

Implementing Large-Scale Electronic Health Records: Experiences from Implementations of Epic in Denmark and Finland

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Abstract

Background – With the still larger scale of electronic health records (EHRs), their implementation has become increasingly complex. In this study, we focus on one large-scale EHR – Epic.

Purpose – We analyze the Epic implementations in Denmark and Finland to understand how healthcare professionals experience this large-scale EHR.

Method – The study is based on documentary analysis. The analyzed documents include user surveys, assessment reports, material from project partners, and research papers.

Results – The Danish and Finnish Epic implementations are still troubled five and three years, respectively, after the first go-live. In Denmark, the business case and implementation process have been sharply criticized. The correction of usability problems and unstable system integrations have been slow, the time required to perform common clinical tasks has increased, and 32% of the users remain dissatisfied or very dissatisfied with the system. In Finland, the physicians and nurses experience improved technical performance but inferior usability and reduced work support compared to the EHR they used before Epic; only 4.7% (physicians) and 7.3% (nurses) agree that patient information is easy to access, and only 9.3% (physicians) and 26.2% (nurses) agree that Epic helps improve the quality of care.

Conclusion – The post-implementation experiences from the two implementations contradict pre-implementation expectations. Specifically, the consequences of using Epic have become salient only after go-live. As a result, the implementing organizations and their users have predominantly found themselves in a reactive mode of fending off problems rather than a proactive mode of realizing benefits.

Keywords: electronic health record, adoption, implementation

1 Introduction

Electronic health records (EHRs) are challenging to implement, as evidenced by the large number of troubled and failed EHR implementations [1, 2, 3, 4, 5]. These difficulties create a chasm between the high rewards that are believed to be attainable with EHRs and the meagre outcomes that often result from EHRs [6]. Currently, the healthcare institutions in many developed countries are replacing their first-generation EHRs with large-scale EHR suites, such as those by Cerner and Epic. The extended

scope and sophistication of these systems promise increased rewards but also incur increased implementation risk. In this paper, we investigate the implementation of such large-scale EHRs in the Nordic countries Denmark and Finland.

Previously, the communication and documentation associated with the patient trajectory have been spread across multiple systems with restricted facilities for information exchange. The large-scale EHRs provide different healthcare professionals with tailored views of a shared database, thereby seeking to increase information access, ease communication, reduce data fragmentation, and improve overview formation. However, the inclusion of more functionality increases the sociotechnical complexity of the systems and adds to the implementation risk [7, 8, 9]. We ask the research question: *How do healthcare professionals in Denmark and Finland experience the implementation of large-scale EHRs?* We focus on Denmark and Finland because they are neighboring countries with comparable health services, because Epic's large-scale EHR has recently been implemented in both countries, and because these implementations exemplify a global EHR market where EHRs are implemented in countries beyond those for which they were initially developed. Epic is a US-developed EHR suite with integrated functionality ranging from patient administration, through systems for physicians, nurses, pharmacists, radiologists, lab technologist, and other care providers, to billing systems, integration with the primary health sector, and a facility for patients to access their own data. The two Epic implementations analyzed in this paper are:

- *Danish Epic implementation* – Epic went live at the hospitals in two regions in Denmark in 2016-2017. This implementation is restricted to hospitals and has interfaces for exchanging data with primary healthcare, such as general practitioners and home-care services.
- *Finnish Epic implementation* – Epic went live throughout one region in Finland in 2018-2022. This implementation extends beyond hospitals to include primary healthcare and social care, such as behavioral health services and services for families with children.

Previous work on EHR implementation shows that going live is hectic but brief; the larger activities are the preparations leading up to go-live and the adaptations following after go-live [8]. The preparations include activities such as data migration, workflow changes, staff training, infrastructure support, and leadership [4]. The adaptations are about responding to unanticipated issues, recognizing emergent possibilities, and realizing benefits continually [10]. EHRs have been found to improve productivity, documentation, and the quality of care, but they have also been associated with productivity loss, erroneous data, poor usability, and privacy/security concerns [4, 11, 12, 13, 14, 15]. These mixed findings about the outcome of EHR use are accompanied by mixed findings about the satisfaction with EHRs among physicians, nurses, and patients [14, 15, 16, 17]. To understand – and in the end hopefully counteract – dissatisfaction and adverse outcomes, we need analyses of contemporary EHR implementations.

