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Use of Electronic Medical Records and the road towards paperless hospitals in Norway: A socio-technical perspective

Thesis for the degree of philosophiae doctor

Trondheim, December 2007

Norwegian University of
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ISBN 978-82-471-5238-6 (printed ver.)
ISBN 978-82-471-5241-6 (electronic ver.)
ISSN 1503-8181

Theses at NTNU, 2007:236

Printed by Tapir Uttrykk

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Doctoral thesis

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Summary

Electronic medical records (EMRs) have for a long time been a topic of interest for researchers and practitioners both nationally and internationally. The main reasons seem to be the expectation that EMR-systems can contribute to higher quality and more efficient health services.

In Norway almost all general practitioners and all except one hospital have introduced and started to use EMR systems. Still, studies have revealed limited utilization of the available functionality, especially among nurses and physicians. One of the reasons for the limited use is argued to be the dual existence of both electronic and paper based medical records. Several Norwegian hospitals have therefore started a process of removing their paper based medical records from clinical workflow. The first study of a Norwegian hospital deprived of the paper based record was published in 2003, and the results showed a higher degree of EMR-system use compared to the control group. The high use was however mostly in tasks where the users had no other choice but to use the EMR-system since the paper-based records no longer existed. To further explore the use of EMR systems in Norwegian hospitals and to investigate the promises of scanning, three broad research questions were established as point of departure for this thesis:

- Why is the functionality offered by the EMR systems not used?
- What are the effects of removing the paper based medical records?
- What can be done to increase usage and fulfill the promises of EMR systems?

In relation to these main research questions, three studies were conducted providing data for four articles.

Article 1 explored change in use and satisfaction with an EMR system over a three year period at a hospital deprived of the paper based medical record. The results showed a significant increase in use of optional functionality among physicians and nurses largely

independent of technological factors, highlighting the importance of seeing technology and organization as interrelated issues.

Article 2 presented results from a questionnaire study about use and satisfaction with EMR systems from 6 hospitals working without the paper based medical record. The results showed large variances between professions and between departments/hospitals, suggesting that for instance the amount of time since removal of the paper based alternatives and the initial situation are important conditions for successful projects to take place.

Article 3 presented an in depth qualitative study of the two departments in article 2 where respondents distinguished themselves with both high reported use and high reported satisfaction with their EMR system. Two main areas were of particular interest at the start of the study; what had they done organizationally during the introduction processes, and how did the clinicians experience working without the paper based records. From the interviews, involvement and close clinical-administrative collaboration during the implementation processes emerged as important prerequisites for the apparent success. Still, even though almost all clinicians preferred EMR-only to maintaining dual systems, the shortcomings of organizing the EMR according to the paper based ancestor was getting apparent and it was clear that the EMR systems only to a modest degree met the clinical needs of experienced physicians.

An EMR-system should not be a goal itself, but rather be an enabling technology in order to provide more efficient and better quality health services. Article 4 investigated the potential for interdisciplinary teamwork in hospitals. The results were promising showing little or no deep cultural differences between various professions. Still, established routines and an EMR reinforcing established professional boundaries might limit the potential.

Even though the range of available functionality is increasing, the articles point to lack of routine changes as a barrier for successful EMR implementation. By having an EMR similar to the paper based records and a workflow following the traditional way, no

large benefits except availability is gained for the individual clinicians, even though some benefits can be gained by the hospital as a whole. Further, for those used to the old tools, a change of tool without a change of routine might result in decreased performance. A change of perspective from the individual's benefits to a hospital-wide focus can be valuable, but it is argued that the large benefits thought to be achieved by EMR-systems can first be reached when seen in relation to organizational change. In the same way scanning and removing the paper based record from clinical workflow has limited potential in isolation. More precisely, work routines and technology should be addressed in parallel. To reach the promises of the electronic medical record, the bonds to the paper-based medical records have to be broken. This implies both a change of EMR structure and a change of routine to fully exploit the potential of new technology. Digitalizing the paper is simply not good enough.

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1 Preface

This PhD-thesis was written as a part of the research program ”effective use of information and communication technology (ICT) in hospitals”, at the Norwegian University of Science and Technology (NTNU). The program was initiated in 2003 in collaboration with St.Olavs hospital in Trondheim, central Norway regional health authority, and the hospital development project for central Norway[1]. The main goal of the research program was to identify factors that promote or hinder organizational change at hospitals, and explore how this knowledge could be used to improve change processes. The background being large challenges related to the introduction of new technologies, especially ICT, at hospitals. The work has also been carried out in close collaboration with the Norwegian Centre for Electronic Patient records[2] (NSEP).

First of all I would like to thank my supervisors, Endre Sjøvold at the Department of Industrial Economics and Technology Management, and Arild Faxvaag at NSEP. Without the close collaboration with my supervisors this thesis would not have seen the light of day. I would also like to thank Aksel Tjora and Per Trossmark for their assistance, and Hallvard Lærum who shared his empirical data and also contributed in the first article of this thesis. My fellow PhD students also deserves to be mentioned, Jostein Engesmo, Fay Giæver and Frode Heldal. The guys at the Norwegian Research centre for electronic patient records (NSEP) should also be mentioned, but are too numerous to specify here. Thanks anyway.

I would also like to thank my contacts around at the various hospitals involved in the studies. Especially Rut Naversen at St.Olavs hospital and Tom Schultz at Arendal. The remaining contributors cannot be mentioned due to the fact that the hospitals are made anonymous, but they are not forgotten. The folks at Dips ASA should also be mentioned for their always prompt feedback to my questions.

[1] These three have also financed this thesis, each with 1/3.
[2] Which has financed the traveling involved

Finally, I would thank the guys who made sure my academic and social life was balanced. As above all cannot be mentioned, but from my time at Bakklandet I would name especially Magnus, Ola, Mack, Iris, Bodil and Jonne. After I moved from the commune to the penthouse, Kjersti, my flat mate, and Kent deserves an extra thanks.

Last, I have to mention my mother, father and my two brothers who have supported me all the way.

Meldal, October 2007
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1.1 Structure of this thesis

The main theme of this thesis is the use of electronic medical record systems in Norwegian hospitals, and especially the effects of removing the paper based medical records from clinical workflow.

In chapter 2 starts with a short introduction about information and communication technology (ICT) in the health and social sector. Especially the national strategy plans, which govern some of the development, are treated in some detail. Particularly their focus on electronic medical records (EMR) and organizational development.

Chapter 3 continues with a more specific introduction to EMRs. The term is defined, the promises outlined and previous literature about EMR usage is presented before literature regarding possible reasons for use or lack of use is presented. At the end of the chapter some possible scanning strategies for removal of the paper based medical record is outlined.

In chapter 4 the EMR introductions is discussed further. Here from a theoretical point of view, placing Norwegian health-ICT introductions in the theoretical landscape.

Chapter 5 presents the research questions, before the methods used in the articles are described briefly in chapter 6 and main results presented in chapter 7.

In chapter 8 the main research questions are discussed, before some possible implications for stakeholders are presented in chapter 9.

Following the references the articles is attached. Then the questionnaire used in some of the studies is attached in appendix 1, before the list of tasks in the questionnaires and a table of available EMR-system functionality is attached in appendix 2.

2 Information technology and the Norwegian health care sector

For years there have been large investments in information and communication technology (ICT) within the health and social sector. One of the main areas of interest has been electronic medical record systems (EMR-systems), which is the subject of this thesis. The EMR, which has some extra challenges as it can be regarded as both an administrative and a clinical tool, will be further described in chapter 3. In this chapter the national strategy plans concerning ICT in the health and social sector will be briefly described, before their focus on EMR and organizational development will be treated in some more detail.

2.1 National strategy plans

2.1.1 More health for every BiT: 1997-2000[3]

”More health for every bit” (MHEB) [1] was the first national strategy plan for information technology in the health care sector in Norway. Pointing to the rapid growth of information technology in society at large, there was argued to be a large potential for improvements using information- and communication technology to support health care delivery. The basic element being a common uniform infrastructure with a shared information and data foundation. The plan was ambitious in scope and listed several areas to be in focus. These were for instance the creation of secure networks for exchange of health information, to foster the introduction of clinical and administrative information systems (e.g. EMR), to open for better access to health information for the public, to create systems for better data gathering for governing and supervision purposes, standardization, and an adaption of the law to reflect the possibilities of new technology.

