Interoperability after deployment: persistent challenges and regional strategies in Denmark

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Abstract

Quality problem or issue: The European Union has identified Denmark as one of the countries who have the potential to provide leadership and inspiration for other countries in eHealth implementation and adoption. However, Denmark has historically struggled to facilitate data exchange between their public hospitals’ electronic health records (EHRs). Furthermore, state-led projects failed to adequately address the challenges of interoperability after deployment.

Choice of solution: Changes in the organizational setup and division of responsibilities concerning the future of eHealth implementations in hospitals took place, which granted the Danish regions the full responsibility for all hospital systems, specifically the consolidation of EHRs to one system per region.

Implementation: The regions reduced the number of different EHRs to six systems by 2014. Additionally, the first version of the National Health Record was launched to provide health care practitioners with an overview of a patient’s data stored in all EHRs across the regions and within the various health sectors.

Evaluation: The governance of national eHealth implementation plays a crucial role in the development and diffusion of interoperable technologies. Changes in the organizational setup and redistribution of responsibilities between the Danish regions and the state play a pivotal role in producing viable and coherent solutions in a timely manner.

Lessons learned: Interoperability initiatives are best managed on a regional level or by the authorities responsible for the provision of local health care services. Cross-regional communication is essential during the initial phases of planning in order to set a common goal for countrywide harmonization, coherence and collaboration.

Key words: interoperability, health information exchange, hospital care, electronic health records, implementation governance

Quality problem or issue

In Europe, eHealth is a key goal of the European Union (EU) who have released successive health and Information Technology (IT) policy documents designed to foster a harmonious and complementary approach to eHealth implementation and adoption across all 28 Member States as part of their ‘Digital Agenda’ [1–3]. In this article, eHealth means ‘the use of ICT in health products, services and processes combined with organisational change in healthcare systems and new skills, in order to improve health of citizens, efficiency and productivity in healthcare delivery, and the economic and social value of health’ [1]. eHealth technologies can lead to positive impacts on the quality of health care services through the electronic exchange of clinical data such as the increased availability of health information shared between health care providers, improved continuity of patient care and reductions in medical costs, waiting times and errors [4–6]. A key component in realizing these benefits is the interoperability between technologies. In this article, interoperability is defined as ‘the
ability to exchange, understand and act on patient and other health information and knowledge among linguistically and culturally disparate clinicians, patients and other actors, within and across jurisdictions, in a collaborative manner” [7].

Among the EU’s long-term plans of creating a harmonized Europe are the wider interoperability of eHealth services by 2015 and enablement of cross-border exchange of patient data between Member States [8]. However, achieving these goals presents a myriad of significant challenges due to the current discrepancies that exist between Member States health care systems [9], national eHealth policies and strategies [10], legislations [11] and progress in eHealth implementation [12]. In the light of this dilemma, the EU’s Task Force on eHealth published a report recommending the formation of a ‘beacon group’ consisting of leading Member States and regions who can provide leadership and inspiration for other countries [13]. The report identified Denmark as one of the countries who have the potential to take on a key leadership role in the beacon group. The EU Task Force Report’s recommendation is not surprising since Denmark is widely considered a global leader in national-level eHealth. For example, several studies and reports have highlighted Denmark’s high levels of eHealth usage in hospitals [14], primary care practices [15] and patient population [16]. Furthermore, a recent study by the European Commission’s Joint Research Centre (JRPC) found that Denmark is also at the forefront for telehealth [17]. Nevertheless, the results of these studies seldom discuss the ongoing struggles of Danish health care organizations limited capabilities to engage in the seamless electronic exchange of patient information, unresponsive systems and crash-prone technologies [18–20]. These polarizing results demonstrate the concomitant complexities surrounding ‘successful’ national eHealth programmes.

