

Learnings from the implementation of **Epic**

Benefits, issues, causes and recommendations



Picture from Region H (2016)

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Table of contents

| | |
|--|----|
| Preface..... | 3 |
| 1. Executive summary..... | 4 |
| 1.1 Scope of the implementation..... | 4 |
| 1.2 Observed issues at Herlev/Gentofte Hospital | 4 |
| 1.3 The causes for the observed issues | 5 |
| 1.4 Recommendations for implementing Epic | 6 |
| 2. Investigating the implementation of Epic | 7 |
| 2.1 Important stakeholders | 7 |
| 2.2 Interviews conducted | 8 |
| 2.3 Documents scrutinized | 8 |
| 3. From multiple systems to one integrated solution | 9 |
| 3.1 The old systems and workflows | 9 |
| 3.2 Envisioning one system, one record..... | 10 |
| 3.3 Business case and expected benefits | 11 |
| 3.4 Tender and procurement process | 12 |
| 3.6 Developing clinical and administrative content | 13 |
| 3.5 Technical development | 14 |
| 3.6 Implementation plan | 15 |
| 3.7 Harvesting the benefits | 16 |
| 4. Epic in use | 17 |
| 4.1 Examples from daily use | 17 |
| 4.2 The first public responses from users..... | 19 |
| 5. Issues observed at Herlev/Gentofte Hospital | 21 |
| 5.1 Troublesome documentation and requisitions processes | 22 |
| 5.2 Inconsistent and less detailed medical records..... | 23 |
| 5.3 Long response time when reconciling medicine | 24 |
| 5.4 Requisitions and prescriptions disappearing..... | 24 |
| 5.5 Limited use of clinical guidelines | 25 |
| 5.6 Lack of structured data for research | 27 |
| 5.7 Incorrect coding of treatments and services..... | 27 |

| | |
|---|----|
| 6. The effects on the business case | 29 |
| 6.1 Less effective processes and work procedures | 30 |
| 6.2 Improved patient safety but lack of standardization | 31 |
| 6.3 No economic benefits by consolidating systems | 31 |
| 6.4 Incorrect basis for budgetary planning | 32 |
| 7. What caused the issues? | 33 |
| 7.1 Lack of qualifications among Subject Matter Experts | 34 |
| 7.2 Poor management of user involvement..... | 34 |
| 7.3 Poor training in the system | 36 |
| 7.4 Lack of ownership of business critical components | 37 |
| 7.5 Domain specific components incompatible with Epic..... | 38 |
| 7.6 System deployed without proper testing..... | 39 |
| 7.7 Vision does not create win-win situations | 40 |
| 7.8 Insufficient organizational change management..... | 41 |
| 7.9 Clinical and administrative content not being optimized | 43 |
| 8. Recommendations..... | 45 |
| 8.1 Take responsibility for realizing the benefits in the programme | 46 |
| 8.2 Implement organizational changes incrementally | 47 |
| 8.3 Focus on the benefits when building content..... | 47 |
| 8.4 Implement local changes and adjustments..... | 48 |
| 8.5 Be flexible about changing the go live date | 49 |
| 9. References | 50 |

Preface

The report which you are about to read is a master thesis crafted by Stephan Mosko Jensen and Oliver Metcalf-Rinaldo at the IT University of Copenhagen. It is based on four months of empirical research which was conducted between September and December 2016. Data from several public articles and 19 interviews with representatives from key stakeholder groups, were analyzed and processed. More than 400 people have been involved in the procuring-, developing- and implementation process, and by the exit of 2017 the total number of users will exceed 35,000 clinical workers. Thus, our empirical data only covers a small fraction of the total knowledge held by all the people involved. Some may have entire different experiences than what is described in this report, and some of the issues and causes presented may have been handled by the programme management, the hospitals or the clinical personnel after this report was concluded.

All the informants who have contributed to this research, have been presented with the report and have had the opportunity to comment and give feedback. The clinical personnel are in general agreeing with the conclusions presented in the report and regard it as being a representative account of the implementation of Epic. However, the management at HGH, the region and the programme organization regard it as being a one sided and mainly negative account of the implementation. Their critique is especially aimed at the weight given to the statements of the clinical personnel and the conclusions on the poor prospects of harvesting the benefits described in the business case. The goal of this report is not to blame any of the people involved but to present valuable insights and learnings from the Danish implementation of Epic. Good reading.

1. Executive summary

This paper investigates the Danish implementation of the Electronic Health Record (EHR) system Epic at Herlev/Gentofte Hospital (HGH). It outlines the prospect of harvesting the benefits described in the business case, along with recommendations for authorities and hospitals who are considering to acquire Epic.

1.1 Scope of the implementation

In 2012 Region H and Region Sjælland established the programme organization Sundhedsplatformen to be responsible for the procurement, development and implementation of a new EHR system. The total investment amounts to 2.8 billion DKK, involves 2 regions, 17 hospitals and affects 40,000 healthcare professionals. It is based on a business case which prescribes a world class healthcare sector by, providing more effective processes and work procedures, improving the quality of care and lowering IT operations cost. The repayment period is expected to be 9-11 years from the programme initiation in 2012. The tender was completed in 2013 and Epic Systems Corp. was chosen to deliver the commercial of the shelf EHR system Epic. The first hospital went live with Epic in May 2016 and all 17 hospitals are expected to have the system implemented by December 2017.

1.2 Observed issues at Herlev/Gentofte Hospital

With the Danish implementation of Epic follow new processes and distribution of roles and tasks at the hospitals. The most significant is the abolishment of dictation which means that all doctors will have to write medical records themselves. Moreover, it introduces paperless and standardized work processes and procedures which have to be implemented in all departments. When the system went live at HGH several issues were observed. Some have an impact on the clinical practice while others affect the strategic goals of the regions. The following seven observed issues have a direct impact on one or more potential benefits described in the business case.

- 5.1 Troublesome documentation and requisitions processes
- 5.2 Inconsistent and less detailed medical records
- 5.3 Long response time when reconciling medicine
- 5.4 Requisitions and prescriptions disappearing
- 5.5 Limited use of clinical guidelines
- 5.6 Lack of structured data for research
- 5.7 Incorrect coding of treatments and services

The most significant and persistent impact on the business case stems from the documentation and requisitions processes which leads to lower productivity in the outpatient clinics. In some departments the productivity is at 80%. The tools developed for supporting these processes does not compensate for the extra workload required by the doctors. It was expected that 75% of the economic benefits were to be realized by improving the clinical and administrative processes but this is far from being fulfilled. Moreover, during the first couple of months, technical issues led to long response time and requisitions disappearing which decreased the efficiency even further. However, this is currently being fixed as these issues are highly

prioritized by the programme. The potential of improving the quality of care has been accomplished in some areas but lack in others. Patient safety has improved due to the consolidation of 30 systems which leaves less room for errors as the amount of information being transferred between systems and personnel is limited. However, the aim of providing the best known treatment for all patients in the two regions is far from fulfilled as the clinical personnel often deviates from the clinical guidelines and provide unstructured data, unfit for research purposes. Furthermore, a considerable amount of incorrect coding of services and treatments will require unexpected resources to correct as it serves as an incorrect basis for the distribution of finances between the hospitals. A full overview of the issues and benefits can be found in chapter 6.

1.3 The causes for the observed issues

The observed issues were caused by several different factors which are of both technical, strategic and organizational character. Each cause has a direct relation to one or several issues which is elaborated in chapter 5. The following nine causes are described in detail in chapter 7.

- 7.1 Lack of qualifications among Subject Matter Experts
- 7.2 Poor management of user involvement
- 7.3 Poor training in the system
- 7.4 Lack of ownership of business critical components
- 7.5 Domain specific components incompatible with Epic
- 7.6 System deployed without proper testing
- 7.7 Vision does not create win-win situations
- 7.8 Insufficient organizational change management
- 7.9 Clinical and administrative content not being optimized

Many of these causes can be traced back to the decision of keeping the go live date which was established by the programme in 2012. The development of the system was delayed which affected the training and left limited time for testing the system's functionality, the new workflows and the clinical content. The process of developing clinical and administrative content for Epic has included a considerable amount of user involvement yet the content still fails to support the clinical practice efficiently. This is due to the lack of qualifications among Subject Matter Experts and poor management of user involvement as well as a limited optimization of the content after the system has been deployed.

After go live the integrations to the external systems FMK and Labka were not working properly and the users experienced reconciliation issues with FMK and orders to Labka disappearing. This was caused by the lack of ownership of the business critical components and incompatibility issues with the technical architecture of Epic. Furthermore, the system was deployed without proper testing because of the tight deadline which resulted in these issues not being discovered before go-live.

The individual users and the different departments at HGH were insufficiently prepared for the new work practices and distribution of roles imposed by the implementation of Epic. The training of end users had limited effect as the system was not ready for being demonstrated properly due to the delays in the development process. Furthermore, as the system does not provide benefits for the clinical personnel and

due to insufficient change management, the clinical staff did not take ownership of the system and does not use it as intended.

1.4 Recommendations for implementing Epic

We have compiled a list of recommendations which can be used in other Epic implementations in order to minimize risk and strengthen the prospect of gaining the benefits of the system. Each recommendation is a solution to one or more of the causes mentioned above which is further elaborated in chapter 8.

- 8.1 Take responsibility for realizing the benefits in the programme
- 8.2 Implement organizational changes incrementally
- 8.3 Focus on the benefits when building content
- 8.4 Implement local changes and adjustments
- 8.5 Be flexible about changing the go live date

As seen in the Danish implementation of Epic it is difficult to introduce a new EHR system without complications. Replacing several IT systems and paper based workflows introduces potential benefits as well as risks of degrading the efficiency and quality of the health care services. Two other European countries have acquired Epic, with mixed success. At Cambridge University Hospital the problems were so severe that the hospital was put under administration. Radboud University Medical Center in Holland also had challenges with the implementation but has started harvest the benefits after 2 years of use. It is important for all stakeholders to be aware that such an implementation will impose significant changes to the organization and it will take years of adjusting the system and work processes before the benefits can be realized. A successful implementation depends on many factors, but we argue that end users have the primary role as they are the one harvesting the benefits. If they do not perceive the system as beneficial for their work, they will not use it as intended which can take years to redeem.

2. Investigating the implementation of Epic

This paper presents the results of a qualitative study of the implementation of the EHR system, Epic and its impact on the clinical practice at the Herlev/Gentofte Hospital (HGH) in Denmark. The study was carried out from September to November 2016, which is approximately 3 months after the first go live. Implementing the system at all hospitals in the two regions spans from primo 2016 – ultimo 2017 and thus this study only presents learnings from the initial phase of the implementation. The primary focus has been on the implementation at HGH but we have also included some insights from the coming implementations at the Rigshospital and Nordsjællands Hospital. The findings presented in this paper are descriptions of the most important decisions made by the different stakeholders, the rationale behind and the consequences which they have had on the clinical practice.

2.1 Important stakeholders

Implementing Epic is a task which includes several actors. We have compiled the following model to show the most important stakeholders and their contribution to the implementation in Denmark.

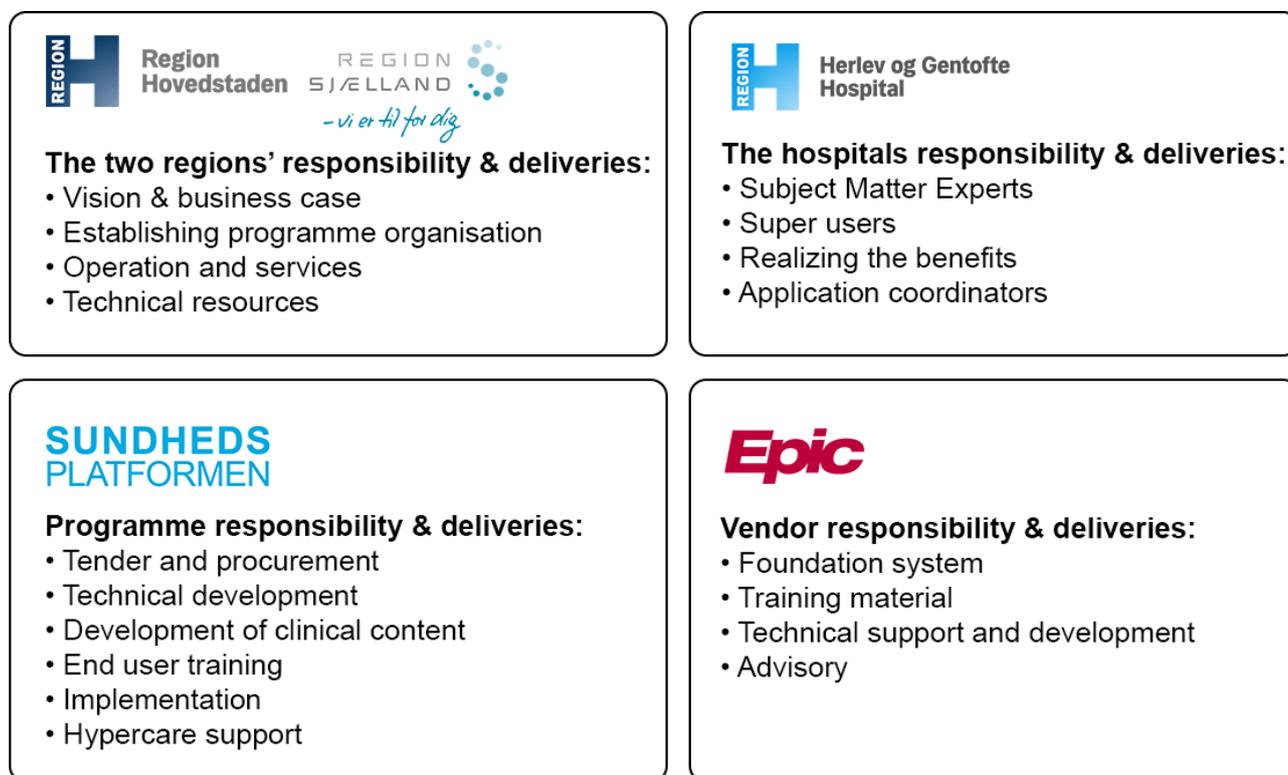


Figure 1 - Stakeholders involved in the Danish implementation of Epic (self-made figure)

