



UvA-DARE (Digital Academic Repository)

Implementing structured data in Electronic Health Records

Joukes, E.

Publication date

2019

Document Version

Other version

License

Other

[Link to publication](#)

Citation for published version (APA):

Joukes, E. (2019). *Implementing structured data in Electronic Health Records*. [Thesis, fully internal, Universiteit van Amsterdam].

General rights

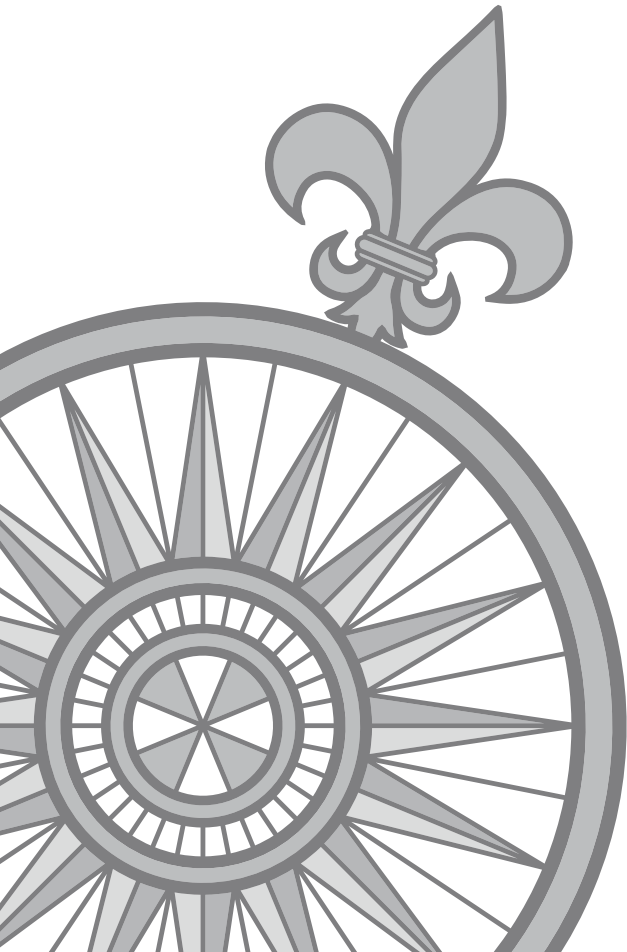
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

Chapter 7

General discussion



We can only see a short distance ahead, but we can see plenty there that needs to be done.

Alan Mathison Turing

Main findings

The studies described in this thesis were designed to support our two aims. We will first describe the main findings of our separate studies per aim. Subsequently, we will provide a discussion combining and interpreting these findings.

Aim 1: To determine the effects of implementing a structured and standardised Electronic Health Record (EHR) on healthcare providers' perceptions of EHR use and performance, and to assess whether these effects differ for centres starting with a paper-based or legacy EHR at baseline.

We found that before starting the implementation of a new EHR there are nine areas that the end-users of the EHR consider important to enable them to work with the new system successfully (Chapter 2). These nine areas are: usability, data use and reuse, facility conditions, data registration, support, training, internal communication, patients, and collaboration (Chapter 2).

The baseline recording process seems to influence the perceptions of healthcare professionals on a new structured EHR (Chapter 3). Investigating perceptions on the themes EHR use, data quality, and data reuse showed that overall perception of users in a formerly paper-based centre improved or remained stable on all three themes. In a legacy EHR centre, perceptions on aspects of our three themes either decreased or remained stable after the implementation. Only on one aspect of EHR use, "The EHR provides all types of healthcare professionals a place to document patient data, in one integrated patient file", users in both centres experienced an improvement (Chapter 3). Additionally, we found that the personnel had high expectations of the new system before the actual implementation. However, in both centres, for half of the measured aspects at least 45% of respondents experienced worse results than expected (Chapter 3).

During outpatient consultations, physicians use approximately 33% of an 11-minute consultation working with the EHR (Chapter 4). After the implementation of the new EHR the length of outpatient consultations did not change, however, the way the time is distributed over documentation and care tasks did change (Chapter 4). The effects of the implementation were different in both centres. When coming from a legacy EHR, physicians have 8.5% less time available to solely dedicate to patient care. Physicians that were used to recording patient data in paper-based records need 8.3% more time for their documentation tasks. However, this was not at the cost of dedicated patient time but at the cost of multitasking, i.e. these physicians could not combine patient care and documentation as well as they were used to.