A case study of Denmark provides an ideal setting for further analysis in terms of attaining transferrable knowledge that can inform broader eHealth initiatives and implementation across the EU. The aim of this study is to examine the recent approach used by Denmark in their efforts to achieve interoperability after deployment—specifically hospital electronic health records (EHRs). A case study approach was used to (i) assess how Denmark previously attempted to foster interoperability between EHRs, (ii) examine the newest strategies to foster interoperability and health information exchange (HIE) and (iii) evaluate the study’s implications for other countries experiencing national eHealth fragmentation. The findings of this study can serve as a learning opportunity for policymakers and health planners by providing them with further insight into broader aspects affecting interoperability after deployment such as the governance of implementation strategies.

**Initial assessment**

The administrative structure of the Danish health care system consists of three levels: state, region and municipality (Box 1). The state maintains the responsibility for overall regulatory and supervisory functions (e.g. legislation and providing overall guidelines). The regions and municipalities are responsible for providing health care services in the primary and secondary care sectors. The public hospitals, perinatal care centres and community psychiatric units are owned and run by the regions. The municipalities are responsible for post-hospital care, nursery homes, nursing homes and rehabilitation centres.

In the Danish health sector, eHealth is the primary tool of trade among Danish health care practitioners. A progressive approach to implementation and adoption via a series of key national IT strategies and regulations enabled an accelerated diffusion of technologies and their subsequent mandatory use (Box 2) [21]. Initially, the diffusion of EHRs relied on a ‘bottom-up’ approach, where the former counties (now regions) were able to select their EHR systems, vendors and technical requirements. The outcome of this approach resulted in a plethora

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**Box 1 Structural reform of the Danish health care system**

- Before 2007, Denmark consisted of 15 counties and 271 municipalities.
- In 2007, a major structural reform of the public sector took place: the 15 counties were replaced by 5 regions, and the number of municipalities was reduced to 98.
- The five regions are Capital Region of Denmark, Region Zealand, Region of Southern Denmark, Central Denmark Region and North Denmark Region.

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**Box 2 Key national IT strategies and regulations**

<table>
<thead>
<tr>
<th>Type</th>
<th>Year</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulations (i.e. budget agreement)</td>
<td>2002</td>
<td>‘Economic Agreement between the Government and the Association of County Councils’: All hospitals have to implement EHRs based on common standards by 2005.</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>‘Mandatory adoption of EHRs under the primary care physician contract’.</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>‘Mandatory adoption of EHRs under the specialist contract’.</td>
</tr>
<tr>
<td></td>
<td>2011</td>
<td>‘Economic Agreement between the Government and the Regional Authorities’: The Danish regions take the responsibility for hospital systems, e.g. regional consolidation of EHRs and single sign-on by 2013.</td>
</tr>
</tbody>
</table>
of proprietary hospital EHRs that were not always fully capable of exchanging clinical data [22]. A report published in 2011 by the Danish National Audit Office also found that the regions were experiencing several significant technological and organizational challenges in connection with the implementation and adoption of EHRs [23].

### Choice of solution

Three major state-led projects were initiated in an attempt to facilitate data exchange between hospital systems. The projects included (i) a national framework specification that required all EHRs to adhere to, (ii) a proposed ‘national electronic health record’ to replace all existing EHRs and (iii) a nationwide HIE platform designed to ‘pull’ and centralize patient data from multiple sources (Box 3). The significant and costly modifications required of these projects in health care organizations and existing technologies led to their eventual abandonment after they were deemed too ambitious and problematic to implement [24].

In response to the lack of progress from the state to develop a viable solution, major changes in the organizational setup and division of responsibilities took place concerning the future of eHealth implementations in hospitals as part of the 2011 Economic Agreement between the regions and the state. The agreement entailed that the regions would assume the full responsibility for all hospital systems, specifically the consolidation of the number of implemented EHRs by 2013 [25]. The regions formed their own eHealth organization—’Regionernes Sundhed-it’ (RSI)—to ensure a cooperative and collaborative effort and vision concerning the consolidation, development and implementation of specific eHealth solutions in hospitals across all five regions. The state formed the National eHealth Authority (NSI) as the government authority tasked with the responsibility of setting national standards for eHealth in accordance with the national IT strategy as well as managing national-level IT projects, including eHealth systems (i.e. ‘the shared medication record’) and registers in the IT infrastructures [22].