[3] Translated by the author. In Norwegian: ” Mer helse for hver BiT”

2.1.2 Say @: 2001-2003[4]

"Say @" [2] succeeded "MHEB" as the strategy plan for information technology in the health and social sector. During this period the state also took over the hospitals from the regional government, and five regional health enterprises were established to enhance coordination and control. Several of the challenges from MHEB were repeated in this plan. For instance in regard to the establishment of a national health care network and electronic data exchange. However, it was emphasized that this time the goals were more realistic and the finances more in accordance with the goals. The main goal was to establish the foundation for holistic cooperation and data exchange across a range of services, and it was the first (IT) plan to incorporate governmental initiatives across both the health and social sector. It was also emphasized in "Say @" that it focused on infrastructure enabling cooperation, not so much the development internally in the various organizations.

2.1.3 Te@mwork 2007: 2004-2007

An evaluation of "Say @" performed by Rambøll [3] concluded that it had contributed positively to accelerate and coordinate information technology development in the health and social sector. However, they pointed out that there had been too little focus on electronic medical records, organizational development and internal development at the various hospital organizations. The new strategy plan, Te@mwork 2007 [4], sought to take this into account. The plan's vision was "Continuity of care for patients and clients through electronic interaction". To achieve this, the scope was narrower than in the rather broad and visionary previous plans. Two main priority areas were outlined; improving the flow of information and greater inclusion of new actors in the electronic interaction (particularly municipal health and social services). The national health network continued to play a vital part, but it had now been established and the focus was turned to getting actors to connect and to promote the creation of new services.

[4] Translated by the author. In Norwegian: "Si @".

2.2 National strategy plans and EMR[5]

Electronic medical records were mentioned as an important topic in all strategy plans, and the focus increasing towards the latest, Te@mwork 2007. According to the first, MHEB, the EMR should be the central information and communication tool for health personnel in the daily treatment of patients. The EMR was also portrayed to be the foundation for health research, quality assurance, internal control and training in addition to being the legal document for treatment performed. According to this plan, the EMR-system would be the core information and communication system in the health care sector. EMR systems was further described as having a potential of enabling the health personnel to do more patient centered work, create a better information and decision basis for diagnosing, treatment and follow up of patients, in addition to give easier access to valuable data for research and quality assurance. A well functioning EMR-system was described as giving fast access to relevant information about a particular patient at the place of the health professional that had legitimate reason to access that particular information at that particular time.

In "Say @" there was not much explicit focus on EMRs, as the evaluation also mentioned, but the statement from MHEB about the importance of EMR-systems was repeated. According to "Say @", effective electronic exchange of information required use of EMR systems both at hospitals and in other part of the health services. Also, it was said, EMR would have a significant impact on the development of work processes and the coordination of patient treatment.

In Te@mwork 2007, the latest strategy plan, there was a strong explicit focus on EMRs. According to this plan, a thorough and general introduction of EMRs was presumed to have the most potential gain of all the ICT measures in the health and social sector, and EMR systems were described as having a lot of promising qualities. For instance in regard to speeding up routine work as writing prescriptions and sick leave notes, and in making the journal more readable and accessible. Beyond the automation, EMR-systems were said to be a source of data for leadership, planning and research. By using

[5] A more thorough review of electronic medical records is presented in chapter 3.

EMR-systems collection of data could be largely automated and expanded. In addition, organization of data and information obtained from reports, diagnosis, treatment and evaluations were perceived to be used to measure the quality and cost of the services provided. Despite the great promises[6], it was acknowledged that a lot of challenges remained. Integration between clinical systems and administrative systems were for instance still poor, And the transitions from paper medical records to electronic applications were often not complete resulting in paper records existing in parallel with electronic records. In addition it was said that the EMR might present new challenges compared to the paper based record. It was for instance suggested that overview could be lost in all the screen images, making it demanding to track the progress for patients with several problems that needed treatment, especially when several different agencies were involved at the same time.

2.3 National strategy plans and organizational development

As for EMR, organizational change and development has to an increasing extent been recognized as an important factor to enhance and broaden use of information technology in the health and social sector. Already in the first plan, MHEB, it was stated that development within ICT had to be seen as an integrated part of organizational development, and that this should be the foundation for planning and implementation of ICT projects throughout the health care sector. By introducing ICT in conjunction with process changes, there was argued to be a large potential of freeing health personnel's time to actual treatment and patient contact. Despite the importance attributed to organizational change, little was said about how this should be done and the more specific actions/goals in the plan were mainly technical.

In a follow up plan to MHEB (1999-2000) [5] organizational factors were mentioned once again, and it was stressed that information technology should be seen as a strategic tool for the sector, not as a goal in itself. It was further acknowledged that the technological development had moved beyond the organizational and legislative development within the sector. Thus it was stated that the major challenges were within

[6] More about the promises of EMR-systems in section 3.2

organizational development and a change in legislation. To cope with this, the plan emphasized identifying best practice examples that should be the norm for new solutions.

In “Say @”, the same message was repeated. New technology should not be seen as a goal itself, but rather in relation to organizational development and political reforms for increased cooperation and better contact with the patients. The challenge then, to find out how technology could help developing better health services and acknowledging that organizational barriers might be the largest challenge. Still, as in previous plan, the main emphasis was on technological solutions and infrastructure.

In March 2004 an evaluation report of “Say @” was published by PLS Rambøll [3]. The purpose of the report was to evaluate how useful the plan had been to the health and social sector. Overall they concluded that the plan had contributed positively to accelerate coordination of ITC development in the sector. However, they pointed out some areas that could have been more in focus. Especially further promotion of EMRs, and how to overcome organizational barriers to ICT implementations.

The latest plan, Te@mwork 2007, continued the tale of the previous strategy plans. There was a stated belief in improved quality, increased efficiency and cost savings by the use of ICT. It was also stated that this would be fully realized only through changes in routines, organizational development, standardization and the management of processes for change both at the national and local levels. Still, it was acknowledged that limited change had been done so far, and one of the challenges that had to be overcome was to remove the paper based solutions where electronic applications were implemented. Other measures for achieving the goals were for instance to identify barriers for development and make possibilities, potential solutions, and practical solutions visible.

3 EMR

The previous chapter described the large governmental interest concerning information technology in the Norwegian health and social sector. Before a theoretical treatment of EMR system introductions is outlined in chapter 4, this chapter will give a specific introduction to what an EMR is and describe some trends and research on the topic of EMR introductions both nationally and internationally.

3.1 EMR defined

According to the Norwegian centre for informatics in health and social care (KITH) [6], an electronic medical record can be defined as:

> *"An electronic collection or juxtaposition of recorded/registered information about a patient in relation to health treatment*[7]*"*

According to KITH the EMR should contain the relevant and necessary information about the patient and the treatment performed, as well as the information needed to fulfill the duty to report specified in law. Normally there should be only one record for each patient within one health enterprise, and this should be used by all professions performing medical treatment. Different enterprises are not allowed to use shared records. Also it should be noted that EMR is a logical term and the collection of information that constitute a patients EMR does not necessarily have to be handled only by what is usually termed the EMR-system.

In the above paragraph both the concept of 'EMR' and 'EMR-system' was used. To put it simply, the EMR contains the data or information while an EMR-system is the software handling the information. These are closely related concepts and an EMR would be useless without an EMR system, and an EMR system without any EMRs would be of little value. In this thesis the terms EMR and EMR-system is used interchangeably. In addition to the EMR system, some information will often be found

[7] Translated from Norwegian to English by the author of this thesis

in more specialized systems, for instance PACS or laboratory systems[8]. Thus, even though the EMR from the definition above is a pure documentation system, additional functionality is usually also offered. Hence it might be more informative to talk about hospital information system (HIS) than EMR systems, as what we usually call EMR systems contains more than what is regarded as EMR according to the definition[9]. According to Lærum ([7], p 16) "[…] a HIS is a computer system designed to support the comprehensive information requirements of hospitals and medical centers, including patients, clinical, ancillary and financial management. Such systems include information for clinical work, but also administrative information needed to run the hospital as a business". From this, it is clear that EMR is included in the HIS definition.

