, Berg M. Understanding implementation: the case of a computerized physician order entry system in a large Dutch university medical center, J Am Med Inform Assoc. 2004;11(3):207-16.
[2] Janols R, Lind T, Goransson B, Sandblad B. Evaluation of user adoption during three module deployments of region-wide electronic patient record systems. Int J Med Inform. 2014;83(6):438-49.
[3] Zandieh SO, Yoon-Flannery K, Kuperman GJ, Langsam DJ, Hyman D, Kaushal R. Challenges to EHR implementation in electronic- versus paper-based office practices. J Gen Intern Med. 2008;23(6):755-61.
[4] Kane M, Trochim W. Concept Mapping for Planning and Evaluation. SAGE Publications Inc.; 2007.
[5] R Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL: http://www.R-project.org/.