The regions published their own IT strategy in 2010 to establish specific milestones designed to guide the coherent and coordinated future development of eHealth services as well as the development of new solutions in accordance with four focus areas (Box 4). In line with the economic agreement and the strategy, the regions aimed to overcome interoperability by consolidating the number of EHRs to one system per region by the end of 2013. Moreover, all EHRs deployed across the five regions would have to be equipped with an ‘EHR landscape’ of core modules to ensure that all physicians have access to the most important information for care coordination. These initial core modules include the following:

- Notes: document the clinical process of the physician’s examination of a patient during care, i.e. memos, diagnosis and discharge summaries.
- Medicine: prescribe, prepare and document the patient’s medication.
- Requisition/response: order of tests (imaging, diagnostics, labs, etc.) and dissemination of the results.
- Booking: schedule patient appointments in relation to the available physical resources.
- Patient administrative system (PAS): support the clinical work by providing the status of the patient’s relationship to the hospital as well as information concerning previous admissions.

To further support cross-regional exchange, the regions also took the responsibility for developing a ‘National Health Record’. The National Health Record will be built upon the foundation of another system already available called ‘e-journal’ project. The e-journal serves the purpose of providing health care professionals with a read-only overview of patient information stored in all public hospital EHRs and/or PASs that is transferred to a central e-journal database [26]. The intentions are for the National Health Record to expand upon this concept by also including the patient’s data from lab reports, medication record, general practitioners (GPs) notes, vaccination history and imaging data.

Other major exchange efforts taking place in concurrence with the regional efforts include the states’ shared medication record (SMR)—a database designed to provide health care professionals with access to information about patients’ medicines and vaccinations [21]. The development of the SMR falls under the responsibility of the NSI, and the regions have to integrate it into their EHRs by linking their own medicine modules to the SMR database. Apart from integrating the SMR into the hospital, the regions and municipalities have also to integrate the SMR across the rest of the public and private health sectors (e.g. pharmacies, dentists, etc.).

### Implementation

#### Electronic health records

Since 2010, the regions managed to successfully reduce the number of different EHRs to just six systems by 2014 (Box 5) [27]. Only one region (Region of Southern Denmark) failed to meet the targeted date of consolidation by 2013.

Each of the regions chose to work with different vendors in order to develop and implement their EHR system. At the time the strategy had been published, Region Zealand had already been using one

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**Box 3 State-led initiatives to create interoperability between EHRs**

<table>
<thead>
<tr>
<th>Name of project</th>
<th>Description</th>
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<tbody>
<tr>
<td>Basic Electronic Health Record (BEHR)</td>
<td>A national framework specification for EHRs that would facilitate information sharing between the different systems used by the Danish health care providers. The modifications required by the BEHR were too problematic to implement into existing EHRs and organizational workflows. The project was initiated in 2001 and abandoned in 2006.</td>
</tr>
<tr>
<td>National Electronic Health Record System (NEHR)</td>
<td>The NEHR was proposed by the former Minister of Health in 2006 (Lars Lokke Rasmussen). However, the outcome of this proposal only resulted in a few PowerPoint slides.</td>
</tr>
<tr>
<td>National Patient Index (NPI)</td>
<td>A platform that facilitates the searching of patient’s health information across many different data sources irrespective of where the data are stored. The project was abandoned in 2013.</td>
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</tbody>
</table>
Box 4 Regions eHealth strategy

