

How Do Users of Modern EHR Perceive the Usability, User Resistance and Productivity Five Years or More After Implementation?

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Abstract

The Electronic Health Record (EHR) has been a principal component in transforming healthcare from traditional pen-and-paper documentation procedures to highly digitalized and interoperable environments. Implementation of EHR is complicated, and success is dependent on the users accepting and utilizing the system to its potential. The present qualitative multi-center study investigated health professionals perceived system usability, user resistance and productivity five to eight years after implementation of a modern EHR, across three European sites. Data was collected with semi-structured interviews with experienced health professionals that had work experience before and after implementation of the EHR. Overall, the respondents considered their EHR to have good usability, reported a low degree of user resistance, and were ambiguous on how the EHR affected their perceived workload at the present, but retrospectively reported that the road towards the present state of satisfaction was not without hurdles.

Keywords:

(Electronic Health Records) (Health Care Quality, Access, and Evaluation) (Implementation Science)

Introduction

Over the last 3 decades, healthcare organizations, healthcare professionals and patients, have witnessed a digital transformation of how health and care services are organized, provided and planned. There has been a change from paper-based and manual processes, towards electronic and web-based services. The introduction of the Electronic Health Record (EHR) and digitalization of patient data has been principal in this transformation. However, adoption and utilization of EHRs has been slow despite policies and financial incentives [10], and the potential for increased safety and productivity remains largely unrealized [13; 26]. In addition, many EHR implementations fails to deliver expected effects due to insufficient socio-technical understanding [4], inadequate organizational readiness [18], improper implementation methods [26], and user reluctance to adopt new technology [10]. To expand on the knowledge on how clinicians experience modern EHR, this study analyzes interview data addressing clinicians' experiences and perception of EHR impact on three commonly applied variables for EHR implementation investigation: *perceived system usability, user resistance and experienced productivity for clinicians*. The clinicians' present perception, as well as retrospective experience, are investigated to shed light on the perspective of users that was employed throughout the implementation process and have had a modern EHR at disposal for minimum five years. The

main objectives for this study are to investigate the following aspects of the user perspective at hospitals that implemented a new EHR 5-10 years ago. Research questions are i) How do clinicians perceive the usefulness their EHR? ii) Did the clinicians experience user resistance or reluctance towards the EHR previously or at the present? And iii) How do the use of a modern EHR affect perceived workload and productivity?

Methods

This study was a qualitative multicenter study that employed semi structured interviews for data capture and framework theory for data analysis. The informants recruited were health professionals from three different hospitals in three different European countries.

Locations

The informants in this study were six tenured health professionals at three different hospitals in Europe. The hospitals were chosen on the criteria that they within the last five to ten years had a large-scale implementation of an EHR. Three hospitals were identified as relevant for the study.

Informants

To recruit health professionals, we contacted the management of the hospitals of interest and presented our wish to get an introduction to the EHR system and to interview knowledgeable health professionals with relevant experiences from the implementation. The health professionals that volunteered to participate as informants had been working at the hospital since the implementation of the EHR or longer, and either had regular clinical contact with patients or supervised such contact. The included informants in this study were assumed to be knowledgeable, and interviews were designed to be thematically focused, resulting in saturation being achieved with a relatively low number of informants. The hospitals suggested a schedule for the interviews and recruited the informants based on our request.

Ethics

Written informed consent was obtained from the informants prior to the interviews. The study did not require approval from the regional ethics committee (REK), according to the Norwegian Act on Medical and Health Research §2 and 4§. In order to retain the anonymity of the informants, information that could associate a specific informant to a specific site were omitted during the data analysis and in the subsequent manuscript.

Interviews

Semi-structured interviews, designed to investigate perceived system usability, user resistance and experienced productivity were used to obtain the qualitative data in this study. Interview guides were designed in an iterative process between all authors. Interviews are regarded as the primary data source for interpretive case studies, as it allows the best access to the participants' views on the events taking place and their personal aspirations [24]. The interviews were conducted on-site of the respective hospitals between March and April 2019. The interviews were recorded and later transcribed verbatim in preparation for the data analysis.