In this thesis the focus is on the (clinical-administrative) electronic functionality offered to users, not so much which specific computer program that offers this functionality. In this, for instance systems for ordering and viewing radiology and laboratory tests are included, as well as some patient administrative functions. Thus, EMR-systems are regarded much like HIS in this thesis, the basis being the clinical tasks specified by Lærum[10].

3.2 The promises

The expectations in relation to electronic medical records have not only been high in national strategy plans as described in chapter 2, but also within research communities and within the sectors for the same reasons; expectations of both higher quality and more efficient services by using such records [8].Van Ginneken [9] lists some of the promises or the potential benefits of EMR systems:

- Accessibility: Computer stored data can be viewed at multiple locations at all times[11].

[8] Sometimes integrated in the EMR system. However, the data structures behind the hospitals IT systems are not the subject of this thesis.
[9] In s similar way, HIS might be more than one system. For instance do several hospitals have separate patient administrative systems (PAS).
[10] More about the method developed by Lærum in chapter 6.1.
[11] At least as long there is no technical problems with the system

- Readability: Scanned documents can be made available at multiple locations, but freehand may be difficult to read.
- Reporting: Data in well-organized CPRs[12] can be used to generate reports for institutional, regional or national repositories, and reduce the need for redundant recording.
- Completeness: Computers can actively prompt for data[13].
- Decision support: A broad area of functions that support diagnosis making and treatment policy, which often involve both assessment of health parameters and treatment. Can be both passive (the clinician requests a response from the system), or active (provide advice without explicit request).
- Diagnosis support: Encompasses all help to solve an open ended diagnostic problem, or test a user-defined diagnostic hypothesis.
- Treatment policy support: Encompasses a relatively broad spectrum of systems that have in common that they help to decide what to do with the patient.
- Protocol support: For an increasing number of diseases, the medical community develops guidelines for work-up and treatment.
- Preventive medicine: Screening and preventive medicine are far more efficient when patient records are available in a well structured computerized form.
- Access to external knowledge sources: Searches of databases with reference knowledge can be performed on the basis of CPR contents.
- Data analysis: Data extraction for various purposes, both clinical and managerial.

In addition for instance ordering and receiving radiology and laboratory tests can be included, as well as the more general goal of enabling increased cooperation and teamwork. As seen above the promises of EMR systems[14] are vast. However, the full range of functionality above is rarely available at hospitals today. A description of the available functionality at the hospitals involved in this thesis is presented in appendix 2.

[12] Synonymous with EMR
[13] But can also be an annoyance for users if misused.
[14] According to a strict definition all areas mentioned above need not to be part of an EMR system, but represent functionality that might be part of hospital information systems in the future.

3.3 Reported use of EMR-systems

As described in the above section and in chapter 2, the promises and the expectations in relation to EMR systems both within the health and social sector in general, and within hospitals in particular are vast. However, both national and international studies have revealed low utilization of EMR systems both among nurses and physicians. Already in 1970 it was proposed that clinical computing would be commonplace in the not too distant future [10]. Yet over three decades later studies show for instance only 10 percent market penetration of computer based order entry (CPOE) in the United States [11]. Further, a U.S. survey from 1999 showed that 51,9% of the respondents had less than 25% of their patient information in a computerized format. The majority of those who had implemented an EMR system also maintained dual records (both paper and EMR) [12]. Also, the gains intended to follow EMR implementations are not so clear as perceived, and Likourezos et.al [13] which assessed physicians and nurses satisfaction with an Emergency Department EMR, said that although most respondents were positive to EMR in general, the clinicians perceived the EMR to currently have minimal impact upon patient care.

In Europe the overall situation is not much different than in the United States. The EMR is portrayed to lead to marvelous benefits, but the diffusion of EMR-systems is still low in several countries. For instance had only 3% of the trusts in England met the goal to have electronic patient records in place in 2002 [14]. In regard to EMR-system diffusion, the Scandinavian countries stand out[15]. According to a 2005 report of the Danish "EHR observatory" [15], 28% of Danish hospital beds were covered by an EMR-system and they found it probable that a critical level of EMR-system diffusion were soon reached in Denmark. According to the same report, EMR-systems were generally used within the Swedish hospital sector with about 60% of the clinical documentation within hospitals being electronic. Among GP's, about 95% of the clinical documentation were said to be in an electronic format.

[15] But there is still a struggle to achieve the intended benefits also in Scandinavia.

Like the other Scandinavian countries the degree of EMR diffusion is high in Norway. More than 90% of primary care physicians and all but one somatic hospital in Norway have implemented an EMR system. Furthermore, an increasing proportion of lab reports, referral and medical discharge letters are exchanged via the National health care network. Still, studies have reported limited utilization of available functionality among health care professionals also in Norway. In 2001 Lærum et.al [16] conducted the first evaluation of EMR system use among hospital-physicians in Norway. 227 physicians from 32 hospital units in 19 hospitals participated in the questionnaire study[16]. The survey was based on 23 clinical tasks commonly performed by hospital-physicians, and while most tasks listed in the questionnaire (15/23) were generally covered with implemented functionality in the EMR systems, the systems were used regularly only for 2-7 of the tasks mainly associated with reading patient data. Thus, the article concluded that physicians used the EMR systems for far fewer tasks than the systems supported.

Of those involved in the study mentioned above, all had a paper equivalent of the EMR available thus having the opportunity to choose which medium to use. In 2001 Aust Agder hospital Arendal, as the first hospital in Norway, scanned and eliminated their paper based medical records leaving the users with no option but to use the EMR-system for at least some tasks. To evaluate the promises of scanning, Lærum et.al [17, 18] conducted in 2002 a survey among physicians, nurses and medical secretaries at Aust Agder hospital Arendal, using a modified version of the questionnaire used in the 2001 national survey. Results showed that the physicians routinely used the system for nine of 11 tasks regarding retrieval of patient data, which the majority of the physicians found more easily performed than before[17] [18]. However, for tasks regarding data input and more interaction with the system the usage was still low. The same tendency applied for nurses, while medical secretaries reported both high usage and high satisfaction with the system [17]. Physicians and nurses also reported low user-satisfaction with the features of the EMR relating to the use of the scanned document images, and it was recommended that the images should be considered as an

[16] More about the method used in chapter 6.1
[17] They had previously only the paper based medical record available

intermediate step towards fully electronic medical records. Still, the results showed a greater degree of use than in comparable hospitals that used the paper medical record in parallel, and demonstrated that eliminating the paper based record was feasible.

3.4 Why the apparent lack of EMR use?

As described in the above section, success stories about EMR introduction at hospitals are still rare both nationally and internationally. This despite the fact that primary care physicians have used EMR systems for decades[18] and report this as being an invaluable part of their daily practice [19]. At the same time there are some differences between primary care and hospitals, for instance in regard to incentives [20] and scalability [21]. Still, the success in primary care should at least demonstrate that there in principle should be no deep conflict between performing medical work and using information and communication technology. Why then are the systems utilized in such limited degree at hospitals? This section will present some factors mentioned in the literature thought to affect EMR use before a theoretical view is presented in chapter 4.

3.4.1 Computer literacy and availability of computers

Computer literacy and availability of computers is often mentioned as a prerequisite for system usage, and Lærum et.al [16] mentioned this as a possible reason for the low level of use amongst physicians. However, their survey also indicated that most physicians had good access to computers and had at least basic computer skills. Still, they said that it could not be ruled out as a possible reason. Several other studies have also included computer skills as a factor when trying to assess EMR use. However the strength of the relationship, or if there is found a relationship at all between computer literacy and use of EMR systems, vary.