**Focus area** | **Milestones**
--- | ---
**The clinical IT workplace** | 1. Every region has a consolidated EHR landscape (notes, medicine, requisition/response, booking and PAS) by 2013.  
2. Each region has expanded their EHR landscape for the clinical IT workplace to include paraclinical information (RIS/PACS, microbiology, clinical/chemical and pathology) by 2013.  
3. All of the regions’ hospitals have quick and easy access to essential systems in the clinical IT workplace (including single sign-on) by 2013.  
4. By 2011, hospitals in the five regions will have the possibility to use digital dictation.  
5. In the spring of 2011, all regions will present a plan of how they intend to incorporate Speech Recognition into the hospitals.  
**Optimal operation of hospitals** | 6. The regions’ hospitals will be equipped with electronic boards in all major emergency departments by the end of 2011.  
7. Tele-interpretation will be available in relevant hospital departments by the end of 2012.  
8. The regions will have a plan for how IT will support pre-hospital efforts (including ambulance records) by the spring of 2011.  
9. The five regions take into consideration IT and automatization as part of the design of the new hospitals and larger outbuildings, including ensuring the exchange of experience. At the same time, the regions make sure that relevant knowledge is utilized in relation to existing buildings.  
10. In the spring of 2011, the regions will prepare a strategy on how telemedicine will optimize hospital operations.  
**Coherence and cooperation** | 11. e-Journal: All hospitals can transmit relevant data from PAS and EHR to the e-journal, and all hospitals have access to e-journal in the clinical IT workplace by the end of 2010.  
12. The regions expand the e-journal into becoming the National Health Record by the end of 2013. The National Health Record receives an improved and more intelligent user interface that can be used to access significant data (notes, cave, laboratory data, medication, diagnostic and imaging).  
13. The Danish regions collaborate with the government to ensure that GPs and specialists make their data available in National Health Record by the end of 2012.  
14. MedCom standards are fully deployed in regional hospitals by the end of 2012.  
15. The regions will coordinate IT-supported solutions for efforts concerning the chronically ill.  
16. All regions have integrated the SMR into their systems by the end of 2011.  
17. The regions can exchange images between all hospitals in Denmark before the end of 2012.  
18. The five regions make common nationwide data sources available to the health sectors and other stakeholders in line with that they develop.  
**Patient empowerment** | 19. The regions now make the e-journal available to citizens. Sundhedsjournalen will also be available to the public when it is fully developed.  
20. All regions will send relevant appointment letters and other letters to the patient digital document box before the end of 2012.  
21. All regions will send SMS reminders to patients prior to planned appointments with hospitals by the end of 2012.  
22. The regions will complete a large-scale project designed to provide an IT-supported solution for a select chronic disease group by the end of 2011.  
23. The regions will release 2500 Danish-language and evidence-based articles concerning health, disease and treatment to citizens and patients via the ‘Patient Handbook’ on sundhed.dk by 2011.  
24. The five regions will develop a common strategy for IT to support patient empowerment with a focus on joint efforts.

Notes: This is the author’s translation. The original version is available in Danish at http://e-pages.dk/regioner/31/.

Box 5 Consolidation of the number of EHRs per region in 2010 and 2014

<table>
<thead>
<tr>
<th></th>
<th>Number of EHRs in 2010</th>
<th>Number of EHRs in 2014</th>
<th>Target year for one consolidated EHR system in 2010</th>
<th>Realized/expected target for one consolidated EHR system by 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Region of Denmark</td>
<td>3</td>
<td>1</td>
<td>2012</td>
<td>2010</td>
</tr>
<tr>
<td>Region Zealand</td>
<td>1</td>
<td>1</td>
<td>2008</td>
<td>2008</td>
</tr>
<tr>
<td>Region of Southern Denmark</td>
<td>5</td>
<td>2</td>
<td>2013</td>
<td>2015</td>
</tr>
<tr>
<td>Central Denmark Region</td>
<td>4</td>
<td>1</td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>North Denmark Region</td>
<td>2</td>
<td>1</td>
<td>2013</td>
<td>2013</td>
</tr>
</tbody>
</table>

Source: Danish National Audit Office [27].
EHR called ‘OPUS’, which was developed by CSC Scandhealth—the Scandinavian division of CSC’s health IT providers. Capital Region Denmark chose to use an EHR also developed by CSC Scandhealth called ‘H-EPJ’. Central Denmark Region hired the Danish vendor Systematic to design, develop and implement the EHR ‘MidtEPJ’, which was based on the Columna Clinical Information System. The region started implementing the EHR in 2010 and finished rolling out the system in the summer of 2013. North Denmark Region chose to work with CSC Scandhealth to implement their EHR system—CSC Clinical Suite. Region of Southern Denmark hired the Swedish vendor Cambio to implement the Cambio COSMIC system for all their hospital EHRs. The implementation process began in 2010; however, the region was unable to finish the roll-out by 2013.