Concept definitions

In this study, *Perceived system usability* refers to the perception of how well the EHR can be used by specified users, in this case clinicians, to achieve specified goals and perform tasks in the context of delivering healthcare [11]. Interview questions constructed to probe this topic relates to the users' perception of how well the system facilitates effectiveness and efficiency when performing regular tasks in the EHR, such as documenting patient information, and retrieving and searching for data, as well as experienced ease of use. Although several standardized tools for measuring usability en masse exist [2], we found a qualitative approach more suitable as we were interested in retrospective experiences as well. *User resistance* is identified as one of the major barriers in EHR adoption [12], and is a common phenomenon in change processes in general. In this context, user resistance is defined as a gap between the system implementers and intended EHR use on one hand, and clinicians who try to maintain their status quo with undesirable behaviors towards change and new workflows [20]. *Experienced productivity* differs from objectively measured productivity, such as patient volume or time measures, by that the focus rests on the clinicians' sense and opinion of how well the EHR facilitates efficiency in their tasks. This concept closely relates to cognitive workload, reflecting on the clinicians' mental activity associated with using the EHR [25].

Data analysis

The transcribed interviews were analyzed by AJF and KMN using the framework method [9]. The analysis involved distinct phases for familiarization with the material, development of initial set of codes, revision of codes and application of the final set of codes to passages of text in the transcript. The analysis was summarized in a framework matrix with one column for each interviewee, and one for each code. The material were then thematically analyzed [6], and sorted into the categories perceived usability, user resistance and perceived workload.

Results

Perceived usability

All informants stated that they were satisfied with the functionality and usability of their EHR. In addition, they all expressed that the general impression among clinicians in the hospital was that the EHR functioned well, although they all stated that there had been discontent in the time following the implementation. Several of the informants stressed that how well the EHR had been implemented and configured was more important for the satisfaction with the system than specific functionalities. Although the informants expressed an overall satisfaction with their EHR, there still were aspects they thought needed improvement. Regarding general usability, one informant complained about a lack of intuitiveness in the system. Several of

the informants also mentioned that the amount of information presented could be problematic, and that the search functionality did not always return the correct information. This required them to review large amounts of data to find the information relevant for the task at hand. Another informant stated that this could be especially problematic when reviewing the medication history for a patient. One of the informants, a clinician working in an intensive care unit, expressed that the configuration of the system seemed to be geared towards the workflow and routines in general wards, and less suited for an intensive care setting. This was exemplified by the ordering of blood test, where you in a general ward would order one set of tests for a patient each day, you need to order multiple tests during the day for an intensive care patient. Every time they ordered blood test, the EHR would prompt several messages asking if the clinician was sure he wanted the tests done, resulting in an unnecessary number of clicks to complete the task. While none of the informants had formal education in informatics or computer science, two of the informants had participated in thorough internal education for their specific EHR system, and all had participated in some form of EHR learning course. They all stated to have a high degree of general interest in technology, both professionally and personal. Given that their work depends on technology and computer systems, the informants also expressed that they experienced technological knowledge and interest as a necessity for their day-to-day work.

User resistance

All of the informants had been employed at the hospital since before the implementation of their current EHR. Furthermore, two of the informants had been involved in the planning and organization of the EHR implementation. Informants at one of the three sites stated that the implementation of the new EHR had been a gradual process characterized by continuous development of the system. The EHR was developed in close cooperation between the vendor and the clinicians at the hospital, resulting in a great sense of ownership towards the system. The informants at the two other sites expressed that the EHR was implemented more or less "over night" - in one instance in conjunction with the moving of the hospital to a new location. Common across all sites was the fact that clinicians stated that the EHR was still "in development", in the sense that it needed continuous adaption and customization. Although the hospitals had chosen different implementation methods (gradual; "big bang"), all informants emphasized the importance of workflow adaption in relation to the new system. All hospitals had organized task groups to specify workflows, division of work between professions and strategies for operationalizing new routines. These groups were still, years after implementation, still active and used for prioritizing and defining clinicians' requests for change in the EHR. The informants involved in the organization of the implementation, stated that they still had regular contact with the vendor, and that the vendor played an important support role in the continuous adaption of the EHR. All of the informants reported that there had been user resistance when the EHR first were implemented. One of the informants stated that a general skepticism towards technology among the clinicians had contributed to this resistance, and elaborated that several healthcare professionals initially had refused to participate in the EHR learning courses. As described above, the informants experienced that clinicians generally were pleased with the EHR now, and that presently, there existed little resistance against the system. One informant described that she experienced information flow and continuous dialog between clinicians and management throughout the implementation phase as a crucial measure for counteracting resistance and