Aim 2: To determine factors that influence healthcare professionals' intention to record structured data.

To describe the concepts underlying the adoption of structured data recording among healthcare professionals we created and validated a theoretical model based on the Technology Acceptance Model (TAM) [87,88] with 29 concepts related to information systems as well as organisational factors and personal beliefs (Chapter 5). Using Partial Least Squares Structural Equation Modelling (PLS-SEM) we showed that our model is supported to a large extent by questionnaire data collected in seven of the eight Dutch university hospitals (Chapter 5). Intention to record in a structured and standardised way emerged as a significant factor of reported behaviour. This intention is influenced most by attitude.

After showing the validity of the model we identified the most important factors to influence the intention of healthcare providers to start recording structured data (Chapter 6). In this final study we included the maturity of the EHR in the analyses to see whether EHR maturity affects the relevant factors. Both centres with high and low-mature EHRs agree that the process factors Awareness, Attitude, Structural assurance, and Perceived risk are the most important factors influencing intention to record data in a structured way. Centres with a low-mature EHR additionally include Accuracy, Format, Integration, Accessibility, System Satisfaction, Interpersonal Influence, Subjective Norm, and Institutional Trust. These factors are related to the system itself and the transition to high EHR maturity. High-mature centres also include Perceived ease of use as an important factor that influences intention to record data in a structured way.

Implementing an EHR

The implementation of an EHR is a sociotechnical process [33,34]. The system that is to be implemented is not the only factor influencing the success of the implementation process. The environment in which the system is introduced, with its specific work processes, traditions, and culture plays an important part in its success or failure. In Chapter 2, 3, and 4 of this thesis we studied the implementation of the same EHR that was introduced in two different organisations. The main difference being the recording practice before the implementation, either paper-based or legacy EHR. In these two organisations we found that the implementation of the EHR had different effects on processes and the personnel's perceptions.

In Chapter 3 we showed that on the aspects where the perceptions of healthcare providers actually changed, employees of the previously paper-based centre experienced improvements whereas those in the legacy EHR centre experienced deteriorations. This indicates that in the legacy EHR centre the new EHR was perceived as a deterioration in some areas compared to the old system. Was the new EHR actually worse than the old system? Or could this difference be based on divergent expectations?

The introduction of new technology (physical or digital) has two main effects on an organisation. First, the new technology is used to perform the same tasks as before, but with the intention that it should improve efficiency or efficacy. Second, once the new technology is used in practice, new ways of working become apparent that were not possible before because the necessary technology was lacking. This second phase could instigate a paradigm shift where the use of the technology fundamentally changes the way people think or work. An example would be the introduction of the steam engine during the industrial revolution. Steam engines initially replaced existing power sources one-on-one. Later on the vast capacities of steam engines introduced a centralised "power plant" with novel power distribution techniques. Although the first phase of introducing the steam engine had a relatively limited impact on productivity growth [103], ultimately it led to substantial changes to society.

Similarly, these same two phases can be seen in the introduction of EHRs. First, the introduction consists of replacing the old technology (paper-based records) with the new technology (an EHR). Second, the use of new technology creates possible uses and reuses of data that were not possible before, which leads to new work processes and a paradigm shift in recording practice (towards structured data recording). Transitioning from paper to digital recording means a large change in tools available to perform daily tasks. This first introduction of an EHR can be characterised as using new technologies to perform the tasks that were already present in the old work processes. The data are stored in a new (i.e. digital)

format but the same type of data is stored in comparable structures. Users will experience an improved way of working supported by the new system. The experienced change and the room for improvement that the new system brings are perceived as large. This can be explained because the new method of working solves a number of problems that were present in the old process. That is, the new EHR should solve problems inherent to the paper-based records, such as low availability, and the illegibility of the infamously bad handwriting. Even when there are downsides to the new EHR, in general most people will perceive it as better than the old situation, having paper-based records, with its major problems. All this helps to make it easier to create a positive perception with the staff that will be using the EHR.

Implementing a new structured EHR in a centre that already has an (old) EHR brings different challenges. In these organisations the inferior technology (paper-based records) has already been replaced and all basic benefits from transitioning from paper to digital recording were experienced at that moment. Implementing a new structured EHR in this kind of organisation means replacing one EHR with another. The comparison the staff will be making is between the old EHR and the new structured EHR. The new structured EHR will have to perform better than the old one to create a positive perception with the staff using the EHR. A complicating factor is that the old system will have evolved to support the regular existing work processes of the staff over the years while the new EHR will include new work processes to support the paradigm shift towards structured data recording. These new work processes will be different from what people are used to and therefore might feel as a worsening of usability.