Van der Meijden et.al [22] reported that satisfaction appeared to be related to self-rated computer experience where inexperienced computer users tended to be more positive about the paper records. Similarly, Dansky et.al [23] found that computer experience, computer anxiety, and perception of organizational support predicted the degree to

[18] At least in Norway. In some other countries, for instance in the U.S., use of EMR systems are not common among primary care physicians either.

which physicians and mid-level practitioners viewed the EMR effort positively. As for nurses, Ammenwerth et.al [24] found indications that the previous amount of self-confidence when using computers influenced the acceptance of a new computer based documentation system. In contrast, Likourezos et.al [13] was in line with Lærum et.al unable to correlate computer background and experience with EMR user-satisfaction both for physicians and nurses. So from a pragmatic point of view, computer skills seem to be at best a necessary but not sufficient factor for EMR use, and that computers have to be available goes without saying. Also, as Davis argues, usage might be more related to perceived usefulness than perceived change of ease[19] [25]. Still, basic computer skills might be necessary to realize the usefulness.

3.4.2 The flexibility of the paper based record

Another factor mentioned by Lærum et.al. [16] was the flexibility of the paper based medical record. The paper based medical record existed in parallel with the EMR at most Norwegian hospitals at the time of their study, and health personnel could choose which medium to use[20]. Paper based medical records also have some advantages compared to EMR's. There is for instance faster to read text on paper than on a screen, the paper is easier to carry around etc. Partly because of this, Elberg [26] raises a question about whether today's EMR systems are too similar to the paper based records, the focus being on automating existing practices rather than innovations in the way things are done. This is also reflected in other studies, where EMR's are described as good for information extracting but no so well for entering information. Partly because of the narrative way of medical documenting [16, 22, 27, 28].

3.4.3 Traditional work routines

Linked to the above section, EMR systems based upon the previous paper based record, a debate about the future role of traditional work routines arises. According to Lærum et.al [16] their results coincided with the traditional division of work at hospitals. That is, reading associated with physicians, writing by medical secretaries and mediating of requests by nurses. Further they said that none of the EMR systems in the study had

[19] Or that ease of use operates through usefulness
[20] A description of the trend to become paperless is described in section 3.6

stimulated to establish new and better ways of working, but rather reinforced previous routines. A possible reason being the document based way of structuring the EMR as suggested by Ellingsen [29]. One of the reasons for establishing EMR systems with close proximity to the paper based record might have been an idea that a familiar structure would make the systems easier to use and in that way accelerate adoption [9]. However, data[21] suggest that this approach highlights the advantages of the paper record more than the advantages of a computerized record, and Lærum et.al takes this as a sign that a well functioning EMR system can not be achieved by technology alone but have to be seen in conjunction with organizational aspects.

3.4.4 The introduction processes

Whether new technology is based on traditional routines or not can be seen in relation to the introduction processes, and it can be argued that there for years has been an underlying hope that technology alone can improve work practices[22]. During the latter years this has changed somewhat, and as described in chapter 2.3 organizational factors have received larger attention lately. However, organizational development should not be something that has to be done after the technology is introduced, and as Berg [27, 30, 31] argues technological and organizational factors have to be seen as interrelated. Berg also warns about focusing too strongly on so called critical success- or failure factors in the introduction of information systems. Insights can be valuable, but organizations are unique and solutions have to be adapted to the local context. It might also be argued that the learning processes underlying these factors might be just as important as the factors themselves. Other factors mentioned as important in this stage are for instance involvement, communication throughout the organizations, and generally create an understanding of why the introduction is necessary and giva an honest description of the likely consequences, both positive and negative [32, 33].

3.4.5 Management-clinician relationship

An area often portrayed to be challenging when attempting to make hospital-wide changes that affect both administrative and clinical functions, is the relationship

[21] For instance in article 3 of this thesis
[22] More about the introduction processes from a theoretical point of view in chapter 4

between managers and clinicians [34]. Glouberman and Mintzberg [35, 36] describes the “world” of healthcare to consist of four different worlds, or four mindsets. That is cure, represented by physicians, care represented by nurses, control by administrators and community by trustees. Clinicians and managers are according to this framework separated both horizontally by clinical work and vertically by the degree of connection to the institution. In line with this framework physicians can be described as more committed to their specialized and professional skills than to the organization, whereas administrators have a higher degree of loyalty to the organization and the running of the hospital. This “split” has also been mentioned in relation to EMR introductions as some physicians regard EMR as more of an administrative control system than a tool for clinical work. This might also be one of the reasons why clinical department systems often have been more successful than large hospital-wide systems [37]. However, this “split” does not necessarily have to be ‘real’, something that will be treated theoretically in chapter 4 and also empirically in article 3 of this thesis, which outlines close administration-clinical collaboration as one of the most important factors for a successful implementation, in line with for instance Ash et al [11].

3.4.6 Change readiness

Introduction of EMR systems are as previously mentioned thought to improve both the quality and efficiency of health care delivery, which in turn implies a change of the way things are performed. Changes are not necessarily easy to achieve in any sector and in the health care sector with the potential life and death situations, changes might be particularly hard to achieve. Organizational culture is often mentioned in relation to change and is said to govern the organizations member’s perception of daily events and what meaning these events hold. Edgar Schein [38] defines culture as “... a pattern of basic Assumptions - invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration - that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems.” (p. 9). The culture is, in other words, the glue that holds the organization together and separates it from its environment.

The role of organizational culture has also started to receive attention in relation to health care management, and in a review of literature about culture and health care performance Scott et.al [39] found that four of ten studies claimed to have uncovered supportive evidence that culture and performance were linked. The other studies failed to find a link, though none provided strong evidence against the hypothesis. Further, Studier [40] who performed a literature study about organizational factors and EMR introductions, found that organizations with a culture of change and that value innovations may have greater likelihood of effectively implementing an EMR system. This is similar to Ingersoll et al [41] who suggests that when change is seen as a positive characteristic of the environment, employees are more likely to commit to the work of the institution. They suggested further that organizational readiness might be a more important indicator of the potential for redesign success than the environmental variables more commonly considered.

3.5 Holistic view

Technology per se has been largely ignored in the sections above. This is a deliberate choice, as it is a basic assumption that the technology must work. However, whether the technology works as intended or support the activities it is supposed to do is another matter and is largely dependent on other factor than the technology itself. Which factors that are most important or the relative weighting of the factors are however largely unpredictable and might vary from context to context as suggested above. Thus it is regarded as important that a holistic view toward EMR introductions is taken not seeing technology in isolation. This is further elaborated from a theoretical perspective in chapter 4, and also an important point in several of the articles in this thesis.

3.6 Going paperless

As mentioned in chapter 2 the existence of parallel paper-based and electronic solutions has been regarded as a major barrier to extensive EMR usage. Having this in mind, several Norwegian hospitals have or are in the process of removing their paper based medical records from clinical workflow. Although the focus in this thesis is on the effects of removing the paper based medical record, it should be noted that there are several challenges also in the process before the paper is removed. The EMR should for

instance be approved as the legal record, and there are also strict demands regarding system availability and emergency procedures have to be established in case of system down-time. In short the hospital has to convince national government that their way of removing the paper-based record is safe in terms of information preservation and information availability. Also, they should alter routines to reflect paperless workflow and decide upon a scanning strategy. In 2004 the Norwegian Centre for Informatics in Health and Social Care (KITH) published a report presenting some issues worth taking into consideration when making the transfer from paper based to electronic archives [42]. In the report, five strategies for scanning was outlined:

1. **No scanning**. New paper documents are still stored in the paper based medical record, monitored by the EMR system. The degree of paper will decrease as more and more is done electronically.
2. **Scanning of new paper documents**. All new information in an electronic format. Paper based records available upon request.
3. **Parts of the paper based records scanned**. Only parts of the record deemed relevant for later treatment are scanned.
4. **Active records scanned.** Records are scanned when patients are admitted to the hospital, thereby avoiding scanning for patients which do not return.
5. **Total scanning**. All information in all records is scanned in the shortest time possible. However, this takes a lot of resources and might lead to problems finding relevant information at a later stage.

Of the hospitals involved in this thesis a combination of strategy 3 and 4 were most common. For further description of scanning strategies, please see the material and methods chapters in article 1 and 2 of this thesis and in the introductory section of article 3.

4 EMR in Norwegian hospitals: A theoretical perspective

The last two chapters presented an overview of the national strategies regarding health, ICT and change, as well as a more detailed discussion of EMR and scanning strategies. Having those factors in mind, this chapter will discuss EMR introduction from a more theoretical point of view.