managing expectations. She also expressed that a wide user involvement in this phase was essential for the usability of the system. By all informants, a strong user involvement was portrayed as important still, also five to 10 years after initial implementation. All of the informants that mentioned the ability of the clinicians to change the functionality of the EHR, described some variant of continuous improvement process. The informants reported the possibility to change functionality at the individual and at the system wide levels as positive factors. At the individual level, the ability to customize the user interface to the particular task at hand was emphasized. At the system level, the ability to add and tweak functionality is a way of gradually improving the hospital-system fit was deemed as important. For instance, one of the hospitals had created a user board that received reports and suggestions from the clinicians. The user board discussed the suggestions and made a consensus-based list of improvements, and transferred it to an on-site developer team. Informants from another hospital pointed out that describing the desired changes in functionality precisely was not always easy, and required an understanding of the present workflow. Although all informants emphasized the importance of having the ability to contribute to the continuous EHR development and adaption, informants from one hospital stated that this process had been at a stand-still due to financial reasons. They also expressed that the loss of this ability was a source for discontent among clinicians.

Perceived workload

All of the informants stated that the EHR resulted in an increase in time spent on documentation work. One of the informants pointed out that the time spent on configuring the system to the individual workflow had a return of investment later on. Interestingly, one of the informants pointed out that regardless of the EHR in use, the general demand for written documentation of procedures is increasing, and that a considerable portion of the clinicians' work hours is spent in front of the computer. All of the investigated systems included structured data elements. The informants emphasized the use of clinical codes, automatically generated text based on journal content and smart forms as convenient. However, some of the utility, for instance the ability to perform reliable searches in the journal content depended on correct user input. In addition to making the journal data searchable, it appeared that routine documentation such as patient summaries and discharge notes were the actions that benefited the most from the use of structured data.

Discussion

System usability

Although clinicians' acceptance rate of EHR are found to be high, fundamental concerns regarding own competency in EHR use, preconceived and potentially unrealistic expectations from the system, and concerns related to time consumption are all demonstrated to affect perceived system usability [19]. Clinicians' perceived usability and human-computer interfaces is identified as a major risk factor in EHR implementations, along with socio-technical factors such as cultural fit, in line with previous research [15; 17]. All informants emphasized the importance of user involvement and possibilities to adapt the system to individual and group requirements, and highlighted the importance of adaptability and work practice adaptations as imperative for success in the implementation process, describing it as an on-going process still. Previous research has demonstrated a strong correlation between clinicians perceived system usability and the EHRs fit with organizational culture and work

processes [13]. This correlation has also been used to explain why implementations of certain EHRs fail, when they have been successfully implemented into organizations elsewhere [3]. It is therefore possible that the continuous end-user engagement and ability to affect system configuration and adaptability is more important for long-term effects. Expanding the timeframe on when EHR implementations are investigated also allows for both system and organization to mature, making clinicians more aware and capable of contributing to the further development of the system, and the organization more proficient in incorporating new functionalities and necessary work practice adaptations. EHR systems' user interfaces has in other studies been directly linked to errors in the provision of care, stressing the importance of design and possibilities for adaptability, and for the adequate handling of these change processes [16]. Association between clinicians experienced workload and the perceived system usability of the EHR indicates that user-led changes in system functionality can improve both cognitive workload and performance, and involvement of clinicians are therefore argued to be essential for the quality and usability of the EHR [14]. Studies performed closer to implementation has reported major challenges surrounding changes in workflow and routines, further stressing the importance of maturation [19]. Previous research has failed to discover how long it takes for new workflow processes and routines to stabilize after EHR implementations, or when, or if at all, system adaptability is complete, indicating that it is a continuous process [13]. This emphasizes the importance of understanding how perceived usability might change over time through necessary maturation, and how disparities between short-term and long-term impact occurs.