2.2 Interviews conducted

The majority of this report is based on 19 qualitative interviews with different stakeholders who hold insight into the procurement, development, implementation and use of Epic. Our informants have wished to be anonymized and thus will not be cited in this paper. The findings presented in this paper represent individual stories and our assessment of their statements. The interviews have been conducted with representatives from:

Herlev/Gentofte Hospital

- Clinical staff
- Department management
- Hospital management

Programme organization

- Programme management
- Clinical content development
- Technical development
- Subject Matter Expert

Nordsjællands Hospital

- Clinical Staff

Region H

- Business change management
- Risk management

Radboudumc (Dutch Epic customer)

- Information management

2.3 Documents scrutinized

We have included several official documents and news articles to provide additional insights. They are used both as primary sources and to support the findings from the interviews. The documents are:

Region H

- Presentations
- Benefits catalogue
- Status reports and press releases
- Summary of business case and risk assessment

Programme organization

- Tender Material
- Presentations
- Memorandums

Other sources

- News articles
- Q&As from NGOs

3. From multiple systems to one integrated solution

The following chapter will outline the old work procedures and the vision and business case for acquiring a new EHR system. The IT solutions used to support the clinical and administrative tasks in the Danish healthcare sector have been criticized for many years (Politiken, 2013 & Dagens Medicin, 2010). The systems are outdated, difficult to use and impose significant risks of errors. To treat a patient, many different systems have to be used and data such as CPR-nr and test results are copied between the systems. By investing in one integrated EHR system which covers all clinical and administrative processes, Region H and Region Sjælland expects to reduce expenses and provide higher quality treatment. In 2013 the American commercial of the shelf EHR system Epic was chosen as it was expected to accommodate the needs of the clinical personnel. The configuration of the systems and the organizational implementation were to be managed by the programme organization. The first implementation was in May 2016 at HGH and the remaining hospitals will follow the next 1 ½ years. When fully implemented the regions will be responsible for operating the system and the hospitals will be responsible for harvesting the benefits. The below plan outlines the activities of the programme after the tender process.

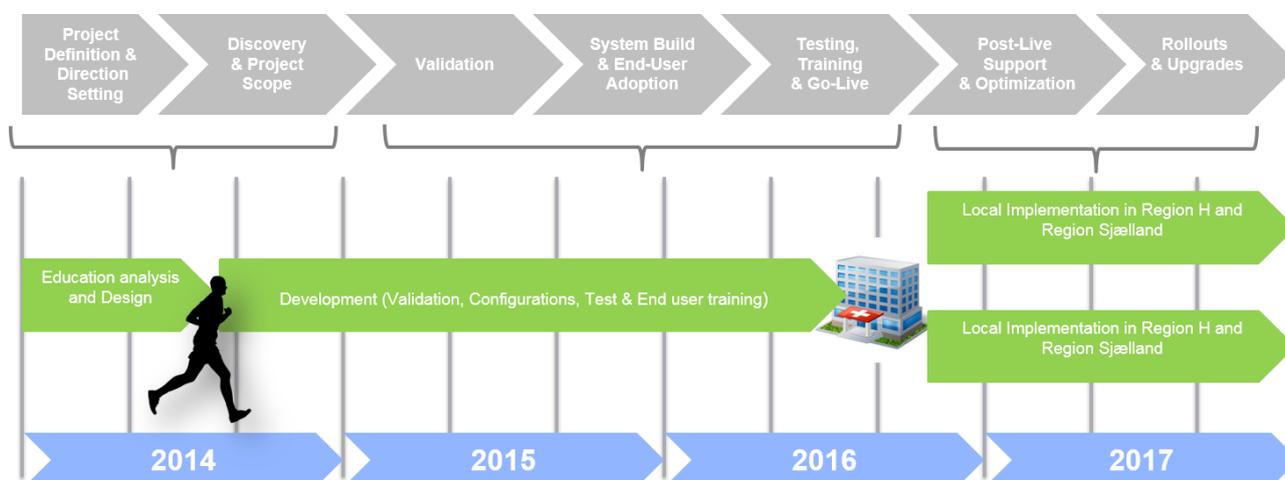


Figure 2 – Official timeline showing the plan for the programme after the tender (Appendix 1, p4)

3.1 The old systems and workflows

The old practice at the Danish hospitals involves dictation, semi-digital documentation and ordering processes, and log in to several non-integrated systems. This practice had a distinct division of clinical and administrative task, performed respectively by doctors and secretaries. This process entails significant risks of errors when information changes hands or is transferred between systems. To provide an example of how this process was performed, a walkthrough of a patient's visit in the outpatient clinic is given.

Viewing the medical record

The secretary compiles a list of patients with appointments, and hands it over to the doctor, who prepares for each consultation by reading the patient's records and checking up on lab results, diagnostic imagery, former treatments, medications or image diagnostics. The doctor uses several systems, one for each clinical task, and has to copy the CPR-number to each system to look up the patient.

Semi digital workflows

Doctors usually make several requisitions during an outpatient visit and this includes both paper and several different systems. Medical prescriptions can be made either in the system Elektronisk Patient Medicinering (EPM) or Fælles

Medicin Kort (FMK) depending on whether the patient is hospitalized or if the medicine is to be taken outside the hospital. Paraclinical examinations such as blood tests and diagnostic imagery are ordered on paper which is handed over to the secretary who places the order in a system such as Labka. To order chemotherapy the doctor has to access a local oncology system such as Hillerød Onklogiske

Behandlingsystem (HIOBS) and place

the order. Then a paper note goes to the secretary who books the treatment in the system GS and a note to the nurse who executes the treatment.



Picture 1 - The paper based workflows of ordering treatments and tests. Nordsjælland hospital

Making the record entry

When the consultation is done the doctor dictates the results of the consultation in the system MIRSK, which is then transcribed and written as a record entry by the secretary in the EHR system OPUS. The records however, are not transcribed right away, and it is normal to have a period of 2-3 weeks from the consultation until the record entry is made. Sometimes the secretary needs to ask the doctor to clarify parts of the dictation if it is difficult to understand.

Risk of errors when information changes hands

For each handover and translation of information between doctors, nurses and secretaries there is a significant risk of errors, which are mitigated by having close contact between the groups. It is a combination of digital and analogue practices, where the secretary has a central role in documenting and executing the doctor's orders. The workflow is very nontransparent, even for the ones involved, and it has a lot of hidden work mainly performed by secretaries. In some cases, patients have experienced that their blood test results were gone as they were hidden in a pigeonhole or that their record was not updated as the secretary did not have time to transcribe it.

3.2 Envisioning one system, one record

To reduce the risk of errors of the workflows and systems the two regions wanted to invest in one EHR system covering all clinical practices and procedures and consolidating 30 old systems. This overall vision for this system is to provide a more patient centered treatment with less information being transferred between systems and personnel. In order to achieve this, it is required that doctors are responsible for

performing both clinical and administrative tasks such as writing records, making requisitions and coding treatment of services. Furthermore, a standardization of clinical processes and procedures should ensure that all patients would get the best known treatment across the two regions.

Patient centered treatments

The vision is to have better contact between the doctors and the patients. When making ward rounds the doctors usually sat in an office, reading up on the patient's medical status and performing different clinical tasks on paper and in the systems. With the new EHR system the patients should be included in this process, by making the system an active part of the consultation. Using the system to view test results and make requisitions during the consultation should provide more insight for the patient into his/her diagnosis and treatment.

Standardizing treatment across the two regions

The system should also make it easier to be a patient and healthcare professional in the two regions. The numbers of patients being transferred from Region Sjælland to Region H each year, amounts to health care services worth 2 billion DKK. Standardization of clinical treatment and workflows based on best practices should ensure high quality treatment and interregional cooperation. This should make it easier to be a patient with multi-regional treatment plans and improve the employee's mobility between the two regions.

3.3 Business case and expected benefits

Based on these visions the two regions made a business case prior to the procurement in 2012. We have not had access to the original business case as it is classified information. However, there are publicly available summaries (Appendix 1) and some of our informants have provided information about the business case. The implementation of a new EHR system is regarded as a long term investment by the two regions, with an expected repayment period of 9-11 years from the year 2012. After 2020, the annual profit is expected to be 575 to 910 million kroner for Region H and 195 - 335 million kroner for Region Sjælland. These figures are calculated by the management of the two regions and the management at the hospitals.

The cost of procurement, development and operations

In the business case it is only the expenses of Region H which are specified in some detail. The total investment for both regions amounts to 2,8 billion DKK whereas Region H covers 2.1 billion DKK. Out of these 2.1 billion DKK, 1.1 billion DKK is used on the procurement of the system and 1.0 billion DKK is spent on the programme organization and education of end users (Appendix 1, p.7-8). These expenses are allocated to cover the duration of the programme from 2012-2017. Additional expenses, such as temporary decrease of productivity at the hospitals and improvements of the system after 2017 are not taken into account.

Identifying economical and qualitative benefits

When creating the business case, the regions identified several benefits:

- B1. More effective processes and work procedures
- B2. Better continuity of care and patient treatment
- B3. More effective and stable IT operations and service
- B4. More correct billing

- B5. Better patient safety and satisfaction
- B6. Better decision support for management
- B7. Better work satisfaction
- B8. Possible structural improvements

The first three benefits are regarded as having the potential of realizing economical capacity and are the basis for the calculation of the repayment period in the business case. These benefits were broken down to several elements (Appendix 2) on which the hospital management could make cost saving estimations. The remaining five benefits are expected to provide indirect qualitative benefits that either are not measurable in the budgets or first seen in the longer term. A model showing these benefits can be found in the business case summary in Appendix 1.

Calculating the economic benefits

The cost saving estimations were made before the tender and thus provided a vague foundation as the system to be implemented was yet unknown. The results were arbitrary, for example the hospital should make estimations on how much time a nurses could save on documentation if they had more efficient documentation tools. Another calculation was done on the reduction of readmission numbers. It was estimated that a system with better decision support could lower the numbers by 0.4% resulting in an annual saving of 20 mil. DKK in Region H. While these figures are very specific it is uncertain if and how they can be fulfilled as it depends greatly on the choice of the EHR system, the local configuration and the organizational implementation.

3.4 Tender and procurement process

The tender process started in 2012 and took almost two years before Epic was chosen. The two regions allocated more than 100 FTEs to work full time on the tender process. Furthermore, a huge amount of clinicians was involved at an ad hoc basis equivalent to around 45 FTEs. Beside the cost of internal resources around 20 mil. DKK were spent on external consultants, project administrative expenses and compensation to non-winning vendors.

Assessing the different solutions

The tender material included 3,593 pages, 1,838 requirements and 58 use cases. The process encompassed a high involvement of end users. 250 clinicians participated in a workshop for defining the use cases for the requirement specification. The suppliers developed scenarios describing work- and business processes which covered key requirements. They were presented for 450 future end users, who evaluated the requirements through questionnaires. A simulation test of the different solutions was performed to evaluate their ability to support the clinical work practices. This was to assess the functionality of the systems which were the most important award criteria. The economic cost and benefits of the systems were regarded as the second most important criteria (Appendix 6). Five vendors were prequalified to participate in the tender process.

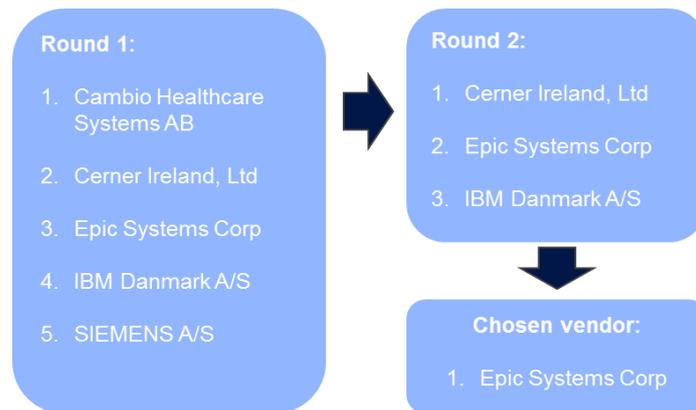


Figure 3- The vendors who participated in the tender (self-made)

Choosing a large American vendor

Epic was chosen as the clinicians from the two regions preferred the user interface and functionality over the other systems. Furthermore Epic was chosen due to its widespread use in the American market in which 1.100 hospitals have adopted the system.

However, Epic Systems Corp. did not have any experience with the Danish healthcare system and Epic has only been implemented at some English and Dutch hospitals. These two countries have had mixed experiences with Epic. After some difficulties the Dutch hospitals are beginning to see the benefits after having used Epic for over 2 years. In England the implementation has had more negative consequences, and after several problems with the system Cambridge hospital was put under administration.

3.6 Developing clinical and administrative content

After the tender, the programme organization was expanded from 75 to 400 people in order to complete the task of developing and implementing Epic at the hospitals in the two regions. The programme organization is responsible for developing the clinical and administrative content in the system for the clinical personnel to use. This content consists of treatment plans, medical record templates, department specific workflows and different views of patient related data. All this content is validated by 300 clinicians who were appointed as Subject Matter Experts. It was a demand that this content would be designed to support standardized and structured processes, treatments and documentation (Appendix 3, p. 18). The clinical and administrative content were based on tools and workflows available in the Epic Foundation System.