2 Method

We answer the research question through documentary analysis, which is recognized as an effective method for studying implementation projects in healthcare [18]. Due to their size and implications for patient safety, projects like EHR implementations are subject to scrutiny from various parties. Our analysis of the Danish Epic implementation is based on research papers [19, 20] and reports made by the regions [21, 22, 23, 24], clinicians [25], medical associations [26], and independent parties [27, 28]. The reports include expert assessments as well as questionnaire surveys. Our analysis of the Finnish Epic implementation is based on research papers [29, 30], material from project partners [31, 32], and an open data set from the Finnish Institute for Health and Welfare [33]. This data set provides the responses from several instantiations of a nationwide survey about how physicians, nurses, and social workers experience their EHR. Before implementing Epic, surveys were conducted in 2017 (physicians and nurses). After the implementation of Epic, surveys have been conducted in 2020 (nurses and social workers) and 2021 (physicians).

In analyzing the material, we first read the documents to appreciate their overall argument and mark up key passages. We also explored the open data set to understand its structure and contents. Then, we extracted information for inclusion in our analysis. We restricted ourselves to the extraction of overt and explicit information, thereby minimizing the amount of interpretation. Finally, we revisited the documents at the end of the analysis to validate that the meaning of the analysis text had not drifted in the revision process.

3 Danish Epic implementation

In December 2013, the Capital Region of Denmark and Region Zealand signed a contract with Epic to deliver its EHR to the twelve hospitals in the two regions. These hospitals totaled about 50000 coming users of the system and served a population of 2.6 million citizens. The contract amounted to 375 million euros. After signing the contract, extensive preparations began to configure Epic for Danish hospitals, adapt hospital procedures to Epic, and streamline work processes. Expectations were very high. They were stated in May 2014 by the CIO of Region Zealand: *“We are lowering our cost, we are getting better quality, we are getting better patient satisfaction, and we are getting better processes and so forth. It is a win-win all round [...] There is absolutely no reason not to move in this direction”* [22, p. 224].

Epic went live at the first of the twelve hospitals in May 2016. In spite of considerable problems [20], the implementation on the other eleven hospitals proceeded according to the pre-made schedule. The last hospitals started to use Epic in November 2017. Sadly, problems continued in the following years:

In March 2018, it was documented that 16 of 90 clinical quality databases were missing input from Epic [24]. It was unclear whether data from Epic were missing for an additional eleven databases. The clinical quality databases provide countrywide data about the quality of care for selected diagnoses. Missing the data from two of the five healthcare regions is detrimental to Danish medical research and quality-improvement efforts.

In June 2018, Rigsrevisionen [28], an independent auditing institution under the Danish Parliament, sharply criticized the business case and implementation process. The business case estimated that the productivity dip following go-live would merely last for three weeks. While the basis for this estimate was unclear, it entered into the planning at the hospitals. As a result, they were unprepared and short on compensatory measures when the productivity dip continued month after month.

In October 2018, the law firm Bech-Bruun [27] concluded that the Epic implementation was at high risk of violating the general data protection regulations (GDPR). Specifically, 152 Epic support staff in the US had full access to all patient data in the system, and the contractual regulation of this access was vague. Furthermore, there were issues about protecting the personal data recorded about the Epic users.

In June 2019, an expert committee set up by the Capital Region criticized that the correction of technical errors took far too long and that data quality received insufficient attention [21]. The medication process was of particular concern; it had suffered from poor usability and unstable system integrations since go-live at the first hospital. The committee also found that a plan with clear targets and stringent follow-up was missing, thereby criticizing the regional change management.

In November 2019, 309 (39%) of the chief physicians in Region Zealand responded to a survey from their medical association [26]. They estimated that they spent more time on 13 of 13 common tasks, such as ordering blood tests, finding microbiological examination results, and writing patient-record notes. The mean increase in time spent was 35%. As a result, the respondents saw 2.4 patients per hour, compared to 2.9 before the introduction of Epic.