4.1 Technology and change

Introduction of an EMR-system is as mentioned earlier both an introduction of a new system and, at least the intention, a change in health care delivery. The EMR can thus be regarded as a technology that through interaction with humans (according to the broad HIS definition in the last chapter both physicians, nurses, administrative personnel and other clinical and non clinical personnel) are supposed to help reaching quality and efficiency goals and generally contribute to provide health services in the best way possible.

The interplay of technology and people/organization is not something new and has been an area of interest for centuries, but in an increasing degree since the industrial revolution and in relation to information technology especially the last 30 years or so. To get a better sense of the relationship between information technology and workers/humans it can be worth while to start with a brief description of the role of workers in a production environment, with particular emphasis on the technology-human relationship. Going back almost a century the principles advocated by Friderick Winslow Taylor [43] dominated management thinking for a long time, and some of the ideas are still evident in practice today. The main focus in Taylorism was to find the most technically efficient way to organize workers to maximize overall efficiency. To achieve this Taylor raised five principles [43, 44]: Shift all responsibility of organization form worker to manager, use scientific methods to determine the most efficient way of doing work, select the best person to do the job designed, train the worker to do the job efficiently and monitor the worker to ensure that appropriate procedures are followed. Thus, an era was born where the ones performing the job was

separated from the ones deciding how the job should be done In short there was believed to be one optimal way of organizing technology and workers to maximize productivity. Technology was regarded as the dominant factor, and by designing correctly predictable outcomes could be achieved.

In the early 1950's alternatives to Taylorism started to get more and more attention. Especially the Tavistock Institute in Great Britain played an important role in emphasizing the importance of human factors, and Trist and Bamforths study of human factors in relation to coal getting can be regarded as one of the seminal works [45]. Greenwood and Levin [46] presents three major conceptual schemes that emerged around the Tavistock environment. The first is sociotechnical thinking, which is, building direct links between technology and work organization. Second, work design according to psychological job demands, and third, the idea of semiautonomous groups. Compared to earlier theories the role of the worker was now more emphasized and was no longer regarded mere as a mechanical part that could be easily manipulated. In addition to organizing more in accordance with psychological job demands, this also represented a departure from the cause-effect thinking because of the inherent uncertainty involved. The core principle in sociotechnical design, and the core principle of this thesis, is thus to make the adjustments between technology and organization at the same time seeing technological and organizational design as inseparable elements of the same web of relationships. Hence neither the technology nor the organization is longer seen as the primary decisive factor, and the importance of human interaction and diversity is highlighted.

A perspective focusing on human interaction that challenges the cause-effect thinking at its core is social constructionism [47]. Without rejecting the possibility of an external reality [48], social constructionism perceive everyday life and our perceived reality as socially constructed. Instead of people discovering more and more of a given world as in the positivistic position, a social constructivistic view perceives the world, as we know it, as constructed by the joint action of human beings. The key point in the last sentence is "as we know" it. It may very well be that there is an external or objective reality but there is no way we can say if we have uncovered it or not. This does not

mean that there can not be some descriptions that make more sense than others. For instance would few deny the existence of gravity (even though it is a man made term) and anyone hit by a moving truck will have a personal experience of momentum. The point is that the argument that "wins" is the argument that enough people use which subsequently becomes institutionalized into a fact and eventually regarded as real (closure in Pinch and Bijker's [49] terms). For natural phenomena this works well, but problems may start to arise when organizations, which is human by nature, becomes regarded as something objective and non negotiable.

As for technology it can also be considered as socially constructed as values, culture and skills in the design process are built into technological artifacts [50]. This stands in contrast to the mechanical view, where technology is the main factor and taken to the extreme end up in technology determinism. However, a social constructivistic position taken to the extreme can correspondingly be regarded as social determinism. Still, it can be argued that social construction can be interpreted to take both social and technological issues into account [51]. According to Pinch and Bijker [49] the social environment shapes the technical characteristics of an artifact, and with their emphasis on social shaping they deny technological determinism. In line with Pinch and Bijker Levin [50] argues that technology is socially constructed, and as technology is implemented it is also an organizational development process. Hence it is fruitless to think of technology transfer and organizational development as two separate processes, and instead the whole process should be seen as a social learning and development process. According to Levin technology has three faces; The material artifacts, how to use the artifacts to reach desired goals, and the knowledge of how to utilize it. Based on this it is evident that technology is linked to human activity,and based on Levins argumentation, development of technology is a social process in which the resulting technology cannot be separated from the actors engaged in shaping it. However, as Adler and Winograd [52] argue, all too often new technologies are introduced into the workplace without sufficient planning for their implication for the workforce. They argue that new technologies will be more effective when designed to augment rather than to replace the skills of users, the key challenge being to take advantage of users skills in creating the most effective and productive working environment.

4.2 Technology and change within health informatics

As pointed out in the last section there has during the last century been a gradual acknowledgment of the importance of human factors and how both technology and organizations can be seen as socially constructed mutually influencing each other. This is relevant for health informatics and EMR introductions as well. Development and introduction of an EMR system will involve organizational changes which should be taken into account. According to Lorenzi and Riley [53] it was in a working conference in the IMIA 1993 that people and organizational aspects formally and broadly was introduced in the area of medical informatics. The book "Organizational aspects of health informatics" [54] was the concrete outcome of the initial work in the working groups, and the groups decided to undertake a four phase strategy to promote and address people and organizational issues in medical informatics [53] (p.122-123):

1. Build awareness of the importance of the topic of people and organizational aspects of medical informatics.
2. Educate people in research from other disciplines that is relevant for medical informatics.
3. Apply established methods and models from other disciplines to the medical informatics arena.
4. Develop new, discipline-specific research methods and models.

As for the first stage, Lorenzi and Riley's 1995 book [54] can be regarded a starting point of this promotion "campaign" of people and organizational issues in medical informatics. In line with the four phase strategy above Lorenzi and Riley base both the understanding of these issues and how to deal with them on established organization- and management theories. In general, management trends the last decades such as total quality management (TQM), business process re-engineering (BPR) and recent ideas of complexity theory, all seem to have found their way into the discourse around health organizations [55-57]. Like TQM, BPR is a management trend that promises dramatic improvements in performance. However, there are reports of high failure rates (60-67%) among TQM projects, and as Arndt and Bigelow's [55] review of health care literature on reengineering shows, little evidence exists to support the optimistic claims of the

BPR movement. As for TQM, failure to reach the promised goals in BPR project is often attributed to management and their failure to properly implement the plan. So, should health organizations adapt practices from the industry? Arndt and Bigelow [55, 58] urge hospital executives to be cautious about applying principles from the private industry directly to hospitals. The underlying assumptions may not fit and hospitals are in many regards different from the private industry. Hospitals cannot for instance add or delete services with the same freedom as most firms in private industry. However, since hospitals are often portrayed as inefficient compared to firms in the private sector, they may improve their image by claiming to be engaged in practices that are associated with efficiency and service improvements in the private industry [55]. Along with their lofty promises, this may be one reason why practices like TQM and BPR have been adopted in health care management.

Resuming Lorenzi and Riley [54] they provide a general introduction to different aspects of people and organizational issues, based on a combination of evolutionary learning organization theory and more traditional rational analytical planning approaches. Still, they point out some interesting reasons to why people and organizational issues have not received the attention they should have (p.13-15): These issues have not got the visibility as technological issues, measurability is also more difficult, humans are more difficult to predict than technology, accountability is more difficult and respectability of dealing with the softer sciences is lower. Timeliness, together with these other factors, makes the effort of dealing with people and organizational issues dwindle and leave the technological efforts in charge. The last point illustrates the fundamental problem, that is, when faced by the actual resource constraints, such as time, money and people, one often ends up focusing on technology. Visibility would be desirable and possible to address, bringing people and organizational issues onto the agenda. Following this the question of how to handle these issues arises.