Foundation System

Epic provide their Foundation System which is a collection of all the functionality developed by former Epic customers. It is based on one shared database and contains both cross-disciplinary and specialty specific functionality. The Foundation System is available for the programme organization and provides the basis for the development of clinical content and the training of end users. It contains a great deal of content to support clinical examinations, treatments and workflows which can be reused or modified for the specific content.

Application Coordinators

Most of the clinical and administrative content is developed and configured by Application Coordinators working full time in the programme. The Application Coordinators consist of clinicians bought out from the hospitals and technical resources provided by the two regions. Application Coordinators are required to receive certifications by Epic in specific parts of the systems such as specialty specific modules. When the system has been implemented the development of new content can be done by Physician Builders. They have the same certifications as the Application Coordinators but work half time at the hospital and half time developing content.

Subject Matter Experts

The programme uses Subject Matter Experts (SME) to validate the clinical and administrative content being developed. The health care councils (Sundhedsfaglige råd) in the two regions appointed 300 clinicians from different departments and hospitals to work part time as SME's for two years. The clinical and administrative content is discussed in both cross disciplinary and specialty specific groups before being developed by the Application Coordinators. It is mostly doctors and nurses who are represented, but also secretaries and therapists are part of the SME groups.

MyChart

In addition to the Epic system, the regions also bought the patient aimed platform MyChart (minsundhedsplatform.dk). All patients in the two regions can access MyChart to view their medical records, book outpatient visits and view test results. There is a potential for improving both the efficiency and quality when patients start to use MyChart. However, the potential is far from fulfilled, since very few patients are using it. MyChart will not be investigated further in this paper.

3.5 Technical development

Implementing Epic at all hospitals require more than 70 integrations to 20 systems. This includes paraclinical examinations systems such as the laboratory system Labka and the regional diagnostic system RIS/PACS. Most of these integrations were developed by the programme but some were mainly Epic's responsibility. Some of the integrations are required by law including the national medicine register FMK, and LPR register which depend on the Danish patient contact model.

Fælles Medicin Kort (FMK)

The integrations to FMK are crucial for any EHR implemented in Denmark. FMK (Fælles Medicinkort) is the national, central database containing information on all the Danish citizens' electronic prescriptions and medicine bought the last two years (Sundhedsdatastyrelsen, 2016a). The database is hosted by Sundhedsdatastyrelsen in Aarhus. It is stated in the Danish health care law that EHRs must be synchronized with FMK so that medical information is always available for both the doctors and patients. Updated information about the patient's medical prescriptions is a necessity to provide efficient, high quality and safe treatment.

Landspatientregisteret and DRG

The billing of services and treatments in the Danish health care system is done using the DRG classification system. The DRG system is used to calculate and distribute financial resources between the different

hospitals depends on their activity and the reported SKS codes (Sundhedsdatastyrelsen, 2016b). These codes are matched with a patient's contact with the health care sector which is used to calculate the activity of each hospital and departments. The data used for the DRG systems stems from the national patient database (LPR) which contain all information about a patient's contact with the Danish healthcare system (Sundhedsdatastyrelsen, 2016c).

The Danish patient contact model

The patient contact model describes the hospital's core business activities around examinations and treatments of patients. In Denmark, a patient's course of treatment consists of one or more contacts with the health care sector which is either inpatient, outpatient or referred. As the model cover the entire healthcare sector it enables treatment across different regions, hospitals and sectors. It applies only for the Danish context and is fundamentally different and more complex than what is seen in other countries.

3.6 Implementation plan

Implementing Epic at all of the 17 hospitals will take around 1½ year and will be executed in 5 steps. The strategy for the implementation is to implement the system at the largest hospitals first. By starting out with the two major hospitals, HGH and the Rigshospital, most of the specialties and the interdependencies will be tested early on. The strategy was also chosen to accommodate the typical employee turnover rate in similar public project, which is around 2-3 years. This is to ensure that a significant part of the employees will be in the program organization when system will be implemented at the largest hospitals.

| Hvor | Hvornår |
|---|--------------------|
| Herlev/Gentofte | 21 maj 2016 |
| Rigshospitalet/Glostrup | 5. november 2016 |
| Nordsjællandshospital, Amager/Hvidovre, Bornholm | 18. marts 2017 |
| Bispebjerg, Frederiksberg, Psykiatri (Region H) | 20. maj 2017 |
| Næstved, Slagelse, Ringsted, Nykøbing Falster | 23. september 2017 |
| Roskilde, Køge, Holbæk og Psykiatri (Region Sjælland) | 18. november 2017 |

Figure 4 – Official implementation plan showing the 5 steps

Training of end users

Epic provided a great deal of training material and methods for organizing the training of the end users. The material contains workflow descriptions based on how the system is used at American hospitals. In order to adjust the material to fit the Danish health care context, several clinicians were certified in Epic to become Principal Trainers. They adjusted and developed new training material to be used by the Certified Users who are responsible for carrying out the training of end users.

Change Management Groups

Several Change Management Groups were formed 9-12 months before the implementation. The group consists of departments managers and serves the purpose of preparing the clinical personnel for the organizational changes the system will entail. Representatives from the programme facilitates these meetings which take place every third week until the implementation. The groups represent areas such as the outpatient and inpatient setting.

Big Bang implementation

It was stated in the requirement specification that each implementation will be done as a big bang implementation, involving all departments and specialties in the hospital (Appendix 3, p.15). The big-bang

strategy was chosen to mitigate the risk of having two EHR systems running simultaneously in the hospital. This would entail the risk of having double registrations on a patient's medical record and difficulties following clinical guidelines as these might be different in the two systems.

Hypercare

With each implementation follows four weeks of intense support and lowered activity. To support the users around 1,000 supporters consisting of Epic floorwalkers, super users and IT resources from the programme are available. Each day during this period, the reported incidents are evaluated and prioritized by relevant stakeholders on top-10 meetings. Based on experiences from other countries and Epic's recommendations it is predicted that after the four weeks of Hypercare, the productivity will be back at 100%.

3.7 Harvesting the benefits

After the system has been implemented at all hospitals, the regions will initiate an optimization phase. The purpose of this phase is to improve the workflows and clinical content across all hospitals for optimal support of the clinical practice. The hospitals are responsible for ensuring that both the economical and qualitative benefits of Epic are harvested. However, it is not specified in the business case how the benefits are to be realized.

Business change management office

To accommodate this Region H. established a business change management office in 2015. The office created a benefit catalogue containing 26 proxies called operational goals which they plan to monitor. The operational goals serve the purpose of making the process of harvesting the benefits more manageable. Each goal has specific KPIs and relation to one or more benefits. They are elaborated in detail in appendix 2. As the office is anchored in Region H and not in the programme, they are able to advise the hospitals on realizing the benefits after the programme has ended.

Plan for harvesting the benefits

The hospitals are required to develop a plan that specifies which operational goals they choose to follow. The plan must be made six months before the implementation and the business change management office provides consultancy. If they fail meet the goals they will be required to initiate an investigation of why and how they will succeed. The reporting of the operational goals starts January 2017, so we have not been able to gather any of the results and we will not investigate them further.

4. Epic in use

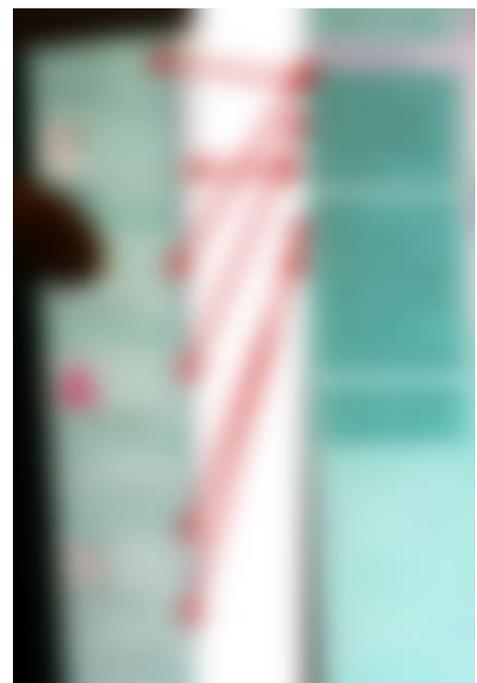
When Epic is fully implemented it will cover all clinical content used at all hospitals in the two regions. It replaces the old paper based practices and 30 systems. The system entails many new tasks for the clinical and administrative staff. Doctors now have to write the medical records, code the activities and order treatments and tests directly in the system. As many of these tasks have been removed from the secretaries, they are also faced with different tasks. They are now more responsible for the communication with the patient and helping them through their course of treatment. The nurses are still performing many of the same tasks as before and thus the system has not changed as much as the other groups. Epic is a comprehensive system, which includes a significant amount of functionality and is designed for clinical and administrative tasks to be performed in many different ways. After the implementation at HGH, the media reported dissatisfaction among the clinical staff as both the performance of the system and the new workflows were causing several issues.

4.1 Examples from daily use

When using Epic, clinical personnel have to log in only once to gain access to all parts of the system. While the system has the functionality to cover all clinical and administrative tasks, these can be performed in several ways. Many users have the possibility to log in with different roles which presents different views and functionality. Some have access to both emergency and inpatient modules while others can use both the intensive care and anesthetics module. The many options make the system complex and comprehensive, but it allows the clinical personnel to perform the tasks in ways that suits them. A few pictures of the system in use can be found in Appendix 7.

Viewing information about the patient

In order to see all the relevant information on a patient, the doctor can either search on the personal CPR number or chose a patient from the department overview. Information regarding a patient's medical history can be found in different parts of the system. The *Resume* view shows limited but important information about the patient such as critical diagnosis. The view *Vis Journal* presents the doctor with an overview of all registered records entries. In order to get the full overview, the doctors have to check multiple views to find the needed information about the patient's diagnosis list, medical- or surgical history. Depending on the role of the user, different views are presented. The pictures to the right shows the difference between menus presented for a user in the emergency setting (picture left) and a user from anesthesia (picture right). Both the order of the buttons and graphical design differs as seen with the buttons for viewing notes (Notater).



**Picture 2 - Menu from two different roles
(Epic has disallowed our use of the picture)**

Using department specific applications

Some applications in the system are only available for some groups of users. Some of these applications are Stork (gynecology and obstetrics), Anesthesia (anesthetics) and Beacon (oncology). They contain the most common procedures and workflows used in the departments. Beacon replaces the old oncology systems such as HIOBS used at Nordsjællands Hospital. It covers most of the oncology department's workflows, such as devising treatment plans, ordering chemotherapy and paraclinical examinations. As the old practice in oncological treatment relied heavily on paper based records, the Beacon module in Epic has replaced a whole room of paper based records at HGH.

Using Order Sets

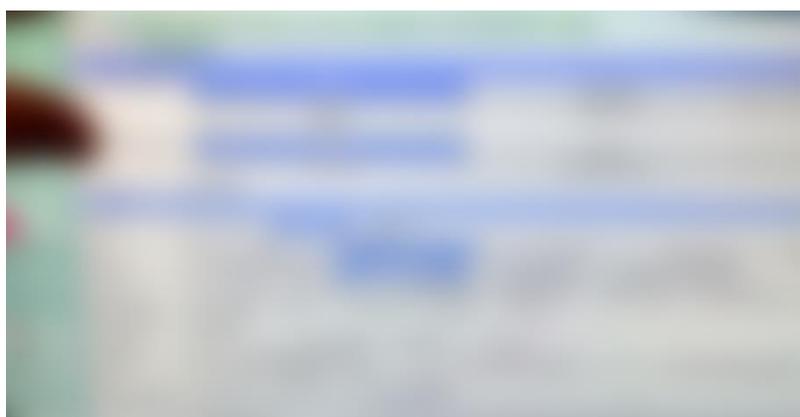
Besides using department specific applications, ordering medicine, treatments and preclinical examinations can be done through in the module called *Best./ord*. In the module, orders can be placed individually or collectively through Order Sets which are prebuild packages used for specific diagnoses. The Order Sets are available for all departments but are related to specific diagnoses. After a patient has been diagnosed the doctor can choose an Order Set which contains both the medications, tests and treatments appropriate for the patient. A picture of an Order Set can be found in Appendix 7, p. 26.

Using Preference Lists

Another way of performing orders is through Preference Lists, which typically contains a small selection of orders from a larger Order Set. Preference Lists are not pre build as the Order Sets, but are created by the clinical personnel and can be shared between departments and hospitals. Some doctors from the neurological department at HGH have created a Preference List for a specific blood test which only requires one click to complete. This has been widely shared among the doctors. A picture of a Preference List can be found in Appendix 7, p. 25.

Writing record entries with Click Records

Epic contains a click based system for making medical record entries which are designed for specific types of patients. The Click Records have a range of predefined options for describing the patient's medical status. When submitting the Click Record it converts the chosen inputs to a text which is saved in the record entry. The below picture shows a Click Record from the emergency setting where the record among other things contains four levels of frequency for patients with diarrhea, ranging from *less than two times a day*, to *more than 10 times a day*.



Picture 3 - Click Record from the emergency setting (Epic has disallowed our use of the picture)

Writing record entries with SmartPhrases

Another way of writing medical records is with the use of SmartPhrases. This function makes it possible to combine free text with predefined paragraphs and medical information retrieved from the system. SmartPhrases is an Epic feature and can be generated in the records by typing the name of the SmartPhrase with a period beforehand: *“.nameofSmartPhrase”*. If doctors are tired of writing *“the patient is throwing up on a daily basis”* they can create a SmartPhrase containing this paragraph by a simple user defined abbreviation. Many of the Smartphrases are developed by clinical personnel and shared between departments.