In spring 2021, 14628 (29%) of the Epic users in the two regions responded to a satisfaction survey [23]. While satisfaction had increased marginally since the previous survey, the median response was

still “neither satisfied nor dissatisfied”, see Figure 1. Several thousand respondents (32%) were dissatisfied or very dissatisfied with Epic. The dissatisfaction was strongest among the physicians, who five years after go-live at the first hospital gave Epic a mean satisfaction rating of 2.5 on a 1-5 scale.

PLEASE, INSERT FIGURE 1 ABOUT HERE

The continued problems stood in contrast to the pre-implementation expectations. As a concrete instance of the problems, the translation of the Epic user interface from English to Danish caused frustration and usability problems. For example, ‘Caesarean section’ (i.e., C-section) was translated into a Danish term that back-translated into ‘the top executive level of the hospital’ (i.e., C-level) [25]. Apart from usability and technical problems [20, 21, 26, 28], new work procedures also caused problems. Most prominently, it caused severe problems to transfer documentation tasks from the medical secretaries to the physicians, who were expected to enter data into Epic while face to face with their patients. The commenced layoff of medical secretaries had to be aborted [25]. In addition, the post-implementation tailoring of Epic to hospital-specific and department-specific needs caused problems because it ran counter to intentions about region-wide standardization. All reconfigurations had to go through a centralized approval process, which was experienced as slow and burdensome by the users who had received training in configuring Epic [19].

4 Finnish Epic implementation

After four years of preparations, the Apotti project signed a contract with Epic in April 2016. The project extended beyond healthcare to combine the health and social care records in the Helsinki-Uusimaa region into one large-scale system covering specialized healthcare, primary healthcare, and social care. The about 50000 users of the system would serve a population of 1.7 million citizens. After signing the contract, which amounted to 384 million euros, the implementation began. Hundreds of users participated in preparation and implementation activities [32].

The first go-live of the system was at Peijas hospital in November 2018. Like in Denmark, considerable problems ensued. Six months after the system went live at Peijas hospital, the clinicians still experienced technical difficulties with the integration with the national prescription center, complicated workflows for patient transfers, medication lists that did not work as the clinicians were used to, technical issues with the routing of test results, and everyday tasks that required lots of clicks [32]. Over the next four years, the system went live in multiple stages at the region’s hospitals, public health stations, and social service offices. According to the project plan, the rollout of the system will be completed in 2022 [31].

Big economic benefits were expected from the system-enabled changes in operational routines and the more effective data utilization [31]. When the benefits did not materialize after go-live, the Managing Director of Apotti announced, in October 2020, that it took time to implement the operational changes associated with the system and, therefore, the benefits of the system might become visible only after years of use [29].

In 2020, the nurses in the Helsinki-Uusimaa region were surveyed about their EHR experiences [33]. Table 1 shows the responses from the nurses who had started using Epic (they were within their first or second year of using it) and, for comparison, the responses from the preceding survey in 2017 (when the nurses still used EHRs other than Epic). The nurses experienced improved technical performance but inferior usability and reduced work support with Epic. Specifically, only 7.3% agreed that patient information was easy to access and only 26.2% agreed that Epic helped improve the quality of care.

In 2020, the social workers in the Helsinki-Uusimaa region were surveyed [33]. Few social workers had started using Epic at the time of the survey, so it merely gave first indications. The social workers answered several of the same questions as the nurses and provided roughly similar answers, see Table 2. The largest difference was that the social workers were more optimistic about the technical performance of Epic.

In 2021, the physicians in the Helsinki-Uusimaa region were surveyed about their EHR experiences [33]. Table 3 shows their responses (three years after the first go-live) and, for comparison, the responses from the previous survey in 2017 (a year before the first go-live). With Epic, the physicians experienced improved technical performance but inferior usability and reduced work support. Only 4.8% of the physicians found the terminology in Epic clear and understandable. Furthermore, the number of physicians who agreed that information systems help improve the quality of care had dropped from 44.1% (before Epic) to 9.3% (with Epic).