In Lorenzi et. al. [59] and Lorenzi and Riley [53, 60] they continue to emphasize the same point, which is promoting people and organizational issues and the importance of bringing in other disciplines in addition to the already mentioned discipline of

organization and management. Because, they argue, the people and organizational issues area are a blend of many disciplines and bringing in the rich body of research that exists in these disciplines will strengthen the potential of addressing the human issues appropriately. This corresponds to phase two and three in the strategy presented above. Kaplan et. al. [61] also argue for the importance of bringing in the disciplines of psychology, social psychology, sociology and cultural anthropology for establishing a research agenda for medical informatics focusing on people, organizational and social issues. Thus, it may appear as phase three of the strategy above is reached (as of 2003), but that at the same time phase one is not terminated.

Southon et. al. [62] argue that there *is* an increasing awareness that there are people and organizational factors to be considered, possibly more complex than the already incorporated training and user-requirement issues. These, they claim, have expanded a former narrow technology focus. The same authors suggested two years earlier that there was a need for such awareness, thus indicating that there have been some progresses to the target of phase one. Still, they argue that the dramatic benefits that informatics promises: "… is being severely compromised by our inability to adequately address the problems that organizations present to the development of information systems" ([62], p.44).

To sum up so far, contributors in the discourse of medical informatics are more aware of people and organizational issues, as also described in chapter 2. In addition there are several voices emphasizing the need of bringing in other disciplines on the way of developing a distinctive research agenda inside medical informatics. Still, this is not an easy and predictable path, and following the message of start dealing with the people and organizational issues, is the discussion of how to deal with them. It is easy to try to reduce these issues to what they are not, that is, simple and predictable.

4.3 The inherent unpredictability in change projects

Attacking the volatility and unpredictability by measuring and predicting could be counterproductive when addressing how to deal with the people and organizational issues. Atchison [63] argues that we must learn to measure and manage the intangibles

with the same rigor and intensity that we currently use with the tangibles. Despite the good intention this might be self-contradictory. As to unpredictability, Aarts et. al. ([64], p. 214) looking at people-related practical implementation problems argue: "… it would be too simplistic to say that a checklist with critical success and failure factors could have prevented the problems". Further, Berg [31] points out the danger of focusing on critical success- or failure factors in the implementation of a patient care information system (PCIS) as a recipe towards success, and as such addresses the potential counterproductivity in a struggle for making people and organizational issues predictable. He emphasizes the fundamental unpredictability in such change projects, due to the inherent complexity in a mutual relationship between the organization and technology where both transform each other. User-involvement is an easy slogan, he argues, but still an essential part of a project. The danger then is in the belief that a focus on critical success factors, as a part of a plan based on assumptions and intentions of control and prediction, will solve the people and organizational issues and ensure success. Rather he suggests: "The uncertainty and unpredictability of PCIS implementation processes is an *inherent* characteristic of such processes, which should be accepted and even nurtured rather than 'overcome'"([31], p.150). His cautions about critical success factors clearly show a stand opposite general and prescriptive ambitions and solutions. Still, this does not necessarily mean that he gives up the ambition of coming to insights that may be useful in general. But this together with a predictable and prescriptive aim is what he warns about.

Further, Timmermans and Berg [51] argue like the sociotechnical perspective outlined earlier for a mutual relationship between technology and organization where both influence and transform each other. Heath et. al.[65] argue that it is now realized that technology is understood and used in practical everyday interaction, still there is a need from moving beyond just realizing that social interaction is important. In the same way, Timmermans and Berg argue that it has been common to employ a socially oriented perspective to warn against high expectations for technology in health care, but that it is now time to turn focus on how to exert influence in the process of the technology creation and implementation.

It is natural, based on the critical role the medical record serves in a hospital, that technological factors are treated with utmost care. However, perceiving both technology and organization as socially constructed jointly influencing each other does not mean inferior technological solutions. Rather, involving the users from the beginning before the technology is "black boxed", or when the organizational practice is institutionalized into the technology [66], leads to a better fit to the community of practice and thereby better solutions which again are easier adopted by the practitioners. Still, this is yet only to a limited degree the case in Norwegian hospitals. As Brown and Dugid says [67] the ways people actually work usually differ fundamentally from the ways organizations describe that in manuals, job descriptions and so on. Still, organizations tend to rely on the latter in their attempts to understand and improve work practice.

4.4 The management-clinician relationship

One reason why the formal, "objective realities", form the basis for change might be found in one of the factors that characterize hospitals and contribute to their complexity; the dual leadership. Hospitals can a bit simplified be considered to consist of two groups; the clinicians and the administration (at least in terms of leadership). Though dependent of each other these two groups are often portrayed to be in a conflict relation [34] and thus reinforce the focus on technological factors. Or, in other words, due to the established agreement underlying established formal work practice (truce in Nelson and Winters words [68]), the focus of change becomes the technology, which can easier be changed without threatening the underlying routines. Thus the view from the administrations part, sometimes legitimate, that clinicians are unwilling to change their work practice, have led to a technically dominant approach based on existing work practice. The thought being that clinicians will change their routines and adopt to the system once it is installed. Drawing on Nelson and Winter [68] the existing routines can be described as a socially constructed truce between the various stakeholders. Thus, adoptions that appear "obvious" and "easy" to an external observer may be foreclosed because they involve a threat to internal political equilibrium. So as Nelson and Winter says (p135): "Firms may be expected to behave in the future in ways that resemble the behavior that would be produced if they simply followed their routines of the past". In the case of EMR this tendency seem to be reinforced by technology supporting work

routines similar to past ones even though a change of routines is desired. According to Nelson and Winter linked routines is what make up an organization. However, these routines may not necessarily be found in an organizational blueprint because of their largely tacit and emergent nature. Instead, it is argued in line with Nelson and Winter [68] and Levin [50] that an organization will result from the actual social interaction among members and meanings constructed through this process.

This calls for close cooperation between clinical and administrative personnel before, during and after the EMR introduction (which is more than coordination as further outlined in article 4 of this thesis). However, the traditional working relationship between these two groups might limit the potential (at least at larger hospitals with less personal relationships). Partly explaining this may be the notion of power. Early thinkers such as for instance Hobbes perceived power as something held by people, a given quantitative capacity [69, 70]. Like a mechanical view of organization, this involved a sense of determinism and the outcome of any conflict could in principle be predicted once the distribution of power was known. According to Hindess this view of power, as a quantitative and mechanical phenomenon which determines the capacity of actors to realize their will or to secure their interests, has been enormously influential in the modern period. Moving on to Lukes as described by [69, 70] there are three dimensions of power where the description outlined above belongs to the first dimension. A bit simplified, the second dimension can be described as non-decision making or setting the agenda where one group prevents certain interests from be raised. The third dimension is similar to the second, but here the “victims” fail to realize the exercise of power.

This second dimension of power is at the outset quite similar to the situation between administrators and clinicians. The main purpose of hospitals is to treat patients, and clinicians perform the actual treatment while administrators are supposed to support or control this treatment. However, by their unique medical knowledge, clinicians can prevent certain issues to be raised by referring to medical excellence. So, even though the cases are not always covert, clinicians can from a traditional view to a large degree

decide the agenda. And from a classical quantitative point of view and following Lukes second and third dimension, they therefore have a large degree of power

This thesis will not delve into a detailed investigation about power at hospitals, which would be a large undertaking in itself. However, in line with the discussion above it is argued for a social view of power as well as for organization and technology. Inspired by social constructionism [47] it is argued that power both is and does what people believe it does. In the same way that we cannot say for certain what power really is, we cannot say for certain what persons real interests are and it is argued that they cannot say themselves either. Consequently it is argued that the strong position clinicians have in hospitals today, as well as the conflict relation between administrators and clinicians in regard to certain issues, is socially constructed and reinforced by institutiolizing new personnel into this order. Both administrators and clinicians have a common goal of treating people and have different roles in this process. However, it is argued here that the differences between these two groups over time have been reinforced such that they perceive one another as homogenous groups rather than individuals with different interests. Similarly, one perceives the other group as not understanding the importance of certain factors, thereby leaving the viewpoints of the other groups largely unaddressed when trying to change the organization or simply base new solutions upon established or agreed upon practices.