End of the consultation

When a consultation is done the doctor has to reconcile the medicine with FMK as the system prevents them from closing the record or discharging the patient before it is done. Furthermore, they have to register the services provided by assigning SKS codes to that specific patient contact. If a patient has to be transferred to another department for further treatments or operations, the doctor has to transfer the patient to that specific department in the system. This can include logistics such as booking a hospital bed and transportation from one department to another.

Using the system as a part of the consultation

How Epic is used in consultations and treatments of patients depend on the particular setting. In the outpatient clinics, some doctors perform their consultation with the patient while placing orders, prescribing medicine and writing the medical record. In the emergency setting the doctors often perform these tasks after having examined their patient as they are often in a condition which requires the doctor's full attention. In the inpatient setting doctors have access to workstations on wheel (WOW) which allows them to take along their computer and use it when doing ward rounds.

4.2 The first public responses from users

It is common for large public IT projects to receive a lot of attention from the media which can have consequences for the development and implementation of the systems (Bonnerup et. al., 2001). As Epic is the biggest public healthcare IT investment in Denmark, many were eager to report stories about the first experiences after go-live. Some national newspapers even created communication channels (BT, 2016) where users or patients could contact the editorial staff with negative stories about Epic. The regions were quick to celebrate with champagne on the day of go-live and internal newsletters stated that the implementation went well (Region H, 2016a). However, it did not take long before the media were filled with negative stories about Epic.

Problems with transitions between sectors

Right after go live, at HGH it was reported that the clinical personnel had problems communicating with the primary sector and other hospitals (Computerworld, 2016a). Epic had to use the MedCom standard to send messages, and this integration proved to be problematic. Many references from general practitioners were not received, and had to be resent several times. This problem received much attention in the media, and was also regarded as a major concern for the programme management. However, the issues were quickly fixed.

Doctors fearing for the safety of their patients

Only a week after the implementation, 62 chief physicians expressed their concern with Epic through a collective letter to the region's management (ComputerWorld, 2016a). They were greatly dissatisfied with the announcement from the programme management, that most technical problems were solved, and that the biggest challenge was for the clinical personnel to adapt to the new workflows (Politiken, 2016a). They found that the system had several major flaws, which could threaten the safety of the patients. They suggested that the old systems should be taken in use, until the issues with Epic had been fixed. A suggestion the programme management and the regions did not honor.

Positive communication from the programme and Region H

The communication from the programme management and the regions regarding Epic was mainly positive. They expected between 1,500 and 2,000 incidents each day during the first week but only received half of that (Computerworld, 2016b). It was announced that the implementation was going according to the plan as there had been fewer issues than expected (Politiken, 2016b). Many of the clinicians who had used Epic disagreed with this and it sparked major discussion in the media the following months. This mismatch between the attitude of the clinical personnel and the regions/programme management was to form the public opinion of implementation of Epic in a negative way.

5. Issues observed at Herlev/Gentofte Hospital

The prior section described some of the negative responses from the clinical personnel in the first couple of weeks after go live at HGH. While most of them were well founded, they were also sensational stories well suited for getting extensive media coverage. As our interest is in uncovering the potential for gaining the expected benefits with the implementation of Epic, we have looked at specific issues and their impact on the clinical practice. Some the observed issues, presented in this chapter have challenged the work of clinical personnel while others affect the hospital and the vision created by the regions. How these issues impact the business case will be outlined in chapter 6. The below table shows the issues and the related causes, which will be elaborated in chapter 7.

| Issues Causes | 5.1 Troublesome documentation and requisitions processes | 5.2 Inconsistent and less detailed medical records | 5.3 Long response time when reconciling medicine | 5.4 Requisitions and prescriptions disappearing | 5.5 Limited use of clinical guidelines | 5.6 Lack of structured data for research | 5.7 Incorrect coding of treatments and services |
|---|--|--|--|---|--|--|---|
| 7.1 Lack of qualifications among Subject Matter Experts | X | | | | X | X | |
| 7.2 Poor management of user involvement | X | X | | | X | X | |
| 7.3 Poor training in the system | X | | | | X | | X |
| 7.4 Lack of ownership of business critical components | | | X | X | | | |
| 7.5 Domain specific components incompatible with Epic | | | X | X | | | |
| 7.6 System deployed without proper testing | | | X | X | | | |
| 7.7 Vision does not create win-win situations | X | X | | | X | X | X |
| 7.8 Insufficient organizational change management | | X | | | X | X | X |
| 7.9 Clinical and administrative content not being optimized | X | X | | | X | X | |

Table 1 - The relation between the issues and causes

5.1 Troublesome documentation and requisitions processes

The doctors have been faced with new tasks such as writing medical records and making requisitions directly in the system. It was expected that Epic would provide efficient workflows and tools for these processes but the doctors find them difficult to use efficiently. This led to less time to treat the patients and difficulties for the doctors to keep their schedules. The ineffective tools and processes have been caused by the following:

- 7.1 Lack of qualifications among Subject Matter Experts
- 7.2 Poor management of user involvement
- 7.3 Poor training in the system
- 7.7 Vision does not create win-win situations
- 7.9 Clinical and administrative content not being optimized

Writing records is time consuming

It is difficult for clinicians to write medical records in Epic in an efficient way. This is especially evident in the outpatient clinics where time is often an issue, as patients have fixed timeslots. Some doctors try to write the record while having the consultation with the patient, but it still takes up more time than making dictations for the secretaries to transcribe. In the emergency setting some doctors are writing notes on paper while overseeing the patient, only to document them in Epic afterwards. It was envisioned that the doctor would use the Click Records to automatize the process of creating records. However, the doctors quickly stopped using these, as the quality and the lack of nuances in the output was too poor. Instead doctors are using SmartPhrases which can be faster than writing, but it takes time to learn how to use them efficiently. This especially applies for the many older and the less IT competent doctors, who have difficulties in learning how to use the SmartPhrases.

Performing requisitions is unintuitive

As with writing records, doctors report that making requisitions in Epic is unintuitive. They have to click multiple times to order the right medicine, lab test and find available timeslots for these. To ease the requisitions process, the programme has built Order Sets which are meant as an efficient method for placing several orders at once. However, the use of Order Sets is very limited, and are not as efficient as it was expected. Instead many doctors create and share their own Preference Lists, which somewhat eases the task of making requisitions. However, the Preference Lists does impose other challenges which are described in section 5.5.

Complex system create uncertainty

Some tasks are more rare and can consume a disproportionately amount of time, as the doctors lack routines and knowledge about how to do it. This could for example be when doctors at an outpatient clinic have to write a special medical certificate for the municipality. As Epic is a complex system, doctors feel uncertain or are unaware about how to perform such tasks. Before Epic such a task would be done by writing a note for the secretary, who had the knowledge on how to do it. Now some doctors spend up to 30 minutes after the consultation on figuring out how such tasks are performed in the system.

Doctors spend less time on patients

As Epic fails to compensate for the doctors extra workload they have less time to treat the patients. Additionally, many of the outpatient clinics at HGH struggle to treat the required number of patients. Several doctors report that even with a fully efficient use of SmartPhrases, the process of writing medical records still take more time for doctors compared to the old practice of dictating. At the Rigshospital 462 doctors have been granted exemptions from writing medical records and will still make dictations for the secretaries to transcribe. While this might be efficient it goes against the vision of reducing the amount of information changing hands.

5.2 Inconsistent and less detailed medical records

While the doctors are spending more time writing medical records they also experience that the quality has decreased. Especially the click based records fail to communicate important details in an effective manner. Instead many doctors use SmartPhrases, which allow for a more subjective account but results in inconsistency in the content of the records. Clinical personnel either lacks important information regarding the patient's medical situation, or spend more time finding it. The problems are caused by the following:

- 7.2 Poor management of user involvement
- 7.7 Vision does not create win-win situations
- 7.8 Insufficient organizational change management
- 7.9 Clinical and administrative content not being optimized

Click Records lack important nuances

The click based records built by the programme are not being used by the doctors. They regard the output as failing to communicate the patient's medical situation in a detailed and satisfactory manner. The nuances are lacking as the Click Records only have limited predefined options or paragraphs. Many patients express their pain and symptoms through stories or metaphors, like *"it felt like a knife in the back"*. A pain pattern can be tied to either a pathological or a psychological condition and these details are important for doctors to know in the following treatment. The doctors do not feel that the predefined paragraphs in the Click Records describe the individual patient and the final output is criticized to appear like a static impersonal telegram.

Need for more SmartPhrases

Instead the doctors build and share SmartPhrases which are more flexible and allows more room for subjective observations by the doctor. Even with the use of SmartPhrases, many doctors believe that the quality of the records has been reduced, as the extra documentation puts pressure on their work. Doctors report that the records are less precise, lack details and important professional terminology. They lack enough SmartPhrases to cover all patient groups and diagnosis. The low quality of medical records makes it more difficult for doctors to deliver treatment focused on the needs of the individual patient.

Inconsistent admission records

There are lacking common guidelines on how to write a medical record and the content which are included in the SmartPhrases is different from each specialty. When writing an admission record (AOP), some doctors only include active prescriptions, latest session values and patient care plans to make the record

short and save time. Others include more specific information such as medical case history, former diagnosis, and alcohol and tobacco consumption in the AOP, since they regard it as being important for the following course of treatment. The problem caused by this inconsistency is that doctors risk not having the full overview of the patient's medical history. Before an operation, anesthetic doctors and nurses have to know the current diagnoses of the patient. They use the AOP to get an overview, but as the patients have been admitted by doctors from different specialties, it is not certain that it contains all former diagnoses. Not knowing a patient's former diagnoses can make the clinical personnel look unprofessional, or even worse, result in errors which can have negative consequences for the health of the patient

5.3 Long response time when reconciling medicine

The doctors experience many technical issues related to managing medicine in FMK. Many have to wait several minutes for the reconciliation process to complete which contributes to a decrease in efficiency. This is regarded as the most acute problem as FMK is a central part of many clinical processes involving the vast majority of all patients being treated. The technical issues were caused by the following:

- 7.4 Lack of ownership of business critical components
- 7.5 Domain specific components incompatible with Epic
- 7.6 System deployed without proper testing

Reconciling medicine did not work

The primary issue with medication management is the long response time when reconciling and updating medical prescriptions in FMK. Each time a patient is hospitalized, given new medicine or discharged, the doctors have to reconcile the medicine in FMK. This enables all actors in the healthcare system to have access to updated information regarding the patient's medication. The long response time creates many situations where the users cannot close a record or discharge a patient as they cannot get a connection to FMK. This cause the users work to be delayed, up to several minutes in some cases and results in uncertainty about the registrations in Epic. They either have to wait for FMK to process their input or redo the process.

Users working around the system

Reconciling medication in FMK have decreased the efficiency of the clinical processes as many clinicians are forced to wait for a connection before being able to hospitalizing or discharging patients. As a workaround many use FMK-Online which is a web based version of FMK, to check if the data is registered correctly. However, this workaround causes the users to spend extra time as they have to login in to FMK-Online, find the patient and update the medication. The response time while using FMK has been brought down several times and is now at an acceptable level, but the program management have problems communicating this to the end users. Many do not perceive the problems as being fixed, and some still use FMK-online as they believe that the FMK module in Epic is still causing issues.

5.4 Requisitions and prescriptions disappearing

Many clinicians experience that information is not being properly registered in the system. This became evident as other departments and sectors failed to receive blood tests, diagnostic imagery and information about the patient's medication. The clinicians have to spend time communicating with the laboratories and

clinical personnel from the primary sector in order to ensure the information is received correctly. These issues have been caused by the following:

- 7.4 Lack of ownership of business critical components
- 7.5 Domain specific components incompatible with Epic
- 7.6 System deployed without proper testing

Orders not being registered correctly

The clinical personnel are faced with problems when ordering blood tests in Labka and ordering diagnostic imagery from the X-ray system, RIS/PACS. Not all orders are received in the laboratories or the radiology departments, even though Epic is showing the orders as being processed successfully. In some cases, patients showed up at the radiology department, with what they thought was a confirmed booking, but as it was not registered in the system, the patient had to be rebooked. The issues with Labka also causes prioritizations of tests assigned by doctors to be changed from urgent to normal as they are processed by the system. It is especially an issue when the patient is transferred from one course of treatment to another or when the patient shifts departments.

Information not transferred between sectors

Transferring patients between different health care sectors causes incorrect transmission of data between Epic and FMK. Patients are not properly discharged from the hospital, which cause problems when the primary sector have to take over the treatment. The clinical personnel at HGH are contacted by the municipal homecare on a daily basis, as they do not receive information about the medicine prescribed at the hospital. Moreover, general practitioners encounter problems as they do not receive the discharge letters from the hospital as the patients are still technically admitted in the hospital.

Time wasted because of technical issues

The clinical personnel quickly learned to double check orders by calling the lab to ensure that they had received the orders. In many cases, they have to redo the processes, which can be troublesome as they have to spend time finding the medical information for that particular patient. Many of the issues with Labka, FMK and RIS are being solved on an ongoing basis, but the clinical personnel are still facing technical issues which affect their workflows (Region H, 2016b).