The advantages that the new system brings are less clear than those when transitioning from paper to electronic recording. Additionally, although the burden of recording structured data lies fully with the healthcare providers, part of the benefits can be found in the work processes of other professionals working in the hospital (e.g. researchers and management). This makes it more difficult for physicians to see why the additional work of structured data recording is worth the effort, even when they experience their own share of benefits such as improved decision support. All this means that it is harder to create a positive perception among the staff. It is crucial to look at the specific expectations of the staff in these centres to see what the expectations actually are, and whether they are relevant and feasible. The expectations in these centres might be less clear-cut and less obvious than those in a paper-based centre.

Structured data recording

Over the years EHRs became more extensive and technological possibilities increased with cheaper and larger storage, and more computing power. This meant that the list of possible reuse goals of data increased. With this increase of reuse goals, people started to ponder on the necessary quality of the data to enable these types of reuse. This meant changing work processes to accommodate better data quality through structured and standardised data recording. The result is, that today the implementation of an EHR is not only focussed on making sure it is as user friendly as possible, but also on making sure the data are of high enough quality for the intended use and reuse goals.

This additional demand on EHRs means that the focus of vendors and implementation teams has to shift from just user-friendliness to a balance between that and data quality for reuse purposes. This balance is currently one of the main topics in the field of medical informatics as more and more organisations are implementing their first fully integrated EHR,

or updating their old EHR with the intention to record data as efficiently as possible, while allowing as much reuse as possible. One important question therefore is: how can we change work processes that have been in place for years, to make optimal use of the benefits that EHRs have to offer?

The results of our study into the allocation of time during outpatient consultations shows that the burden and benefits of structured data recording are not always balanced. We observed that after the implementation of a new EHR, during outpatient consultations, physicians spent more time on recording patient data in the patient record and less on patient interaction. The return on investment in structured data recording therefore seems to be present in a more efficient reuse of data, not in a more efficient recording of data. This does imply that it is important to show the healthcare professionals where the benefits of structured data recording are present. If they do not experience these benefits, either because they are obscured by other tasks, or because only others seem to benefit from them, they will only experience the heightened burden of structured data recording.

This is in line with the most important factors influencing healthcare providers' intention to record structured data. Awareness, Attitude, Structural assurance, and Perceived risk are essential to increase the adoption of structured data recording. It is therefore important, again, to make sure that end-users know why they should record structured data, and that they realise what the benefits of this method are. Additionally, organisations need to make sure that they have done everything they can, to protect the data, work processes, and patient safety. They have to show their efforts to the personnel to increase the belief in the structural assurance of the organisation. Before working on attitude and organisational culture, centres with a low EHR-maturity will need to work on increasing the maturity of their EHR. This is an important prerequisite for intention to record structured data.

About the studies - strengths and limitations

The implementation of an EHR involves the entire organisation and requires efforts from all personnel. This inherently results in the impracticability of performing Randomized Controlled Trials (RCTs) to measure the effects of EHR implementations. It is difficult within one centre to create comparable study arms in which one arm is provided with a new EHR and one is to continue using the old, baseline, documentation method. Additionally, it is impossible to randomize participants over these arms. The next best study design is a quasi-experimental, observational study around the implementation [104]. Our study designs are, therefore, one of the strengths strength of our studies. By performing measurements before and after the implementation, we were able to compare certain outcome measures such as documentation time and perceptions.

An additional strength is that we investigated the introduction of the same new EHR in two academic medical centres in the Netherlands. These two centres are organisationally comparable and started the process of merging to become one academic medical centre. The same EHR would be implemented in both organisations in an identical design and set-up, by the same implementation team. The main difference between these two centres relevant for our studies is the documentation practice before the implementation. One centre already worked predominantly with a legacy EHR combined, in some departments, with a paper-based record, whereas the other worked predominantly with paper-based records supplemented with electronic information on laboratory and radiology results. We were in the unique position that

we could study these two centres with different baseline documentation processes and the intention to implement an identical EHR.