The low usability and work-support ratings occurred in spite of usability tests of the short-listed systems [30]. Some of the usability issues that became apparent after go-live were solved through reconfiguration; others were not. At the same time, the configuration possibilities worked against standardization intended to promote ease of use. For example, the system that went live at Peijas hospital had 76 different views of patient medication [32]. This example illustrates a more unrestricted approach to local configuration than in Denmark. Extending this approach, the Finnish Epic implementation included an open ecosystem for third-party vendors to experiment with add-ons to the EHR [29].

5 Discussion

The Danish and Finnish implementations of Epic are very large projects. They are also troubled projects, which in spite of years of implementation work have seen extensive user dissatisfaction after go-live. We find five issues particularly noteworthy:

First, the consequences of Epic did not become salient until after go-live. For example, the commenced layoff of medical secretaries in the Danish implementation had to be aborted despite years of preparing the transfer of documentation tasks to the physicians. And the poor usability of the Finnish system occurred despite usability tests during vendor selection. This finding indicates that the years of implementation work prior to go-live lacked the realism necessary to impress the consequences of using Epic on project participants. For the user representatives among project participants, Wagner and Newell [34] argue that until they can get a firm idea of the new system they do not “take notice and show concern about the changes that it might force.” In addition, the number of issues to consider may have overwhelmed the project participants. As a result, important consequences remained dormant until go-live. It adds to the experienced troubles that the lessons learned during the first go-live in Denmark were not sorted out before go-live at the next hospital.

Second, the post-implementation problems contradict the pre-implementation expectations. In Denmark, this has led to discussion, among clinicians and politicians, about terminating the system [25]. In Finland, it has prompted the managing director of the project to announce that benefits may not be realized for the next several years. This raises questions about the role of expectations in EHR implementation. During the preparations, grand expectations help attract interest, investment, and enthusiasm [29]. This way, they justify efforts and create valuable momentum but also increase the risk of glossing over legitimate concerns. In addition, expectations enter into implementation plans, which turn out to be too optimistic when realities run counter to expectations. Unmet expectations create difficulties and frustration after go-live because users and organizations have not anticipated the problems they experience. The Danish experiences could have tempered the Finnish expectations

and resulted in a strong focus on, among other things, usability issues such as clear terminology. The low usability ratings in Finland suggest that the Danish experiences did not instill such a focus.

Third, the usability issues demonstrate the extent of the translation involved in transferring a US-based EHR to a Nordic context. In Denmark and Finland, specialized healthcare is financed via taxes. Thus, EHRs should not issue bills to insurance companies by documenting the care delivered. Being originally developed for US healthcare, which is financed via the citizens' health insurance, Epic has at its heart a very different model of healthcare and the role of healthcare documentation. This model meant that many clicks and workflows were foreign to a Nordic context but so deeply rooted in the system that they could not be configured away [see, also, 35]. In addition, the Epic user interface had to be translated into Danish and Finnish. With the large scale of the system, this translation was a substantial task. In Denmark, it was poorly performed [25]. The considerable number of poor translations made the interface difficult to understand and zero-hit searches frustratingly common.

Fourth, both Denmark and Finland purchased an existing EHR but still spent years preparing it for go-live. Buying an existing system was seen as reducing project risk because Epic was already in operational use at many hospitals. However, the Epic version in use at these hospitals did not meet Danish and Finnish requirements. Extensive configuration was necessary. Hundreds of clinicians have participated in these configuration activities as domain experts. These clinicians are anchored in local matters but also tasked with enforcing standardization. It appears that the two Danish regions have assigned primacy to standardization, while the Finnish region has made more room for local matters and future evolution. So far, neither approach has resulted in a well-liked system. In the ongoing Norwegian Epic implementation, user requirements played a prominent role in vendor selection, but during system configuration they are reshaped by the available configuration possibilities [36]. That is, the requirements partly yield to the system. Like the approaches in Denmark and Finland, this approach may result in frustrated clinicians because they expect a system configured for their needs.