5.5 Limited use of clinical guidelines

The system is meant to ensure that all patients will receive the best known treatments across the two regions. Especially the pre-built Order Sets (Best./ord.) are envisioned to provide clinical guidelines for examinations and treatments of different patient groups. However, the tools provided for this purpose are not being used at HGH. The design of the Order Sets fail to support effective treatments as they are either too comprehensive or contain errors. Likewise, other clinical guidelines, built into the system present cumbersome workflows which lead the users to use workarounds. This is possible as Epic allows tasks to be performed in multiple ways. The causes for these issues are:

- 7.1 Lack of qualifications among Subject Matter Experts
- 7.2 Poor management of user involvement
- 7.3 Poor training in the system

7.7 Vision does not create win-win situations

7.8 Insufficient organizational change management

7.9 Clinical and administrative content not being optimized

Limited use of Order Sets

Our informants at HGH state that the prebuilt Order Sets are being used under 10% which is due to several reasons. Some of the Order Sets are too comprehensive which forces the doctor to deselect many of the predefined orders as they are often redundant for that specific patient. They are designed to perform all of the orders up front, which is often unnecessary as the course of treatment often depends on the prior examinations and test results. For example, an examination or lab result might eliminate the need for other tests and thus making it a waste of resources to order them all at once. Moreover, many Order Sets are too narrow, and while being effective for a particular diagnosis they are only applicable on a very small group of patients. There are also cases where Order Sets contain clinical errors, as seen in the Order Set related to examination of osteoporosis, which contains a wrong type of calcium test.

Doctors prefer Preference Lists

Instead of using the prebuilt Order Sets, doctors have created their own Preference Lists. They are based on the Order Sets, but they only contain specific orders which they regard as useful in the given situation. The preferences lists are pushed between colleagues and departments in large numbers and are seen as an efficient tool from the doctors' perspective. While Preference Lists are efficient tools for the doctors, they create several issues, as they are developed and governed locally. This makes them difficult to maintain as there is no control over the content of the lists or when they are used.

Clinical guidelines not being followed

There are examples of clinical staff not following the clinical guidelines built into the system. The staff is met with cumbersome workflows where they use workarounds in order to complete their tasks. For example, the nurses from anesthesia are supposed to fill out a postoperative evaluation when the patient is coming out of narcosis. In this evaluation the nurse has to answer certain questions such as, did the patient feel any pain during the operation? Are there clear airways? etc. However, the moment the patient awakes from narcosis is a very critical moment where the nurse has to check if the patient can breathe, leaving no time to fill out the evaluation. Instead, the nurses fill out the evaluation while the patient is still in narcosis, thus making the information incorrect.

No enforcement of the use of clinical guidelines

While many clinicians agree upon the benefits of having standardized clinical content such as common limit values for early warning score and treatment plans, much of the content does have an unfortunate effect on local workflows. The standardization of workflows and distribution of roles across departments and hospitals complicates many tasks for the clinical personnel. Instead many clinicians choose not to follow the standardized treatments built into the content and workflow of the system. There have not been any interventions from either hospital or department management to enforce the use of the standardized clinical guidelines.

5.6 Lack of structured data for research

Most features in Epic are built to provide structured data for research purposes. Especially the use of Click Records is envisioned to provide reports and statistics on the diagnosis and treatments of large quantities of patients. The Click Records are not being used, which limits the prospect of using the records for medical research. Instead the doctors are using SmartPhrases and documenting treatments as text. The causes for these issues are:

- 7.1 Lack of qualifications among Subject Matter Experts
- 7.2 Poor management of user involvement
- 7.7 Vision does not create win-win situations
- 7.8 Insufficient organizational change management
- 7.9 Clinical and administrative content not being optimized

Limited to no use of Click Records provides unstructured data

While many doctors understand the value having structured data for research purposes, the far most important thing for them is to provide quality treatments for their patients. As mentioned earlier the doctors prefer to use a combination of SmartPhrases and free text in the records instead of the Click Records (section 5.1 & 5.4). The SmartPhrase can generate the results of blood tests or other examinations, but the doctors often write in free text their remarks to the test. The result of this is that a significant part of the documentation made in Epic cannot be used for research purposes.

Choosing unsupported treatments

Another issue occurs when treatments are not supported by the system. In anesthetic department at HGH, doctors use a specific anesthetic which is not found in Epic as it has been removed from the treatment plans by the SMEs. But the doctors still use the anesthetic as they regard it as being the most effective treatment for specific operations. As the treatment is not included in the system, the doctors document the treatment as free text in the patient's record.

Using tools for structured data is not enforced

When medical records are created as free text it reduces the prospect of gaining the benefit of structured data for research purposes along with the potential of compiling statistical reports on the performance of the different departments. The clinical personnel refuse to use these tools as long as they prevent them from providing a high quality treatment to their patients. As with the clinical guidelines, the hospitals do not enforce use of the tools for structured data.

5.7 Incorrect coding of treatments and services

After go-live at HGH it has become publicly known that a major part of the hospital's activity has been incorrectly registered in Epic. The responsibility for coding has changed from the secretaries to the doctors but they are unaware of how to do it correctly. This creates problems for the accounting and distribution of resources between the hospitals and will require additional resources to correct. These issues are caused by the following:

- 7.3 Poor training in the system
- 7.7 Vision does not create win-win situations
- 7.8 Insufficient organizational change management

Change of roles and responsibility

The doctors are unaware on to apply the proper SKS codes. For example, when a patient has been given a catheter, the doctor has to apply the right code. However there are many forms of catheters each with one specific SKS code associated. A search on the online DRG system provides 104 SKS codes for different procedures related to catheters. The figure to the right is a snippet from the online DRG system (DRG, 2016). In many situations the doctors do not have the time to examine which code to use, but instead use one they know and which is close to. There is a manual with all the services and the corresponding codes, but it is complicated and the doctors seldom have the time to read it when they need the information. Furthermore, the doctors have received no instructions on how to code, but only instructed that they need to do it correctly. Especially resident doctors find it difficult, as they are changing departments regularly and have issues remembering which codes to use in the different departments.

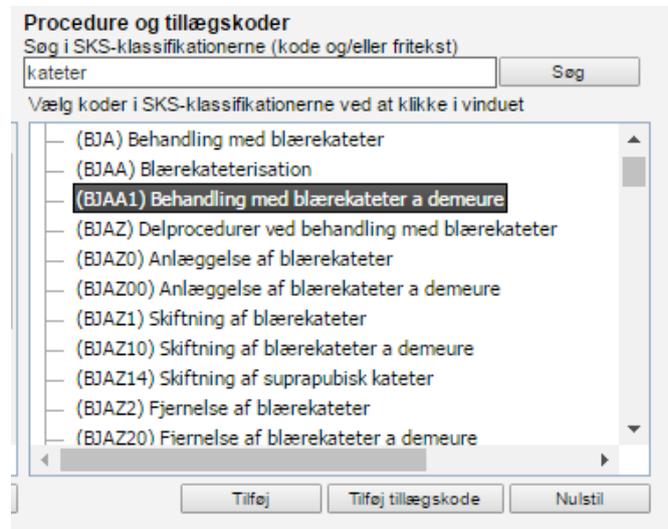


Figure 5 - A search on catheters on “interaktiv DRG” return several SKS codes

Secretaries are still coding

The doctors’ primary focus is on treating patients and they do not feel it is their responsibility to code the services and will not use the necessary time or effort to do it correctly. Some departments have decided to have the secretaries still perform the coding activity to ensure that it is done properly. If the hospitals fail to solve the issues, their basis for the distribution of financial resources will be incorrect. It also affects the data registered in LPR as the coding is used for medical research the patient's diagnosis and treatments.

6. The effects on the business case

The issues stated in the prior chapter have an impact on the expected benefits stated in the business case. Currently, the prospect of getting more efficient processes is significantly decreased as the doctors have to perform more clinical and administrative tasks. Especially the outpatient clinics have difficulties keeping the same activity as before the implementation which entails additional costs for the hospitals.

The continuity of care and patient treatment is improved in some areas as the Epic consolidate many systems and minimize information changing hands. However, the vision of treating patient based on best practices across the hospitals does not seem to be in sight as doctors refuse to use the pre-built tools in Epic.

Some of the other expected economic benefits are not being fulfilled with the implementation. The potential savings generated by lowering the cost of IT operating and services has proven to be insignificant in relation to the overall business case. Furthermore, a considerable amount of incorrect coding complicates the potential of having more correct billing and will require unexpected resources to correct. The prospect of harvesting the remaining benefits such as better work satisfaction and possible structural improvements have not been investigated in this study as they are regarded as long term and are difficult to document. The below table shows the correlation between the issues and the expected benefits:

| Issues \ Benefits | 5.1 Troublesome documentation and requisitions processes | 5.2 Inconsistent and less detailed medical records | 5.3 Long response time when reconciling medicine | 5.4 Requisitions and prescriptions disappearing | 5.5 Limited use of clinical guidelines | 5.6 Lack of structured data for research | 5.7 Incorrect coding of treatments and services |
|---|--|--|--|---|--|--|---|
| B1: More effective processes and work procedures | X | | X | X | | | |
| B2: Better continuity of care and patient treatment | | X | | X | X | X | |
| B3: More effective and stable IT operations and service | | | | | | | |
| B4: More correct billing | | | | | | | X |

Table 2 – Relation between benefits and issues

6.1 Less effective processes and work procedures

Having all medical information in one single system is by most users considered as an improvement of their everyday clinical work. However, the prospect of realizing the benefit of B1: *More effective processes and work procedures* is currently limited due to the troublesome documentation and requisitions processes. It is the main contributor to the lower productivity in the outpatient clinics which is stated to be around 80% (DR, 2016). As seen in the pie chart from the business case summary it was stated that more than 75% of the economic benefits are supposed to be harvested from improving the clinical and administrative processes. If these efficiency issues are not solved it is likely that the repayment plan will be extended as the lower productivity entails extra unforeseen expenses for the hospitals.

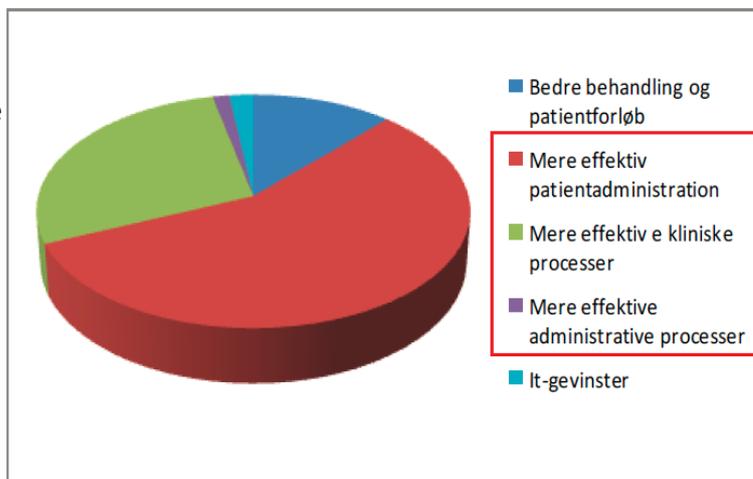


Figure 6- Pie chart from the business case. The red square shows the three effectiveness areas

Inefficient resource utilization

Writing medical records is a time-consuming activity which makes it difficult for the doctors to keep their time schedules. This affects the outpatient clinics which have challenges treating the same number of patients as before the implementation of Epic. Those regulated by legal requirements, spend additional resources to comply. The oncological outpatient clinic at HGH is having extended operating hours to comply with the deadlines for cancer packages. It was expected that after four weeks of Hypercare the productivity would back to normal, but the management at HGH and the programme management underestimated the impact of the implementation. Around 6 months after the implementation, the management at HGH stated that the situation was worse than expected and that they expect the productivity to be reduced until Q1, 2017 (Version2, 2016). There is uncertainty among doctors about the possibilities of ever reaching 100 % productivity in the outpatient clinics (Region H, 2016c).

Technical issues led to inefficient processes

The technical issues affect some of the clinical processes negatively. Issues with Labka makes the ordering of paraclinical examinations process more cumbersome and the doctors have to spend time double checking the orders. The same goes for the efficiency of hospitalization and discharge of patients which is problematic as the doctors cannot reconcile the medicine in FMK. As the programme management are investing many resources in resolving these issues we expect the efficiency to increase. However, the programme still face the issue that doctors do not trust the system and persist to use ineffective workarounds, such as using FMK-online.

6.2 Improved patient safety but lack of standardization

The implementation of Epic has a mixed impact on B2: *Better quality of patient care and treatments*. Having one system leaves less room for errors which improves the patient safety to some extent. However, the prospect of providing the best known treatment across the two regions is not promising. Many doctors refuse to use the standardized Order Sets and Click Records which are expected to provide more evident-based and effective treatment among others (Appendix 4). We have also observed how the implementation have a negative effect on the quality of the records, but the effect of this needs further investigations.

Less information changing hands

As the amount of information being transferred between the staff is minimized, the risk of errors is reduced. There have been no unintended events (UTH) of severe nature related to the patient safety in the first 6 months after the implementation. Both doctors and experts have assessed that the patient safety has not decreased (Region H, 2016d). Taken into concern the risk and complexity of this implementation this is a satisfactory accomplishment which leaves hope for increasing the patient safety with Epic.

Better accountability and transparency

In Epic it is fairly easy to track all entries as they are gathered in the system. This provide more accountability and transparency of the entire course of treatment. Particularly the department managers and the patient safety councils can easily use Epic to analyze why an unintended event has occurred. They can track who have had the responsibility for a patient and where in the course of treatment errors have been made.

Technical issues lead to worse continuity of care

The issues with the integration to Labka and FMK have a short term impact on the cross sector cooperation and medicine management. In the first couple of months the technical issues were responsible for 1/5 of the unintended events (Region H, 2016f) on HGH and have decreased the safety of the patients. However, the doctors are double checking registrations and orders which are mitigating the risk. The prospect of realizing these benefits have improved as a result of the integration issues being solved. While there is still being reported some issues the progress indicates that these benefits can be gained in the coming time.