So from a social constructivist position, and in line with Focault (based on Hindess [70]), what is interesting is the role of power. While a conception of power as a quantitative capacity has an inability to allow for the indeterminacy of conflict, a different conception where power is present in everyday interaction and differentiated according to the particular circumstances [70], fits better in a unpredictable world, as described by Czarniawska and Joerges [71] and also outlined above. Here, power is seen as a “matter of the instruments, techniques and procedures employed in the attempt to influence the actions of those who have a choice about how they might behave. The exercise of power always involves costs, and its outcome will often be far from certain” (Hindess [70], p. 141). This perspective of power also moves away from the processes of rationalization and the ideal of the person as an autonomous individual, as seen in

traditional notions of power and also in traditional approaches to introduction of technology. So instead of focusing on a universal rationality people should conform to, Foucault focus on the emergence of particular rationalities which do not have to be rational in the traditional sense. Thus the focus of analysis is on local and contingent aspects not so much universal solutions [70]. Also, it emphasizes relationships between individual actors rather than power as something held by a group suggesting dialog rather than avoidance.

4.5 Theoretical implications for the studies

Section 4.1 to 4.4 have briefly described the theoretical development regarding technology and change, with particular focus on health informatics and health organizations. The theoretical foundation in those sections influences both the focus of study and level of analysis in the studies. This section will briefly describe how the theoretical foundation influence the studies..

4.5.1 The challenge of multidisciplinary research

The topic of this thesis crosses multiple disciplines of research. The three most obvious fields are organization- and management, informatics and medicine as illustrated in Figure 1. These different areas have to some degree different traditions of research and there are also several strands of development within the different areas. An extra complicating factor is that while my background and point of departure is organizational theory, the main audience for this thesis is professionals at Norwegian hospitals and to some degree EMR vendors (illustrated in Figure 1).

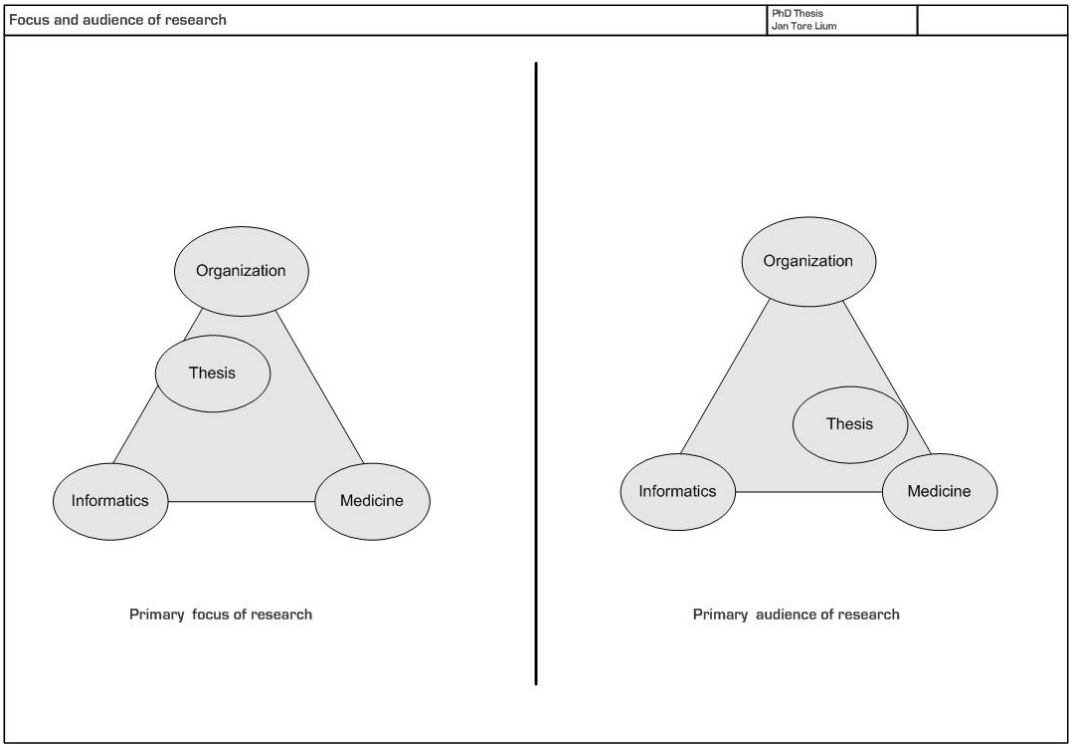

Figure 1: Focus and audience of thesis

While in line with the four phase strategy outlined in section 4.2 it is argued that bringing in instruments from various strands of research is valuable, it also presents some challenges. For instance has it been difficult to introduce ideas from social constructionism and explain the inherent unpredictability of change to medical professionals, who are used to for instance randomized controlled trials and evidence based medicine[23].

The multidisciplinary nature of this thesis, in combination with a desire to do something of practical usefulness and reach a broad audience, has led to downplaying the detailed theoretical discussions in the articles and instead focus on the empirical data. Both to be able to submit articles in journals with primary medical audience, and to continue the promotion of what I believe is important organizational factors towards Norwegian hospitals. There is thus also a political edge to this thesis, i.e, to promote organizational awareness and the importance of human relating to the (at least previously)

[23] This does not imply any critique of randomized controlled trials or evidence based medicine per se, which I am a strong believer of. However it is not necessarily the right approach for organizational research.

technologically dominated field of EMR introductions. Sill the analyses, and not the least the conclusions drawn from the analyses, are heavily influenced by the theoretical foundation.

4.5.2 Levels of analysis

As described earlier explanations of specific EMR implementations should be tied to the local context. Even though some factors are regard as important across settings their relative importance varies and cannot be determined for certain, which is neither regarded as a goal nor something it should be strived for. Thus the processes behind the factors are regarded as more important than factors per se. However, regardless of the importance of local context, it is also argued that a more macro perspective can be valuable. It all depends on the goal of the investigations. The research questions posted in chapter 5 calls for both different methods (as described in chapter 6) and different levels of analysis as illustrated in Table 1 below.

	Articles	**Research question**
Multiple users from multiple departments	Article 2 and 4	Question 1 and 2
Multiple users from single department	Article 1 and 3	Question 1 and 2
Individual physicians	Article 3	Question 1,2 and 3

Table 1: Level of analysis

As seen above the thesis starts with a broad macro view of the EMR situation, describing use at multiple locations and discussing for instance how the "before situation" and "degree of change" affects the outcome. It then moves downwards describing how the typical factors mentioned in chapter three affects the development at single departments (the local context), before individual physicians' are the unit of study for more detailed study of the role of EMRs etc. Thus, explanations/descriptions are sought and discussed at the local context, general remarks extrapolated and discussed at the macro level.

4.5.3 Focus of research

The primary focus in this thesis is the end-users of EMR systems. EMR-systems can be implemented and be regarded as successful from a range of factors, but from this thesis point of view they are nonetheless not successful if not the end users are satisfied with

and uses the systems. Thus the introductions are evaluated in regard to how well they support the daily tasks of medical personnel. Hence both social and technical aspects are in focus, but most of all, the interaction between technical and social. That is, technology at work. Despite the end-user focus, hospitals can be viewed as a large web of relationships between various people from different groups and end users can thus not be seen in isolation. The relations between end users, particularly physicians and the rest of the hospital organization, especially the EMR project groups, are in focus. As described above, the analyses have both individual user, single- and multi department focus[24], representing different aspects of the EMR situation in Norway.

4.5.3.1 Individual

For the individual physicians the role of EMR and the part EMR plays in everyday work plays particular importance. Hence how EMR are institutionalized as part of everyday medical practice. Further there is a focus on validating if the traditional factors mentioned in chapter 3.4 also apply for hospitals, or if more domain specific methods have to be developed. However, due to the inherent unpredictability of change projects, there is no ambition of establishing cause effect relationships between factors developing a predictable roadmap for success. Further there is a focus on how the involvement in the introduction processes influence use and attitudes, and also how informal relations between various physicians influence use and attitudes.

4.5.3.2 Hospital/department

At the department level there is particular focus on the introduction processes and the involvement between project staff and medical personnel. The perceived usefulness of EMR system and the attitude towards the systems has also been investigated, as well as the learning processes involved. Further, how force or mandatory functionality influence attitude is studied, as well as how routine change in conjunction with EMR introduction influences the result. Last, how informal relations across organizational borders influence the process is of importance.