Fifth, the healthcare infrastructure has been built in many steps over considerable time; introducing a large-scale EHR severely upsets this equilibrium. As a result, clinicians are stressed by EHR implementations [16]. It contributes to the stress that EHRs tend to increase documentation requirements – in the interest of improving patient care and research data – and simultaneously come with the expectation of cost savings. In Finland, cost savings are a major expectation, but physicians and nurses experience that Epic provides reduced support for their work. In Denmark, the hospital budgets for 2018 were initially cut with a percentage of the expected cost savings, but this budget cut had to be revoked when it later became apparent that the Epic implementation was troubled [28]. The transfer of documentation work from medical secretaries to physicians is central to the troubles. This transfer upsets the time-honored collaboration between physicians and medical secretaries. Furthermore, it leaves the physicians with less time and attention for direct patient contact. Abrupt changes in such long-standing collaborations and work-critical activities are stressful, even if the changes are for the better. When they are not experienced as beneficial, they cause dissatisfaction, frustration, and possibly burnout [5, 17, 37].

We do not mean to imply that there are simple solutions to the above issues. Rather, our analysis indicates that it is dauntingly complex to implement systems the size of EHR suites. However, the analysis suggests that future EHR implementations should heed three recommendations: (a) Follow up quickly when tests or real use lead to the identification of usability, technical, or other problems. Clinicians who experience the same problem again after having reported it begin to lose faith in the implementation process. Conversely, they gain confidence in it, if reported problems are solved quickly. If the number of problems clearly exceeds the capacity for responding to them quickly, then the EHR is not yet ready to go live. (b) Plan for the transition process to continue for a long time. It is unrealistic to presume that productivity will be back at baseline after a few weeks. Unless hospitals plan for an extended productivity dip, they will be poorly prepared and the implementation process will suffer. Previous studies indicate that the productivity dip lasts 3-12 months [8]. It appears to be even longer in the Danish and Finnish implementations of Epic. (c) Be wary of introducing work-

process changes that are opposed by the clinicians. The Danish transfer of documentation work from medical secretaries to physicians is an example of such a change. It generated considerable frustration and a sense that those in charge of the EHR implementation lacked appreciation of the clinical work. Those in charge should consider whether they will be able to implement the EHR under such circumstances – and whether they are prepared to do it.

6 Conclusion

In Denmark and Finland, dissatisfying post-implementation experiences with Epic have replaced grand pre-implementation expectations. The experienced troubles have occurred in spite of years of implementation work to configure Epic for Nordic healthcare and prepare the healthcare organizations for Epic. Specifically, the healthcare organizations remained unprepared for some of the consequences of using Epic. These consequences did not become salient until after go-live. As a result, the hospitals and other healthcare organizations found themselves in a reactive rather than proactive mode. They have predominantly been fending off unanticipated problems rather than realizing planned benefits.

Authors' contributions

The first author conceived the study, collected the material about the two implementations, and drafted the article. All authors discussed multiple versions of the manuscript and approved the final version.

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Statement on conflicts of interest

The authors have no conflicts of interest to declare.

Summary table

What was already known about the topic:

- Healthcare organizations are replacing their EHRs with large-scale EHR suites
- With still larger-scale EHRs, EHR implementation becomes increasingly complex

What this study added to our knowledge:

- Despite years of implementation work, the experiences from the Danish and Finnish implementations of Epic do not meet expectations
- The consequences of using Epic have not become salient until after go-live, thereby placing the healthcare organizations in a predominantly reactive mode

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Table 1. Nurses' experience of their EHR (percent of nurses in the Helsinki-Uusimaa region who agreed fully or somewhat to the items)

Item	% of responding nurses who agreed	
	Before Epic (2017) N = 597 to 621	With Epic (2020) N = 366 to 384
<i>Technical performance:</i>		
The system is stable in terms of technical functionality (does not crash, no downtime)	35.3	50.0
The system responds quickly to inputs	45.6	50.4
<i>Usability:</i>		
The arrangement of the fields and functions is logical on the computer screen	38.3	12.5
Terminology on the screen (e.g., titles and labels) is clear and understandable	45.3	14.1
The patient's current medication list is presented in a clear format	49.6	12.2
It is easy to obtain necessary patient information using the information system	43.1	7.3
<i>Work support:</i>		
Routine tasks are performed in a straightforward manner and without the need for extra steps	35.6	12.6
The information systems support collaboration and communication among nurses in their own organization	63.4	37.0
The use of information systems disrupts the nurse-patient relationship	68.1	71.7
Information systems help improve the quality of care	50.8	26.2