Clinical guidelines are not being followed

Order Sets and Click Record are seeing limited use among doctors despite the fact that a considerable amount of resources has been spent on validating and developing this content. Thus the regions have not gained more than digitizing the old paper based workflows. While standardization of processes and predefined inputs are conflicting with the needs of the clinicians it still seems to be pursued by the programme. It is doubtful that local workflows can be standardized as these are too diverse across the departments and hospitals in the regions. This implies developing a significant amount of Click Records and Order Sets to accommodate all local needs which is difficult to govern.

6.3 No economic benefits by consolidating systems

It was expected that consolidating the 30 systems would entail economic benefits. However, we have discovered that the economic potential of the benefit B3: *More effective and stable IT operations and*

service is close to zero. The annual operating- and service cost of the Epic implementation in Region H is estimated to 170-210 mil. DKK. Compared to the operating and service cost of the old systems, this will entail an annual economical result ranging from 35 mil. DKK in savings to a loss of 25 mil. DKK. Compared to the overall expectations of savings worth 575-910 mil. DKK we do not consider the potential of more effective and stable IT operations and service as being relevant for the overall business case. Moreover, our informants state that the licensing and operations of Epic are actually higher than stated in the business case thus making this benefit negative, but it was included in the business case because of political reasons. Furthermore, we have not seen any mentions of this expected benefits in any of the work related to the benefits realization and thus it will not be discussed further in this paper.

6.4 Incorrect basis for budgetary planning

While the expected benefit of B4: *More correct billing* has not been addressed in the economical calculations of the repayment period we still regard it as being important for the business case. The medical newspaper, Dagens Medicin (2016) has reported that half of the activity in the first 6 months after go live at HGH, has been incorrectly coded. This amounts to health care services worth 500 mil. DKK which constitutes around 1/3 of HGH's annually budget (Region H, 2016e, p. 47). However, our informants state that this is only the official statement and the incorrect registrations are even higher. In some departments the secretaries are performing the coding which has proven to provide better registrations. However, this is conflicting with the vision of having most information is managed by one person.

Unforeseen expenses

Because of the major issues with incorrect coding, the programme and HGH have established a task force to clean up the existing registrations and to help the doctors with the coding. It will require a lot of resources to correct these issues and it is highly prioritized. This is necessary in order to reduce the consequences but it is also a major and unpredicted expense for the hospital. While more and better training can improve this, it is a fundamental problem that doctors do not consider these tasks as being their responsibility. This prevents the realization of more correct billing through Epic. Moreover, to a large extent the problems with the accounting are related to the complex classifications in the DRG system. Many regard the system as providing an inadequate account of the activity at the hospitals and have emphasized the need for a new system in order to improve the billing process.

No specific strategy for achieving correct coding

We have not found any descriptions on how Epic should achieve more correct billing which indicates it has not been a focus during the development of the business case. Moreover, none of our informants have talked about how the goal is to be achieved and thus we have no indications of how the hospitals or the programme management have worked to achieve this. This indicates that it was expected that implementing a new EHR would in itself provide more correct billing. When implementing Epic in Radboudumc in Holland, more correct billing was one of their main goals and they had specific initiatives in order to achieve this.

7. What caused the issues?

The issues described in chapter 5 are caused by several different factors which are influenced by decisions made by the regions and the programme management. These causes are of technical, strategic and organizational character, and have a direct relation to one or several issues. The below matrix shows the connection between the causes, issues and benefits:

| Issues Causes | 5.1 Troublesome documentation and requisitions processes | 5.2 Inconsistent and less detailed medical records | 5.3 Long response time when reconciling medicine | 5.4 Requisitions and prescriptions disappearing | 5.5 Limited use of clinical guidelines | 5.6 Lack of structured data for research | 5.7 Incorrect coding of treatments and services |
|---|--|--|--|---|--|--|---|
| 7.1 Lack of qualifications among Subject Matter Experts | X | | | | X | X | |
| 7.2 Poor management of user involvement | X | X | | | X | X | |
| 7.3 Poor training in the system | X | | | | X | | X |
| 7.4 Lack of ownership of business critical components | | | X | X | | | |
| 7.5 Domain specific components incompatible with Epic | | | X | X | | | |
| 7.6 System deployed without proper testing | | | X | X | | | |
| 7.7 Vision does not create win-win situations | X | X | | | X | X | X |
| 7.8 Insufficient organizational change management | | X | | | X | X | X |
| 7.9 Clinical and administrative content not being optimized | X | X | | | X | X | |
| Issues Benefits | | | | | | | |
| B1: More effective processes and work procedures | X | | X | X | | | |
| B2: Better continuity of care and patient treatment | | X | | X | X | X | |
| B3: More effective and stable IT operations and service | | | | | | | |
| B4: More correct billing | | | | | | | X |

Table 3 - The relation between issues, causes and benefits

7.1 Lack of qualifications among Subject Matter Experts

The 300 SME who worked two years on validating the content being developed by the program, did not have the proper prerequisites for making informed decisions. Not all of the SMEs were qualified as many departments were reluctant to spare their most skilled personnel. Furthermore, the SMEs did not receive sufficient training in the system which made it difficult for them to understand how the clinical content would work. This decreased the quality of the content and seldom reflected how the end users perceived best practice. It has affected the following issues:

5.1 Troublesome clinical and administrative processes

5.5 Limited use of clinical guidelines

5.6 Lack of structured data for research

Unqualified Subject Matter Experts

Many of the SMEs were not the most experienced and skilled clinical personnel. Epic questioned this, but for many doctors, the prospect of spending 50% of their time and 2 years developing an IT system was not attractive. Moreover, not many department managers were ready to hand over their best people and often sent a reserve or younger doctor. While many SMEs had the necessary competencies, there was a large variation in their expertise, ambitions and effort.

No training in the system

Another issue with the validation process was that the SME did not have the right prerequisites for making informed decisions. The SMEs did not receive any official certification or training in Epic's system. They were learning the system simultaneously as they were making substantial decisions of how it should be built. The SMEs had access to Epic's Foundation System, but they were not required to use it for preparations before each meeting and many did not do it. Moreover, the Foundation System was overwhelming and too different from the workflows used in the Danish hospitals. Thus, instead of spending time on discussing the substance of clinical content they spent a lot of time on trying to understand how the system would work.

Substitution of Subject Matter Experts

Not having the most qualified SMEs resulted in low quality of clinical and administrative content as they lacked an understanding of how to design effective tools and workflows in Epic. As an example some SME groups delivered useful and specific Order Sets where others provided Order Sets that contained too many options and errors. After the implementation at HGH the programme realized that some of the SMEs were unqualified for the job, and as a consequence they discharged an unknown amount of them. But the lack of training was also problematic. Many felt their basis for decision was insufficient and they took decisions without knowing what they were voting about. Some of them expressed they felt like hostages required to take decisions they could not assess and vouch for and some quit because of this.

7.2 Poor management of user involvement

The process of validating and developing clinical content involved 264 Application Coordinators working 4 years in the programme. The plan was to use 80% of the content in Epics Foundation System (Region Sjælland, 2015, p. 6) but as it failed to match the needs of the Danish clinicians new content had to be

developed. The coordinators lacked a common strategy for the process of validation and configuration of the content. As the SMEs had difficulties reaching consensus many different methods were used, with mixed results. The cumbersome validation process led to delays in the development phase and many decisions were rushed. As a result, there are huge variations in the structure and quality of content. This caused an influence on the following problems:

- 5.1 Troublesome clinical and administrative processes
- 5.2 Inconsistent and less detailed medical records
- 5.5 Limited use of clinical guidelines
- 5.6 Lack of structured data for research

Reaching consensus between the clinical staff

The SME groups had challenges reaching consensus in time, and especially the cross-disciplinary groups had issues. An example was the decision on which algorithm to use in the early warning scores which dragged the decision process. The facilitators tried out different methods for reaching consensus but with limited results. The SMEs were presented with paper-based mockups, screen dumps and descriptions. This made it very abstract and they had difficulties understanding how a feature or workflow would fit with the rest of the system. They also made a videoconference with an Epic supporter who demonstrated the Foundation System. However, this sparked several new discussions which made it even more difficult for the SMEs to agree. For some of the larger groups the problem was that many SMEs had their own professional agenda which complicated the process even further.

No clear strategy on quantity or quality of clinical content

The SMEs lacked a common strategy and guidelines for the design and structure of the content they were to develop. The programme had the goal that 80% of the decisions regarding the clinical and administrative content had to be made directly by the SMEs. This strategy gave each SME group the mandate to decide how the content should be developed. The SME group covering the intensive care units decided that Click Records would not work in their specialty. They were met with resistance by the programme management but fought together with their coordinator and in the end, they were allowed to use records containing SmartPhrases instead. This decision was never shared with the other SME groups and as a consequence the users are faced with different types of records depending on the specialty.

Decisions about clinical content delayed

Reaching consensus was an issue that caused the build to be delayed and rushed which resulted in inconvenient workflows and content full of errors. The programme tried to accommodate these issues by trying out different methods for facilitating the process but the quality was still an issue. Some of our informants' state that the risk of this was already anticipated beforehand. As a mitigating action the coordinators from the programme had the option of escalating decisions to the hospital management and eventually to the regions' upper management. However, as there was a goal of having 80% of the decisions being made directly by the SMEs this option was seldom enforced. Furthermore, this caused huge variations in both quality and quantity in the content as decisions were to be taken in the individual SME groups.

7.3 Poor training in the system

The training the of end users received prior to the implementation was inadequate. Region H allocated around 400 mil. DKK for the training of the clinical staff and they received 3-4 days of training each lasting 5 hours. However, the delays faced by the development team resulted in incomplete training material. As a result, the users were trained in an unfinished system. They were not trained in the specific workflows or tools in the system and as a result they were not prepared for the changes that hit them at go-live. It was stated in the risk analysis that relevant and timely training was important to mitigate the risk of resistance among the end users (Appendix 3, p.9). As the programme failed to achieve this, it has influenced the following problems:

- 5.1 Troublesome clinical and administrative processes
- 5.5 Limited use of clinical guidelines
- 5.7 Incorrect coding of treatments and services

Delays in clinical content resulted in poor material

After the tender process the programme expected that the training material from Epic could be used. However, they had to spend extra resources developing new material to fit the Danish configuration. Moreover, as the validation and development of clinical and administrative content took longer than expected, it was difficult to develop training material that reflected the functionality and design of the system. As seen in the below plan for the development of Epic, the building and the training phase was planned as overlapping activities:

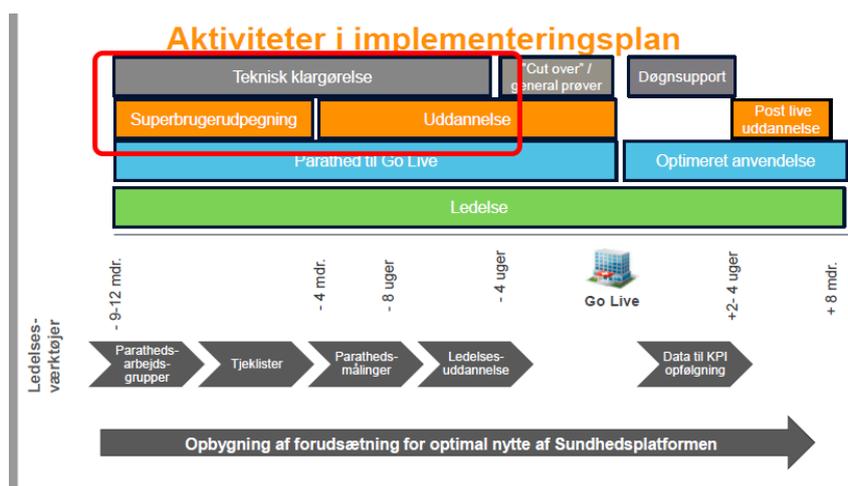


Figure 7 – Official plan showing education (Uddannelse) and development (Teknisk klargørelse) is overlapping activities (Region Sjælland, 2016)

As many parts of the system was not fully developed it was not possible for the users to try out a full course of treatment in the training sessions. Only fragments of the system could be demonstrated and the rest would be examined on a more abstract level, using diagrams and sketches. After go-live at HGH, when the clinical personnel had to use the system, a significant part of the system had changed, and much of their training were useless. It was expected that the super users could assist the end users, but they had even less knowledge about the system as they were trained before the end users where the system was even less complete. The end users were more skilled than the super users after a few days of using the system

Wrong choice of certified users and Principal Trainers

In many cases the Principal Trainers did not have sufficient domain knowledge, in order to create quality training material. Another issue was the hierarchy between clinical personnel and the certified users responsible for teaching. As the certified users were mainly nurses or physiotherapists they had difficulties gaining the required authority to teach the doctors, and the teachers could often not answer domain specific questions. As doctors are more expensive only very few were used for the training.

Training material is still an issue

Many end users reported how they did not gain any knowledge or competencies from the training. They lacked knowledge about how to perform even the simplest tasks in Epic and had to learn the system from scratch while using it to treat patients. Despite bad feedback resources were reduced for the courses at the Rigshospital, cutting down on the training of certified users, super users and end users. Many resources were already used on constantly redesigning the material, as the system changed on a daily basis. There are still issues with the training material being used today. In the e-learning platform many of the walkthroughs in the platform are significantly different than what is seen in the system and some important workflows have never been included. Furthermore, many departments have stopped using the official courses and are spending internal resources on peer-to-peer training of new colleagues.

7.4 Lack of ownership of business critical components

To achieve the goal of having a single record for all patients in the two regions, there was a need of having 70 integrations to 20 external systems. In the requirement specifications it was stated that the integrations from Epic to national health care systems, such as FMK was the vendor's responsibility. This caused problems for Epic, as they had limited knowledge about the architecture of the national systems and spent valuable time trying to understand how the integrations would work. Likewise, Epic had issues implementing the Danish patient contact model, which caused issues with the integration to Labka.