User resistance

Resistance to change among healthcare professionals has been identified as one of the main barriers in EHR implementations, and represents a great challenge for managers and implementers [1; 23]. Inadequate handling of these aspects of ICT implementation are directly linked to increased expenditures and cost [8]. At the time of investigation, the clinicians had no noticeable resistance or reluctance to the use of the EHR and its functionality, they did however report retrospectively a varying degree of user resistance that diminished over time after implementation. Some of the resistance and reluctance towards EHRs have in earlier research been linked to the experiences of early adopters and reports of decreasing clinical practice productivity [10]. In addition, introducing EHRs to the clinical setting is associated with staff anxiety, stimulated by expectations of increased dependency on computers, changes in established routines and practices, and a concerns that the EHR would negatively affect the patient-provider relationship [13]. We found no current difference in user resistance between the sites that had employed a big bang-approach implementation to the site having used an incremental approach. Despite literature recommending incremental, step-by-step implementations for larger complex organizations, giving more time to developing new procedures and work practices [13; 26], the results suggest that shorter and more intensive implementation processes can achieve comparable results, at least when expanding the timeframe for investigation to five year and longer.

Perceived workload

In line with previous research, we found that clinicians experienced that they used more time documenting using the EHR compared to the pre-implementation phase [10]. However, despite the perception that the EHR was time-consuming, the informants had a positive opinion of the system due to the benefits it provided, nor does it seem that an increase in time spent

on certain tasks results in a perception of waste among users, supporting previous research findings [7; 17]. In addition, informants expressed that the increasing time spent on documentation also was a result of cultural and organizational guidelines, and not necessarily a consequence of the EHR system itself. This is in line with previous observations, stating the original purpose of the EHR as a clinical tool for patient information processing is being undermined by managerial needs for quality control and billing [22]. Similar studies performed in closer temporal proximity to implementation has produced findings that are inconsistent with our results. For instance, a high degree of user resistance, reduced productivity and lower perceived system usability has been observed among clinicians four years after implementation [5; 21].

Limitations

This study reports on clinicians' perceptions and experiences after an EHR implementation, and thus relies on subjective opinions from a limited number of informants. It shares some limitations with previous studies in terms of low validity of generalization and transferability of results.

Conclusion

Clinicians perceived the EHR as time consuming, but still had a positive opinion of the system due to the immediate benefits they experienced it produced. We suggest that the reason resistance is low and perceived usability is high in our findings, are that they are conditions dependent on the time factor, specifically to allow for both system and organization to mature. Understanding the long-term impact EHRs have related to clinicians' perception and experience is an important contribution to adjust expectations and sensitize implementers and management in the planning processes - that in turn has the potential to positively affect outcomes described in this study. However, our results also suggest that that there are other factors associated with implementation success that might require an even longer period of time than five to eight years: differences in starting points (culture, technology, infrastructure, activity and processes) prior to implementation will significantly affect the outcomes. All organizations included in this study had paper-based journals before adopting digital tools. Transitioning from paper-based routines to an EHR will to a larger degree trigger immediate benefits for clinical personnel compared to a transition from one EHR to another, specifically in terms of information availability. The impact the existing degree of digitalization within the healthcare organization before an EHR implementation has on the timeline is not fully understood and is largely unrecognized in earlier studies.