Another important strength of these studies is that, in combination with investigating actual changes (i.e. documentation time, Chapter 4), we focused on the intentions, expectations, and perceptions of the personnel that have to work with the EHR. Because of the socio-technical nature of EHR implementations it is important not only to focus on the system aspect of the change process but also on the personal and social aspects. Implementing a theoretically perfectly designed EHR, that has previously been successfully implemented in other hospitals, can still be a failure if the personnel do not accept the system. Therefore, it is essential to investigate what the implementation can do with the personnel's intentions and perceptions.

A potential limitation of our focus on intention of healthcare providers and not on actual behaviour is that intentions have to be translated into action before anything really happens. This can be observed when the personnel are willing to perform some action, but the pre-conditions are not good enough to enable them to do so. For example, a computer system might perform too slow to function properly, or the personnel did not receive the necessary training. Therefore, in the ideal situation the personnel have the intention to show a required behaviour and the organisation provides the proper conditions for them to actually perform this behaviour.

Another related potential limitation is that we only studied the implementation of one EHR in two study centres. This means that some results might be related to the characteristics of the specific EHR. We do feel, however, that the results that we found can be generalised to EHRs of high maturity that are problem oriented, offer structured data entry, and use international data standards. Most vendors on the market today are global organisations offering EHRs with these characteristics.

All our studies were performed in the Netherlands. The results of our studies could be generalised to other western (European) countries. The most important difference is the level of autonomy in Dutch healthcare. Dutch healthcare professionals enjoy relatively high levels of autonomy, especially in academic centres. This means that the success of any change in work processes or the technology used in the organisation (such as an EHR implementation) is dependent on the support of the employees. In organisations with less autonomy, coercing changes in a top-down manner might result in a satisfactory effect. In our situation, this course of action might lead to opposition and suboptimal use of the implemented system.

Practical relevance

Whether it is the change from paper-based to electronic-based recording, from one EHR to another, or from free-text recording to structured and standardised data recording, all change is difficult. The outcomes of the studies included in this thesis can help with these difficult changes. First, the results from Chapter 2 indicate a number of aspects that the implementation team of any EHR should focus on during implementation. These aspects provide an insight into what the end-users actually value during an EHR implementation. Neglecting these aspects might result in the end-users being disappointed and a less effective EHR change process. Each organisation in the process of implementing a new EHR should consider whether these aspects are included in their implementation strategy. For each aspect, actions should be created that describe how, in their specific organisation, they will be incorporated in the implementation process. Creating a checklist with these aspects and the

chosen actions can help in communicating with the healthcare professionals and establishing support among the end users for the new system.

Chapter 3 and 4 show possible effects of an EHR implementation on the efficiency and effectiveness of work processes and the perceptions of the workforce. When implementing an EHR we show that it is important to realise what the baseline recording practice of one's organisation is (paper-based or legacy EHR). This influences what personnel will expect of the new EHR and how one can manage these expectations to prevent deceptions that will lead to a low adoption of the new system. Chapter 3 shows that it is important for EHR implementation teams to find out which aspects of the new EHR are considered most important by the end users. The EHR implementation teams should find out what the expectations are of the end users regarding those aspects, and whether those expectations are realistic given the new EHR. Then either the implementation team needs to make sure that the expectations will be met by taking specific implementation and configuration actions, or they have to manage the expectations by explaining to the end users what the new system will and will not be able to achieve.

In Chapter 4 we showed the effect of implementing a new EHR on the time physicians spend on direct patient care and documentation tasks during outpatient consultations. These results can help in the discussion on the effects of an implementation. Physicians fear that the new system will cost more time. Our results suggest that this is indeed the case. In the former paper-based centre more time was required for recording data and multitasking became more difficult. In the legacy EHR centre, the time that the physician could solely focus on the patient decreased. These effects were, however, limited to approximately 8% change in both centres. During the implementation of a new EHR discussing these results with the healthcare professionals as a form of expectation management is advised. It is important to make sure that they know that a change in time distribution is to be expected. Moreover, it should be discussed what benefits they will obtain in the new situation. Additionally, discussing the results with the implementation team can help to correctly monitor the implementation to minimise unwanted effects and to improve performance of the system during the post-implementation phase when the system will be optimized.