5.3 Long response time when reconciling medicine

5.4 Requisitions and prescriptions disappearing

Lack of ownership for FMK integration

In the requirements specification it is stated that the vendor is responsible for the technical part of the integration to FMK (Appendix 3.1). This entails complying with the public authorities' requirement for the integration at any time. It is required that the vendor receives a certification from the Danish authority, Sundhedsdatastyrelsen, in order to exchange data with FMK. However, Epic has limited experience with integrations to national systems as they are used to deliver the system to local hospitals. Nine months before go live they still had not started on the integration and they had issues receiving the certification. They did not receive any help, even though the regions and the programme had many profound technical resources with knowledge about the architecture of FMK.

Implementing the patient contact model was risky

Likewise, when implementing the patient contact model, much of the responsibility was placed on Epic. The requirement specification state that the solution is required to support a course of treatment as it is described in the Danish patient contact model (Appendix 3.3). The programme warned Epic about how difficult it would be to implement this. Epic were certain that the contact model could be copied from the English model which they developed for the implementation at Cambridge but the difference was substantial. The programme forced Epic to double their resources working on the contact model as they knew it was a major risk. During the development Epic had to allocate further resources on the contact model since it was still causing them trouble.

The programme did not mitigate the risk

The programme knew these areas posed major risks, but failed to take ownership of the deliveries. Relying on Epic to deliver satisfactory solutions, led to several technical problems as described in section 7.5. Furthermore, the process was delayed which limited the time for testing these components as described in section 7.6. This also forced Epic to use a considerable amount of extra resources in the development phase as they had underestimated these tasks. The regions have many resources with expertise in the business critical component which the programme could have provided. Experts from the programme working with FMK and the patient contact model provided inputs to Epic and the programme management about the problems implementing these components. They warned them about how these incomplete integrations would cause issues at go live, but their inputs were not taking into considerations. When the programme ends in 2017 the regions will be responsible for the operations of the system and they will work with these parts of the system. Some technical resources estimate that it will take 1-2 years for the regions to get the implementation of the patient contact model working as intended.

7.5 Domain specific components incompatible with Epic

The technical differences between FMK and Epic caused the long response times in the first few months before a more appropriate solution was found. Likewise, the issues with the requisitions disappearing are related to Epic misunderstanding the Danish patient contact model and the core system of Epic being incompatible with FMK. The following months after the implementation most of these issues have been fixed but the meantime insufficient workarounds have become part of the users routines. This cause has influenced the following problems

5.3 Long response time when reconciling medicine

5.4 Requisitions and prescriptions disappearing

Incompatible FMK integration

The Epic system is designed as one integrated system where all information is managed by one single database. The tight integration between the different modules of the systems allows quick exchanges of information. The Epic developers utilize this by performing many small requests as it provides quick transformation of data between the different modules in the system. However, performing around 20 requests to retrieve the medicine card of one patient in FMK created performance issues. As the FMK database was located in Aarhus, each single request had to go through multiple firewalls on a VPN connection in order to retrieve or modify any data. This means that each of the many requests sent from Epic to FMK will have a significant delay compared to data exchanges made within Epic. As all these

requests had to be executed before the transaction would be completed, the user were faced with substantial delays when interacting with FMK.

Epic incompatible with the Danish patient contact model

Another issue with the integrations is related to the implementation of the Danish patient contact model. Epic missed the understanding of what constitutes a patient in the Danish health care system. The Epic system is built around patients being customers and to become a customer, a hospital service or treatment has to be used. For example, when a hospitalized patient is placed in a hospital bed they are using a service. Epic had difficulties connecting requisitions, such as blood tests and diagnostic imagery to the different form of patient contacts. Particularly for outpatient visits as requisitions can be performed while the patient is not even at the hospital. This was difficult for Epic to implement and they had to make significant changes to the way they processed orders to convert a patient to being a customer. For example, this implied getting patients registered in the booking system when ordering blood tests in order to get Epic to process the patients properly. These workarounds did not always work and the requisitions often got lost in the system as it could not be tied to a specific patient contact.

Efforts to solve the technical issues

In late September a fix was released which reduced the amount of requests made for the medicine card in FMK from around 20 to 3. As a result, the users experienced a substantial increase in performance and reliability when working with the medicine module in Epic. While these issues have been reduced they have not been eliminated and users still encounter problems when working with FMK (Region H, 2016b). Solving these issues was of high priority for the programme management as seen in the monthly status reports made by the Region H (Region H, 2016f). However, in the meantime the users found and learned workarounds. FMK-online was used instead of the FMK module in Epic and some ordered the blood tests directly in Labka.

7.6 System deployed without proper testing

Just before go-live the integrations were technically completed but were not tested properly as the programme and the hospital management at HGH were reluctant to postpone the go-live date. In the requirement specification it is stated that a pilot implementation had to be done at a major hospital, which in this case was HGH (Appendix 3.2). The functionality and performance of the integrations were far below what was acceptable for the clinical personnel, and as a result the productivity decreased as described in the issues:

5.3 Long response time when reconciling medicine

5.4 Requisitions and prescriptions disappearing

Limited time for testing

The deadline was set before the tender process where the regions had little knowledge about how complex the integrations would be. After choosing Epic many of the programme's resources was spent on learning the system and how the integrations would work. Some realized that the differences in the architecture and Epics limited experience with the Danish health care system would be challenging. However, the programme management chose to keep the initial deadline which ended up affecting the quality of the

integrations. Keeping the deadline have been essential for the programme as it posed the most significant risk as seen in the risk analysis.

| Risk number | Risk description | Probability [1-5] | Consequence [1-5] | Total risk (P*C) | Mitigating actions |
|-------------|---|-------------------|-------------------|------------------|--|
| 4 | Schedule and/or budget is exceeded which both delays the realization of benefits and increase the cost. This will result in a longer repayment period | 3 | 5 | 15 | Regularly follow-up and balancing of schedules and budgets with vendors will ensure compliance with budget and deadlines |

Figure 8 – Official risk analysis from the business case summary (Translated from Danish, appendix 1 p.9).

However, the deadline proved to be too optimistic as Epic struggled to get the required certification for FMK from Sundhedsdatastyrelsen and implementing the patient contact model in time. This left a limited amount of time for testing the integrations properly which is seen in the many incidents reported on FMK and Labka in the first couple of months (Region H, 2016f).

Hospital management was left in the dark

The many issues with the integrations were not expected by the hospital management and they were not prepared to deal with these. During the development phase the hospital management at HGH requested more information on how the integrations would work, but the programme was not able to provide with them any useful information. The programme management was informed about the incomplete integrations prior to go live but was unaware of how they would impact the clinical practice.

7.7 Vision does not create win-win situations

In order to achieve the vision of patient centered treatment new clinical processes and distribution of roles have implemented with Epic. In the requirement specification it is stated that a fundamental need of the business is to have all future documentation, reports, registrations and accounting standardized and structured (Appendix 3.4). However, the clinical staff has not received more time or resources which put a pressure on both the efficiency and quality of the clinical processes. This has had an influence on the following:

- 5.1 Troublesome clinical and administrative processes
- 5.2 Inconsistent and less detailed medical records
- 5.5 Limited use of clinical guidelines
- 5.6 Lack of structured data for research
- 5.7 Incorrect coding of treatments and services

Patient-centered treatments lead to more work

A part of the vision for patient-centered treatments is having doctors writing the medical records. They do not regard this as a benefit as it takes more time for them compared to old practice of dictation. Likewise, this applies to the task of coding treatment and services, placing orders and booking time for treatments. Many doctors question this distribution of roles, as they regard it as being a waste of resources. Many of them are highly specialized and have spent many years acquiring a special set of skills. Their primary focus

is treating patients. Some have difficulties understanding the value of the extra tasks as it prevents them from performing their work in a satisfactory manner.

Standardizing processes is not a benefit for the doctors

Furthermore, Epic has become a driver for implementing standardized clinical processes across all hospitals in the two regions. While the aim is to provide the best known treatments, many doctors are experiencing it as a limitation to their clinical practice. Most departments have created unique work practices which enable them to work effectively. They see few advantages in adjusting to the centrally developed guidelines as they regard it as a professional compromise. Furthermore, some of the national and regional quality requirements have been implemented in the system which the clinical personnel have to comply with. This includes additional documentation such as the devising of a diagnosis plan when a patient is hospitalized or the post-operative evaluation mentioned in section 5.5. The clinical personnel are forced to comply with these requirements which entail extra work but have to be done with the same amount of resources.

Extra work does not entail extra resources

Having doctors do more documentation and requisitions have had a critical reception from the clinical personnel especially as it has not entailed additional resources. The doctors do not believe that it is their responsibility and thus many of the tasks are performed in an unsatisfactory manner. This has led the clinical staff to question whether the utilization of resources is optimal as the doctors are a more expensive resource. The doctors still have the same time per patient as before and the hospitals are under pressure as the budgets are decreasing each year. In 2017 Region H has to save 360 mil. DKK (Region H, 2016g), but the amount of patients in need of health care services are only increasing. This requires doctors to increase their efficiency but the extra work assigned to them makes it difficult to deliver this.

7.8 Insufficient organizational change management

While the idea of standardization has played a major part in both the tender and the development process, it has not been implemented in the clinical practice. The establishment of Change Management Groups has not had the desired effect. Neither has the inbuilt tools for standardization and structured data as they are not being used. The department managers and clinical staff are prioritizing their local needs of treating patients efficiently over following the standardized guidelines. This has been a cause for the following issues:

- 5.2 Inconsistent and less detailed medical records
- 5.5 Limited use of tools for standardization and structured data
- 5.6 Incorrect accounting of treatments and services
- 5.7 Lack of structured data for research

Risks of insufficient organizational support

The changes envisioned by the regions require an organizational rearrangement which introduces a time of uncertainty, which is difficult for the clinical personnel to cope with. This was known by the programme and is outlined as one of the major risks in the risk analysis below. Not having the required organizational support could reduce the benefits of having standardized processes. The strategy for getting the necessary support was to engage department to take ownership of the vision.

| Risk number | Risk description | Probability [1-5] | Consequence [1-5] | Total risk (P*C) | Mitigating actions |
|-------------|--|-------------------|-------------------|------------------|--|
| 2 | Failure to ensure the right governance / organization around decisions and implementation of standardization across the two regions may entail that the potential prospect of standardization is not exploited, which will reduce the expected benefits. | 3 | 4 | 12 | Early focus on the management will ensure coherence about the extent of standardization and how it should be implemented |

Figure 9 – Official risk analysis from the business case summary (Translated from Danish, appendix 1, p.9)

Change management groups

9-12 months before go live at each hospital, groups of departments leaders were formed to discuss the impact of Epic on their work practice and how to organize for the changes to come. However, the meetings did not have the expected results. The extent of the changes which were to be imposed by Epic, was not properly communicated to the different departments. The department leaders did not receive proper knowledge about the system, in order to change their workflows accordingly. As the system was not ready it was difficult for the groups to discuss how the specific workflows would impact their organization and how they could use the system efficiently. As a result each department had to invent their own new ways of organizing after going live which were both difficult for the managers and clinical personnel and required a lot of time and effort.

Lack of guidelines for the new work process

Neither clinical personnel nor department managers have received instructions on what is regarded best practice of how to use the system. Instead decisions regarding documentation, requisitions and other tasks are being made at department meetings and are rarely shared between departments. The lack of guidelines is seen in the discussions on who is responsible for releasing a patient's prescribed medication. In some departments it is the nurses who release the medication and in others it is the doctors. The departments cannot agree and there are no overall guidelines to follow. Thus, each clinician is doing what they perceive to be most effective.

Vision not anchored

The effects of the poor organizational change management have not been highly prioritized such as the integration issues with FMK and Labka. The programme has yet to make the clinical personnel take ownership for the vision, the system and its inherent processes. Some guidelines have been built into the system but the clinical staff has not taken ownership of these tools as the quality of the content is poor and they lack proper training. Because of this department managers are also reluctant to enforce the clinical personnel to spend more time on coding or using the Order Sets and Click Records. Many tasks which are not providing a direct benefit for the clinical personnel are being down prioritized. It is certain that the production at HGH would be even lower if department managers had enforced doctors to use the tools in the system. While there is a training project being executed to teach the doctors how to code, establishing local ownership over the vision depends on the optimization phase in 2018.

7.9 Clinical and administrative content not being optimized

The strategy was to implement Epic at all hospitals as quickly as possible, before optimizing the system. As the programme were focused on developing new content for the Rigshospital it left minimal resources for optimizing the content at HGH. This entails the risk of users losing confidence in the programme and start to find alternative workarounds as the errors they report are not getting solved. While a pilot project involving 10 Physician Builders have been initiated to optimize the system, it is uncertain if the project will be scaled to all departments and hospitals. The lack of optimization is affecting the following issues.

- 5.1 Troublesome clinical and administrative processes
- 5.2 Inconsistent and less detailed medical records
- 5.5 Limited use of clinical guidelines
- 5.6 Lack of structured data for research

Minimal focus on the content at HGH

As described in section 7.5 many resources were spent on fixing the technical issues that caused long response time and information disappearing. Meanwhile the development of new clinical content for the implementation at the Rigshospital required a substantial amount of focus. The programme management wanted to avoid being forced to have development and training as parallel activities as it was the case with HGH. This left very few resources for optimizing the clinical content at HGH. When the programme was initiated the plan was to use 50% of the resources for optimizing the content and the rest to focus on the next hospital. This prioritization has changed as now only around 20% are allocated for optimization.