In December 2013, the Capital Region of Denmark and Region Zealand signed a contract with the American vendor ‘Epic’ to completely replace their two aging EHRs with the same health IT solution. The roll-out of the new system will take place between 2015 and 2017, implying that the number of different EHRs in Denmark will soon decrease to four systems.

**Shared medication record**

The SMR has been under development since 2008 and was originally the responsibility of the now defunct cross-governmental organization ‘Connected Digital Health in Denmark’. In 2010, the NSI took the responsibility for the continued development of the SMR as part of the redistribution of responsibilities and organizational setup between the state and regions. Initially, the SMR was scheduled to be completely integrated into all hospitals by 2011. After several delays, the SMR was available in all public hospitals (except one) by mid-2014. However, regional usage of the SMR differed significantly. The Region of Southern Denmark (80%) and Region Zealand (76%) were among the top users in comparison with North Denmark Region (69%), Capital Region of Southern Denmark (62%) and Central Denmark Region (31%) [28].

**National health record**

In 2014, the first version of the National Health Record was launched to provide physicians and nurses with an overview of a patient’s data stored across all the regions and within the various health sectors. The data included recent hospital visits, recent medication orders, allergies and the contact details of their primary care physician. Health care practitioners in hospitals can access the Sundhedsjournalen as part of their workstation, whereas Danish citizens can gain access to the information through the Danish e-Health Portal (www.sundhed.dk).

**Evaluation**

The large-scale diffusion of eHealth technologies built upon varying standards can introduce long-term and persistent challenges to interoperability and the health sectors’ ability to engage in HIE. Denmark’s historical approaches to the matter demonstrate the inherent difficulties associated with a state-led centric approach to technology harmonization. Similar results have occurred when countries apply a top-down approach to national-level shared medical records, i.e. the failure of the NHS National Programme for IT (NPHIT) [29]. Moreover, Denmark’s methods to overcome the woes of interoperability between EHRs demonstrate that HIE is not merely a technical issue but a challenge fraught with organizational and political complexities [25].

The findings of this study imply that the governance of national eHealth implementations plays a crucial role in the development and diffusion of interoperable technologies. Specifically, changes in the organizational setup and redistribution of responsibilities between the Danish regions and the state played a pivotal role in producing viable coherent solutions in a timely manner. This suggests that a coordinated region-led approach to interoperability with minimal interference from the state may be the most efficient method in establishing or repairing trust between both parties. In Denmark, the regions’ position as the administrative authority responsible for the hospital care makes them the most appropriate party to understand the eHealth needs of the local health care organizations. Therefore, a successful approach to nationwide eHealth is dependent on all regions dialogging to establish a joint vision and goal for current and future implementation and adoption efforts. In this case, the milestones outlined in the regional strategy and the formation of the regional eHealth organization RSI proved to be a critical turning point in addressing interregional and cross-regional EHR interoperability. The regions’ approach to overcoming the challenges of interoperability contributes to the discussion as to what other methods can be used to support HIE activities. Denmark’s previous efforts to create standards among (e.g. BEHR project) and tie together existing systems (i.e. NPI project) were problematic.

The strategy of EHR consolidation and completely replacing all existing systems presents a different approach not often discussed. Other solutions bearing similarity to Denmark’s ‘National Health Record’ have been widely covered such as pull-based HIE portals in the USA [30]. The Danish approach raises the question as to whether other countries’ health care systems should opt to collectively phase out their current EHR investments and simultaneously invest into new technologies. Implementing new ICT platforms may be a costly affair; however, it may be the only feasible solution when all else has been exhausted. Such efforts may be met with resistance due to fears of loss of investment in current technologies and failure to have had enough time to re-engineer care processes to create benefits from the technologies [31]. Additionally, there exist substantial risks for regions to work with a one-vendor policy such as the disadvantages related to a vendor having a monopoly over the eHealth market such as being stuck with a technology that ‘becomes inferior in the long run’ or insufficient market friction, which ‘could generate costly and suboptimal changes among technologies’ [32].