Note: data from the open data set provided by Finnish Institute for Health and Welfare [33]

Table 2. Social workers' experience of Epic in 2020 (percent of social workers in the Helsinki-Uusimaa region who agreed fully or somewhat to the items)

Item	% of responding social workers who agreed
	<i>N</i> = 56 to 57
<i>Technical performance:</i>	
The system is stable in terms of technical functionality (does not crash, no downtime)	66.7
The system responds quickly to inputs	68.4
<i>Usability:</i>	
The arrangement of the fields and functions is logical on the computer screen	16.1
Terminology on the screen (e.g., titles and labels) is clear and understandable	8.8
<i>Work support:</i>	
Routine tasks are performed in a straightforward manner without the need for extra steps	21.1
The information systems support collaboration and communication among social workers in their own organization	64.9
Information systems help improve the quality of service	26.3

Note: data from the open data set provided by Finnish Institute for Health and Welfare [33]

Table 3. Physicians' experience of their EHR (percent of physicians in the Helsinki-Uusimaa region who agreed fully or somewhat to the items)

Item	% of responding physicians who agreed	
	Before Epic (2017) N = 1165 to 1304	With Epic (2021) N = 1233 to 1255
<i>Technical performance:</i>		
The system is stable in terms of technical functionality (does not crash, no downtime)	44.4	74.3
The system responds quickly to inputs	34.8	51.7
<i>Usability:</i>		
The arrangement of the fields and functions is logical on the computer screen	44.0	4.9
Terminology on the screen (e.g., titles and labels) is clear and understandable	42.5	4.8
The patient's current medication list is presented in a clear format	38.5	8.1
It is easy to obtain necessary patient information using the EHR system	37.7	4.7
<i>Work support:</i>		
Routine tasks are performed in a straightforward manner without the need for extra steps	29.4	7.3
The information systems support collaboration and communication among physicians in their own organization	62.5	22.0
The use of EHR systems frequently takes my attention away from the patient	69.2	-
Information systems help improve the quality of care	44.1	9.3

Note: data from the open data set provided by Finnish Institute for Health and Welfare [33]

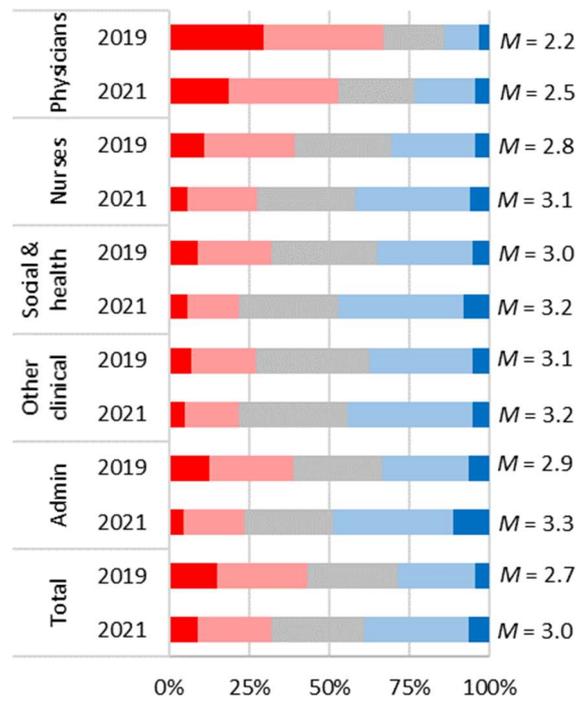


Figure 1. Danish Epic users' response to the question "How satisfied or dissatisfied are you overall with Epic?", $N = 19584$ (2019) + 14628 (2021). Based on Jensen [23].

Legend: Left to right the response options are "very dissatisfied" (red), "dissatisfied" (light red), "neither satisfied nor dissatisfied" (grey), "satisfied" (light blue), and "very satisfied" (blue). M = mean.