Users have stopped reporting errors

The users are experiencing that reported issues and change requests rarely get fixed. The anesthetics department have sent request for a new chart and were told that it would be delivered soon, but after several months they have not received it. Others have reported that they receive incorrect notifications about patients or examinations which they have no relation to. As such errors rarely get fixed, many users have stopped reporting incidents and change requests. They have lost confidence in the programme management and the support organization's ability to improve the system according to their needs. This confident can be difficult to rebuild and there is a risk of many bugs, design flaws or inappropriate workflows not being reported and fixed in the future.

Waiting for optimization leads to workarounds and lower productivity

When the programme was initiated the plan was to have local optimizations at each hospital after the system had been implemented. The original plan in chapter 2 shows this. However this prioritization has changed and the optimization is now being done as one collective effort after the system has been implemented at all hospitals in 2018. The timeline below is from a more recent presentation plan which illustrates this:

Før og efter

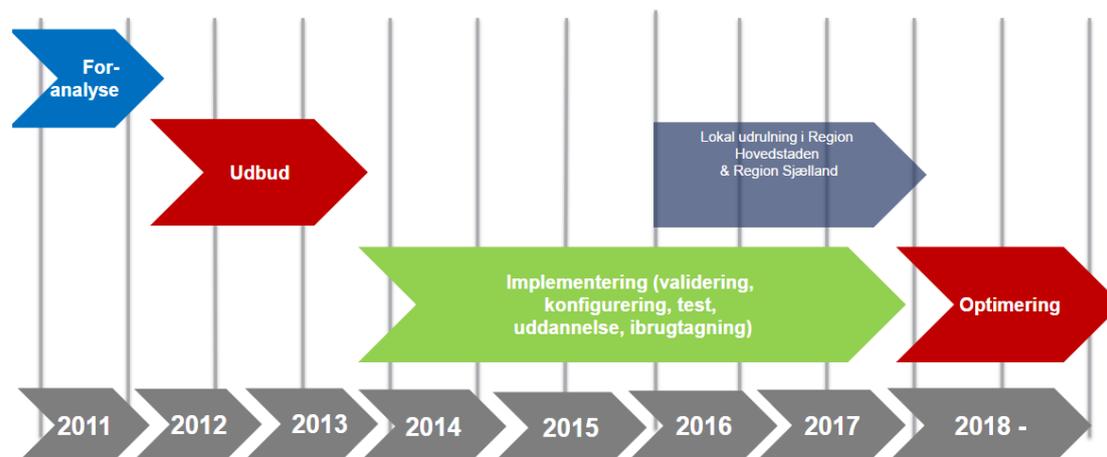


Figure 10 – Official time schedule with the optimization (Optimering) phase after 2018 (E-sundhedsobservatoriet, 2016)

The reason for waiting till the implementation have been completed is to ensure that the system is being optimized in a standardized manner according to needs of all hospitals. However, the specific content and activities of the phase is not yet established. The prospect of waiting till 2018 before the optimization phase entails the risk of the productivity and quality issues not being resolved. The users have already developed workarounds in order to perform their work efficiently and the longer they wait the more difficult it will be to change those. It will require a substantial amount of additional training in order to make the users use the system the way it was envisioned. By not improving the aforementioned issue, there is a risk of having these issues being implemented at the other hospitals as well.

Not enough Physician Builders

Another initiative to improve the system is the deployment of 10 Physician Builders from HGH and The Rigshospital. They can quickly identify the needs of the clinical staff and build content to accommodate them. While the Physician Builders can be effective they are not enough to cover all the required areas. The regions are however reluctant to deploy more Physician Builders as they do not necessarily comply with the overall vision of standardization. They fear that they will develop content which conflicts with decisions made by the SMEs prior to go live. The programme management has to prove to the regions that they can manage the Physician Builders to develop useful content for the clinical personnel, while still getting it validated by the SMEs.

8. Recommendations

We have compiled a list of recommendations which can be used in other Epic implementations in order to minimize risk and strengthen the prospect of gaining the benefits of the system. Each recommendation pose a solution to one or more of the causes mentioned in the prior chapter. They are mainly based on the experiences gained from the Danish implementation and thus some of them accommodate specific Danish needs. However, the recommendations are meant to provide valuable insights for other countries wanting to acquire Epic or other EHR systems.

| Recommendations Causes | 8.1 Take responsibility for realizing the benefits in the programme | 8.2 Implement organisational changes incrementally | 8.3 Focus on the benefits when building content | 8.4 Implement local changes and adjustments | 8.5 Be flexible about changing the go live date |
|---|---|--|---|---|---|
| 7.1 Lack of qualifications among Subject Matter Experts | | | | | |
| 7.2 Poor management of user involvement | | X | X | | X |
| 7.3 Poor training in the system | | | | | X |
| 7.4 Lack of ownership of business critical components | X | | | | |
| 7.5 Domain specific components incompatible with Epic | | | | | |
| 7.6 System deployed without proper testing | | | | | X |
| 7.7 Vision does not create win-win | X | X | X | X | |
| 7.8 Insufficient organizational change management | X | X | | X | |
| 7.9 Clinical and administrative content not being optimized | X | | | X | |

Table 4 - Relation between causes and recommendations

As seen in the table not all causes are being covered in this chapter, as we lack a satisfactory recommendation. While mandatory training can be used to make the SMEs more qualified we have no means of accommodating the challenge of recruiting skilled doctors. Many lack the incitement for spending 50% of their time away from the clinical practice and we have no solution for this. We also lack a satisfactory recommendation for the incompatible domain specific components. This is a technical problem which is related to the choice of EHR. However, we have no knowledge of the architecture of the other competing EHR systems' or if they are more compatible with the Danish domain specific components. To

reduce the impact of this we recommend that the programme organization takes responsibility of the components as described in section 8.1

8.1 Take responsibility for realizing the benefits in the programme

The responsibility for realizing the benefits of Epic has been placed at each hospital. By not making the programme responsible for this, their objective becomes reduced to delivering the system with the predefined scope, within the allocated time and budget. If the programme is made responsible for realizing the potential benefits they will have more incentives to ensure that the system is developed and implemented in a way that provides these benefits. This will provide more incentives for taking ownership for integrating business critical components, adjusting the vision to create win wins for the users, spend more resources on organizational change management and prioritizing the optimization of the system. Having a clear focus on the benefit realization in the programme is regarded best practice by the project model developed by Danish government (Digitaliseringsstyrelsen, 2016).

Let the programme be responsible for business critical components

When implementing an EHR some of the expected benefits can depend on external systems or domain processes which can cause bottlenecks. Relying on these to fulfill parts of the business case can be risky and will require a high prioritization by the programme. In Denmark, FMK and the Danish patient contact model represents such core components where Epic had the responsibility. They are known to accept such tasks even if they have limited knowledge about the components. While it can be expensive for the programme to take the responsibility for integrating these, it is still important for the prospect of gaining the benefits. The right knowledge and competencies are more likely to be available in either the programme or the operating organization and we regard it as an advantage to fully utilize them.

Ensure that the system is used efficiently

The programme has developed and implemented the system according to the overall vision without being critical of which benefits the end users would gain. It was expected that end users would use the system as intended but it has not been the case. By making the programme organization responsible for gaining the benefits we expect it to have more incitements for ensuring that the vision is perceived as a benefit by the users. They will have to adjust the vision according to the needs of the end users and invest more resources in the organizational change management in order to ensure the proper support from both the clinical staff and department managers.

Prioritize that optimization

The optimization phase has to be highly prioritized and initiated right after go live according to the experiences at Radboudumc. If not there is a risk of decreasing the efficiency and quality of the health care services provided and it will be difficult to recover. This is a central factor for gaining the benefits of Epic and the programme has to take ownership for this part. Resources has to be allocated for optimizing the system and it is important to ensure that they are not used on developing new content for the next hospital in line.

8.2 Implement organizational changes incrementally

While it might seem like a good opportunity to use an EHR implementation to create several changes to the organization, it can be too overwhelming for the users. It can be difficult for many to learn how to use a new system while their workflows and daily routines are turned upside down. Instead it is advisable to implement the organizational changes in several small incremental steps. This leaves more time for SMEs to develop clinical guidelines and makes it easier to ensure organizational support for the overall vision of the implementation as the impact is less significant. These changes can in many cases be initiated years before the system is implemented as they are changes to the core business more than changes imposed by the system.

Have doctors write records and code before the implementation

In Denmark some of the radical changes for the doctors were to write medical records and code activities. These changes could have been made years before Epic was implemented as the doctors already had the tools to write the records and code the activities. Making substantial changes to the clinical practice before the implementation makes the transition to Epic easier as the workflows and tasks are more similar. At Radboudumc the recovery time after the implementation of Epic were quicker than in Denmark as the doctors were already used to writing records.

Standardizing content independently of the system

If the vision is to standardize the clinical content it is advisable to start the process before the implementation of Epic. Defining homogenous limit values and treatment plans does not depend on the EHR vendor nor on the programme organization. To initiate such ambitious plans independently of the implementation allows more time for SMEs to reach consensus and ensure high quality of the clinical guidelines.

8.3 Focus on the benefits when building content

Most EHR implementations are based on a vision of more efficiency and higher quality in the healthcare services. While this is important, the vision must also ensure that the needs of the clinical personnel are taken into account. The vision should provide specific benefits for the users which can be both easily achieved and communicated. It is very important to have specific objectives for the content being developed and the business case should be used for this particular purpose. By developing and testing content continuously with end users it is possible to adjust the overall vision so that it provides direct benefits for the users. This creates a better foundation for involvement of users and a vision which creates benefits for the regions, the hospitals and the clinical personnel.

Remember the business case when developing

It is important that all content can be connected to a specific benefit in order to assess how it will support the business and to sort out unnecessary content. Leaving the decisions about the clinical content to the SMEs does create legitimacy and incorporate local needs. However, without a clear strategy the result can be significant variations in quality and quantity of the content as well as scope creep. It can be an advantage to define structures for how to build for example Order Sets. How big a patient group should they be used for, how many actions should they contain and in which order should they be performed.

Furthermore, the risk of scope creep should be reduced by having SME prioritize their work according to guidelines based on the business case.

Show users the benefits of the system

It can be difficult to get the clinical staff to use tools for standardization and structured data as it fails to provide them a direct benefit. At Radboudumc, the information management showed the doctors reports from the system which could be used for research and improving the treatment. This gave the doctors a purpose of using the standardized tools, as they are required in order to ensure high quality of data in the reports. It is advisable to develop and offer such tools as they provide value for the doctors who will otherwise not use the system as it was intended.

Test the clinical content on the end users

To avoid spending resources on developing content which are not being used, testing the content on end users is important to ensure that it actually provides value. At Radboudumc they made simulations of patient treatments and examinations with people where they validated the content. Epic provides a method called Shadow Charting where workflows are tested in the different departments. These tests should provide knowledge on whether the content of the system support the clinical processes. We recommend making extensive use of these methods to validate the content as early in the process as possible.

8.4 Implement local changes and adjustments

Most doctors agree that standardized clinical guidelines and treatment plans are important and valuable for the treatment of patients. However, this one-size fits all strategy seldom encompasses needs of the individual. Epic is a flexible system where one task can be performed in many different ways. The users will utilize this and adjust the system in ways that enable them solve the task most effectively. The programme organization has to integrate these local changes as it is an effective method for optimizing the system which ensures local ownership and a vision which provides direct benefits for the clinical personnel. Furthermore, deploying Physician Builders can provide a systematic approach for developing content which takes into account the needs of the users.

Make it easy to implement local changes into the system

At HGH end users quickly developed and shared Preference Lists and SmartPhrases which had a significant positive impact on the efficiency of the system. But the programme are reluctant to implement these local changes into the system as the changes undermines the standardizations made by the SMEs. While the standardization can provide some benefits, we recommend prioritizing content which present direct benefits for the end users. It is difficult to control the dissemination of such solutions in Epic and they will be shared and used by the clinical personnel no matter what. Therefore, it is important to ensure that local changes and adjustments are implemented into the system as they become easier to govern and maintain. However, it will still require that such changes are validated by the SMEs to ensure that it is compatible with the clinical guidelines.

Make extensive use of Physician Builders to optimize the system

When Epic has been implemented the need for optimizing the systems content and workflows to accommodate local needs will arise very quickly. Using Physician Builders are an effective method as they work with the system on a daily basis and are able to identify areas that need improvement and the proper solutions. The information management at Radboudumc suggests having at least one at every department which would ensure that all parts of the system would be optimized. The alternative is to optimize the system centrally but this require a disproportionately amount of resource compared the limited value these changes will have for the clinicians.

8.5 Be flexible about changing the go live date

The tight deadline for implementing Epic has proven to have consequences for the development of content, the integrations and the training of end users as they were done as parallel activities. In Denmark the deadline was established 2 ½ years before go live. However, making decisions of such importance early in the process is risky as the knowledge about the scope and complexity is yet unknown.

Reassess the scope and plan

Extending the deadline can be necessary in order to ensure that the quality of the system does not impose significant degradations of the efficiency and quality of the health care services provided. But changing the deadline is not cost free. It requires restructuring the implementation plan since training, support and vacations has to be rearranged. It is advised to reassess the scope and plan right after the tender process where key stakeholders have made a qualified assessment of the complexity and extent of the work required. Moreover, reassessing the scope and plan should be done throughout the development of the system.

Perform a small scale pilot implementation

Epic recommend going live with the system as quickly as possible. This entails the risk of implementing a system with defects that can have a negative effect on the production. At HGH more than 5,000 employees were affected by the issues which had a large impact on the region's economy. To limit the impact on the productivity it is recommendable to implement the system on a smaller hospital. This will ensure that critical workflows and integrations are tested in a live environment with minimal consequences as fewer patients and clinicians are involved. This strategy makes it possible to identify and fix the most urgent issues quickly with minimal risk.

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