A modern integrated EHR is a prerequisite for structured data recording. However, the mere implementation of such a system in an organisation is not a panacea that leads to perfectly structured data. To increase structured data recording, adoption by the healthcare professionals is essential. Structured data recording is a current and important issue on a national level in the Netherlands. The Netherlands Federation of University Medical Centres (NFU) together with the Dutch Hospital Association (NVZ) and the centre of expertise for eHealth, Nictiz, initiated a program called 'Registratie aan de bron' (Facilitating clinical documentation at the point of care). The goal of this program is promoting unambiguous and single registration of data in the care process to enable reuse of those data, in other words: structured and standardised data recording. At the national level there is much interest in structured and standardised data recording and many national and local programs and activities have been initiated to implement this paradigm. It is, however, difficult to discuss the matter and create useful interventions when the current degree of structured data recording is unknown. We created a model and questionnaire that was used to create an overview of the current state of affairs concerning structured data recording. These studies (in Chapter 5 and 6) enabled us to comment on barriers and facilitators to increase the intention of healthcare professionals to start recording data in a structured manner. The validated questionnaire could be used in organisations to measure this intention again after the planned actions meant to increase

the intention have finished. Comparing these results could indicate whether these interventions had any effect on end users' intentions to record data in a structured and standardised way.

The results from Chapter 5 and 6 are based on seven of the eight Dutch university hospitals and we believe that the outcomes can help other hospitals that want to increase the adoption of structured data recording. Our model can be used to discuss the current state of a hospital (using the validated questionnaire). Or it could be used to identify the key bottlenecks in an organisation. The smaller sets of factors from Chapter 6 can be used when a hospital would want a quick way of investigating key influencing factors. Based on the maturity of the EHR in the centre, the small list of relevant factors provides a way to do a quick survey and find the key facilitators of adoption by the personnel.

Future research

As mentioned, the next step to increase structured data recording is investigating the actual behaviour of healthcare professionals. They might have the intention, but are they actually recording data in a structured and standardised way? To enable in-depth studies, we need to define a set of indicators that can measure the level of structured data recording. These indicators will need to include structure, process, and outcome measures to give a good overview of the level of structured data recording. This set might include indicators on the percentage of data that is necessary for quality auditing that can be automatically extracted from the EHR, or the extent to which data can be reused for decision support. These indicators should be used to measure whether the intentions of the healthcare providers to record structured patient data are actually being translated into action.

Implementing structured data recording is a balancing act, with usability and data quality directly, and often negatively, influencing each other. At this point in the evolution of EHRs and structured data recording it is clear that we are asking a lot from our healthcare providers in terms of proper data recording. We ask that they record all information about the patient as completely and clearly as possible. Additionally, we ask them to do so in the most structured manner possible using standard terminologies. All this means a large investment of time and effort from our healthcare providers. The question, however, is whether we are seeing the returns on this investment, and who is actually benefiting from these returns.

Therefore, it is important that future innovations focus on enabling the physicians and nurses to use the data to their own benefit while minimising the registration burden. Research should support this goal and explore what new technologies or techniques are most effective and efficient. What extra functionalities can be used when the data are of high enough quality? Can we come up with more uses of data that could help healthcare providers to do their job efficiently and effectively? And most importantly, does the patient benefit from safer and more effective care?

Additionally, starting from the first EHR in the 1960s we have made physicians and other healthcare professionals responsible for the correctness and completeness of the data that are recorded within EHRs. In that role they are, however, dependent on the systems that the market offers. Unfortunately, EHR vendors sometimes make suboptimal design decisions regarding usability, safety, interoperability, integration with other systems, and data standards [105]. Therefore, many of these systems have numerous insufficiencies and can even introduce patient safety concerns [75]. We should, therefore, be careful to put the entire blame for insufficient patient records on healthcare providers. A possible, albeit partial, so-

lution might be the introduction of trained staff that supports the data registration process of the physician. For example, medical interviewers could do the initial intake with a patient. They have more time to ask all relevant questions and can make sure that the basic data recorded in the EHR are correct and complete. This method was already discussed in 1968 in the paper by Weed [13]. Another option might be the introduction of scribes [106,107] or data clerks [108] who make sure that the data that physicians collect are recorded in the EHR in a correct and complete form. The effects of any of these changes will have to be investigated on many levels, starting with data quality, satisfaction of physicians and patients, costs, patient safety and patient outcomes [106–108].

In the end, even if we can successfully implement a perfectly user-friendly EHR, and have good quality structured data, the main asset in any healthcare organisation that wants to provide the best possible care to their patients, is the healthcare professional. In daily practice as much as in scientific studies, we need to keep the focus on their needs and qualities. Only then can medical informatics keep supporting their important work, rather than complicate it, while simultaneously realizing capture of high-quality data for the further good of medicine and mankind.