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References

- [1] S. Ajami and R. Arab-Chadegani, Barriers to implement electronic health records (EHRs), *Materia socio-medica* **25** (2013), 213.
- [2] A. Bangor, P.T. Kortum, and J.T. Miller, An empirical evaluation of the system usability scale, *Intl. Journal of Human-Computer Interaction* **24** (2008), 574-594.
- [3] R. Bergström, Krevende å implementere helseløsninger fra USA, in: *Dagens Medisin*, 2019.
- [4] N. Boulus and P. Bjorn, A cross-case analysis of technology-in-use practices: EPR-adaptation in Canada and Norway, *International journal of medical informatics* **79** (2010), e97-e108.
- [5] M. Boye, It-professor: Ingen beviser for, at Sundhedsplatformen øger effektivitet og patientsikkerhed, in: *ING/Version2*, Teknologiens Mediehus, 2017.
- [6] V. Braun and V. Clarke, Using thematic analysis in psychology, *Qualitative research in psychology* **3** (2006), 77-101.
- [7] G.L. Brotzman, C.E. Guse, D.L. Fay, K.G. Schellhase, and A.M. Marbella, Implementing an electronic medical record at a residency site: physicians' perceived effects on quality of care, documentation, and productivity, *Wmj* **108** (2009), 99-103.
- [8] H. Cripps, C. Standing, and V. Prijatelj, An exploratory study of the implementation of electronic health records: a two country comparison, (2012).
- [9] N.K. Gale, G. Heath, E. Cameron, S. Rashid, and S. Redwood, Using the framework method for the analysis of qualitative data in multi-disciplinary health research, *BMC Medical Research Methodology* **13** (2013), 117.
- [10] M.J. Howley, E.Y. Chou, N. Hansen, and P.W. Dalrymple, The long-term financial impact of electronic health record implementation, *Journal of the American medical informatics association* **22** (2014), 443-452.
- [11] International Organization for Standardization, ISO 9241-210:2010, in: *Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems*, International Organization for Standardization, 2010.
- [12] C.S. Kruse, C. Kristof, B. Jones, E. Mitchell, and A. Martinez, Barriers to electronic health record adoption: a systematic literature review, *Journal of Medical Systems* **40** (2016), 252.
- [13] D.A. Ludwick and J. Doucette, Adopting electronic medical records in primary care: lessons learned from health information systems implementation experience in seven countries, *International journal of medical informatics* **78** (2009), 22-31.
- [14] L.M. Mazur, P.R. Mosaly, C. Moore, and L. Marks, Association of the Usability of Electronic Health Records With Cognitive Workload and Performance Levels Among Physicians, *JAMA network open* **2** (2019), e191709-e191709.
- [15] D.W. Meeks, A. Takian, D.F. Sittig, H. Singh, and N. Barber, Exploring the sociotechnical intersection of patient safety and electronic health record

- implementation, *Journal of the American medical informatics association* **21** (2013), e28-e34.
- [16] S. Minshall, A review of healthcare information system usability & safety, in, 2013.
- [17] K. Nicolaisen and K. Berg, *Electronic communication across organizational borders in healthcare: an empirical study*, UiT Norges arktiske universitet, 2015.
- [18] N. Pollock and R. Williams, Software and organisations, *The biography of the enterprise-wide system or how SAP conquered the world*. London and New York, University of Teeside, UK (2008).
- [19] W. Priestman, S. Sridharan, H. Vigne, R. Collins, L. Seamer, and N.J. Sebire, What to expect from electronic patient record system implementation: lessons learned from published evidence, *Journal of innovation in health informatics* **25** (2018), 92-104.
- [20] S. Shang and T. Su, Managing user resistance in enterprise systems implementation, *AMCIS 2004 Proceedings* (2004), 23.
- [21] Sundhedsplatformen, Hovedkonklusioner og præsentation af udvalgte data til regionernes koncerndirektioner, in, Region Hovedstaden Region Sjælland, 2019.
- [22] J. Søgaard, Sundhedsplatformen blev besluttet på baggrund af naive synsninger og ønsketænkning, in: *Berlingske*, 2020.
- [23] M. Van Der Meijden, H.J. Tange, J. Troost, and A. Hasman, Determinants of success of inpatient clinical information systems: a literature review, *Journal of the American medical informatics association* **10** (2003), 235-243.
- [24] G. Walsham, Interpretive case studies in IS research: nature and method, *European Journal of information systems* **4** (1995), 74-81.
- [25] B.A. Wilbanks and S.P. McMullan, A review of measuring the cognitive workload of electronic health records, *CIN: Computers, Informatics, Nursing* **36** (2018), 579-588.
- [26] J. Øvretveit, T. Scott, T.G. Rundall, S.M. Shortell, and M. Brommels, Implementation of electronic medical records in hospitals: two case studies, *Health Policy* **84** (2007), 181-190.

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