Taking into consideration the EU’s plans for interoperable cross-border eHealth, the exchange standards used in the Danish health sector need to be flexible enough to adapt to the EU eHealth Interoperability Framework’s four dimensions: technical, semantic, organizational and legal [33]. These broader international issues highlight the importance of the state’s responsibilities via the NSI in terms of managing future ICT standards that will meet the requirements of the EU as well as disseminating it to the health sector [34]. Here, transparency and continual dialogues between the state, regions and municipalities are crucial in collaboratively setting a national health care policy/strategy framework that implements EU standards [35]. Existing technologies and organizations will need to be flexible enough to adopt or integrate any new standards across the four dimensions of the EU eHealth Interoperability Framework.

Overall, the study lays the groundwork for future research. As the Danish approach is rather current, future studies should monitor and assess whether the quality of health care services has actually improved. In particular, monitoring physician satisfaction in relation to whether the regional EHRs and National Health Record services are helping meet their information needs and coordination of care. In addition, patient satisfaction concerning their evaluation of the quality of their care when crossing over regional boundaries needs to be measured. Also, the impact of the EU’s standardization plans

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on the current eHealth services should be monitored, and their ability to adapt to change needs to be measured in order to create implications for flexible implementation framework. Lastly, the long-term impact concerning the change in dynamics of the states and regions’ redistribution of eHealth responsibilities should be closely monitored to examine where communication and planning can better be enhanced to guarantee a coherent vision and efficient implementation strategy for national eHealth.

**Lessons learned**

Denmark’s recent approach to overcoming interoperability challenges provides valuable knowledge-transfer lessons for countries facing similar struggles of a fragmented eHealth infrastructure. For policy-makers and health planners, the Danish approach can serve as a learning opportunity.

First, interoperability initiatives are best managed and planned on a regional level or by the authorities directly responsible for the provision of local health care services. Cross-regional communication is essential during the initial phases of planning in order to set a common goal for harmonization, coherence and collaboration. Collectively establishing and publishing a regional strategy that outlines representing the immediate needs with realistic deadlines can help provide direction that all regions can collectively work their way towards. Establishing an eHealth organization that jointly represents all of the regions can help realize these goals, promote unity between regions and manage a joint direction for future eHealth solutions.

Second, the scope concerning the distribution of responsibilities between the regions and the state needs to be established. Limiting the influence of the state to setting national standards and managing national-level initiatives can help accelerate the implementation process if the regions are allowed specifically to focus on eHealth in hospitals and still to work within the boundaries of state-set national frameworks for standards.

Third, the foundations of an EHR landscape should include core modules that are considered the most crucial in care coordination activities. Countries need to investigate the actual information needs of healthcare practitioners and consistently implement these features into all EHRs deployed across the country. Moreover, ensuring that EHRs all have the same modules can help foster easier cross-regional exchange between different technologies as well as physician communication.

Fourth, establishing a centralized database akin to the Danish ‘National Health Record’ and integrating it into the EHRs are vital for countrywide HIE across the entire health sector. In addition to this, the National Health Record serves as a good central point to centralize data from systems developed by the state (i.e. Share Medication Record) and private sector (i.e. pharmacies). Moreover, making the patient data accessible to citizens via the public health portal has the potential to increase transparency and patient engagement.

Finally, the consolidation of systems can help minimize EHR fragmentation; however, prior to beginning this process, it is important to evaluate the pros and cons of keeping a particular system or investing into a new one that can be built upon the standards set by the regional strategy and state. Opting for the former requires that regions are quick in their decision-making process concerning their choice vendors and ensuring that the deadline for roll-out can be met. In Denmark’s case, three of the regions already had begun negotiations with vendors to implement a complete EHR in all hospitals during a roll-out phase over a period of 3 years.

Nevertheless, the lessons learned from Denmark’s eHealth journey imply that countries currently struggling with persistent challenges in interoperability may consider opting for a radical fresh start. After all, new wine should only be poured into new wineskins.

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