[24] Note, some researchers perceive the individual and the plural to be two aspects of the same. The distinction made here is merely a practical division for study.

4.5.3.3 Multiple hospitals/departments: EMR and scanning in general

At the general level trends regarding use of EMR and effects of scanning will be investigated. Still, local context and variations are emphasised. Thus the research should not be interpreted as an evaluation of particular EMR systems. Nor is there an ambition of finding statistical relations. Thus, the explanations of particular findings are sought at the local context, and only high level conclusions will be drawn at the macro level. Relations play an important role also at the general level, as well as diversity in the decision processes. Last, the role of EMR will be discussed based on the findings of the studies.

5 Research questions

In the above chapters research on the topic of EMR introductions and a theoretical baseline has been outlined. This thesis has mainly been inspired by studies which have demonstrated a lack of use of available EMR-system functionality among health personnel, but nonetheless showed that removing the paper based medical record from clinical workflow is feasible. The importance of organizational issues and the mutual relationship between technology and organization has also been an underlying theme throughout the work. Based on this, three main questions were outlined:

1. Why is the functionality offered by the EMR systems not used?
2. What are the effects of removing the paper based medical records?
3. What can be done to increase usage and fulfill the promises of EMR systems?

The questions above (and illustrated in Figure 2) are relatively broad, and are further specified in the various articles in this thesis.

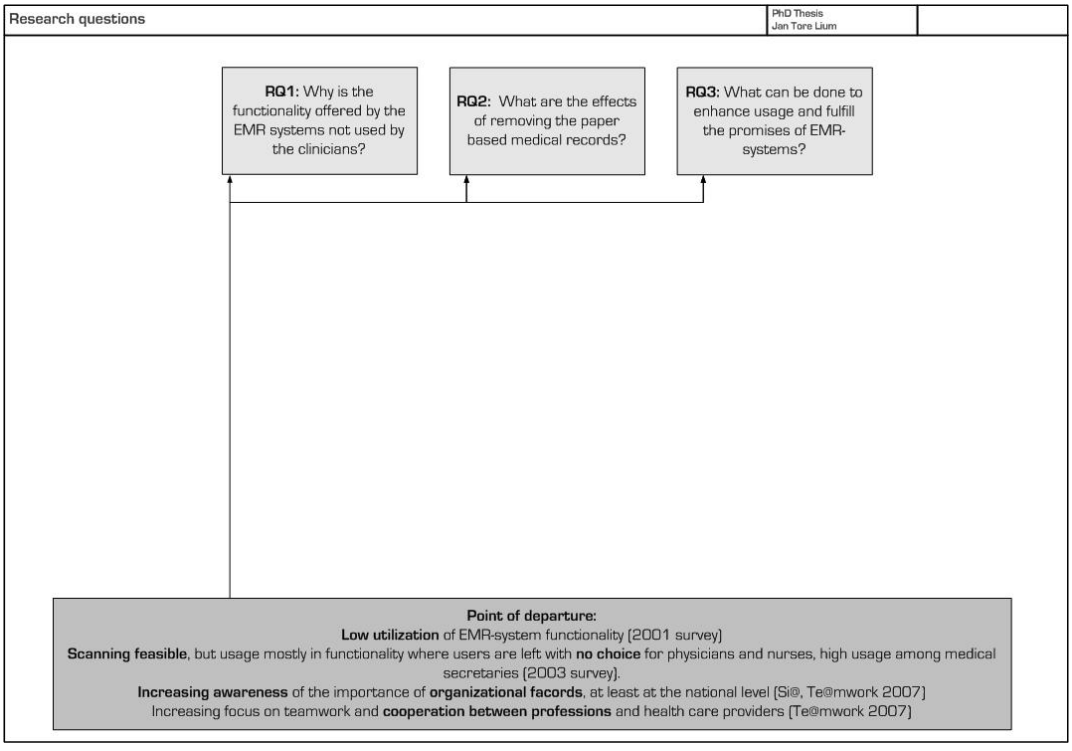

Figure 2: Main research questions

Four articles which focus on different areas related to the questions above are presented towards the end of this thesis:

- Article 1: From the Front Line, Report from a Near Paperless Hospital: Mixed Reception amongst Health Care Professionals.
- Article 2: Removal of paper-based health records from Norwegian hospitals: Effects on clinical workflow.
- Article 3: No paper, but the same routines: A qualitative exploration of experiences in two Norwegian hospitals deprived of the paper based medical record.
- Article 4: Barriers for interdisciplinary teamwork in hospitals: The myth of professional cultures.

5.1 Research question in article 1

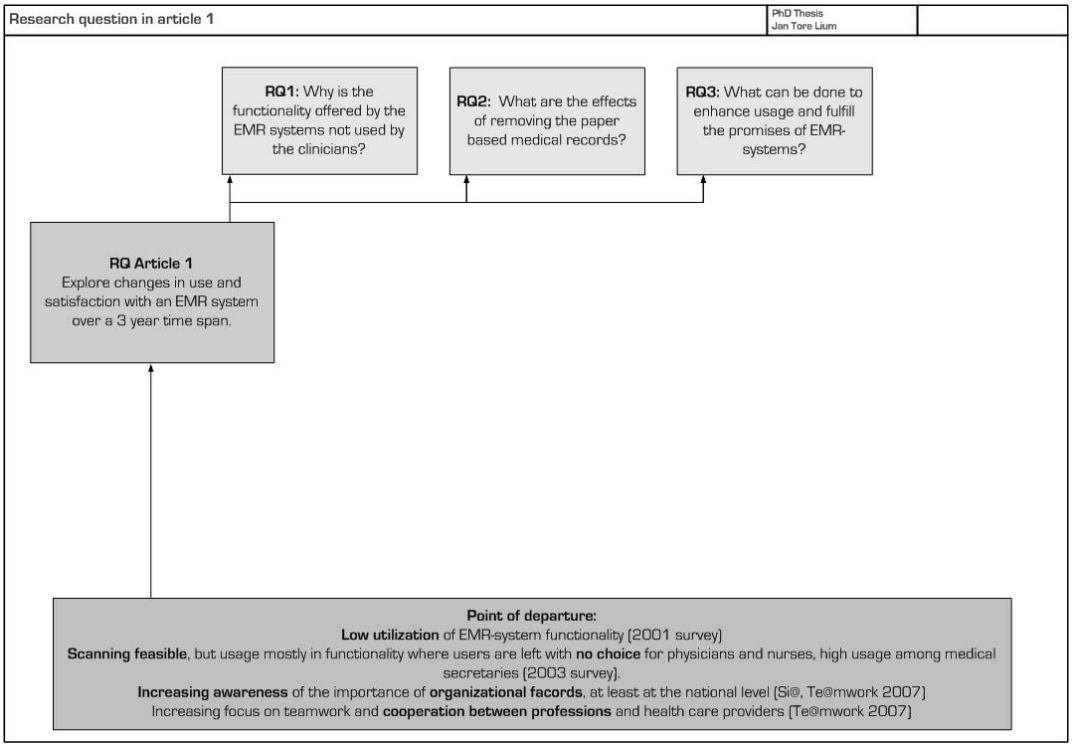

Figure 3: Research questions in article 1

In 2002 Lærum et.al conducted a survey at Aust Agder hospital Arendal, which was the first hospital in Norway to remove their paper based medical record from clinical workflow. However as mentioned in chapter 3.3, the higher degree of use compared to the control-group were mainly in tasks where the users had no choice but to use the paper based record. As mentioned in chapter 3.6, after Arendal showed it was possible to remove the paper based medical record several other Norwegian hospitals have embarked upon the path to become paperless, and the rest intend to do so. However, little research had been done about the effects of these changes. To expand this pool of knowledge the survey was repeated in the spring of 2005 to explore change in use and satisfaction in relation to the EMR. We were particularly interested in the changes among nurses and physicians, as they were the group with the lowest utilization in 2002. Also, we wanted to see whether the negative attitude towards scanned document images had diminished with the increase in routinely available electronic data.

5.2 Research question in article 2

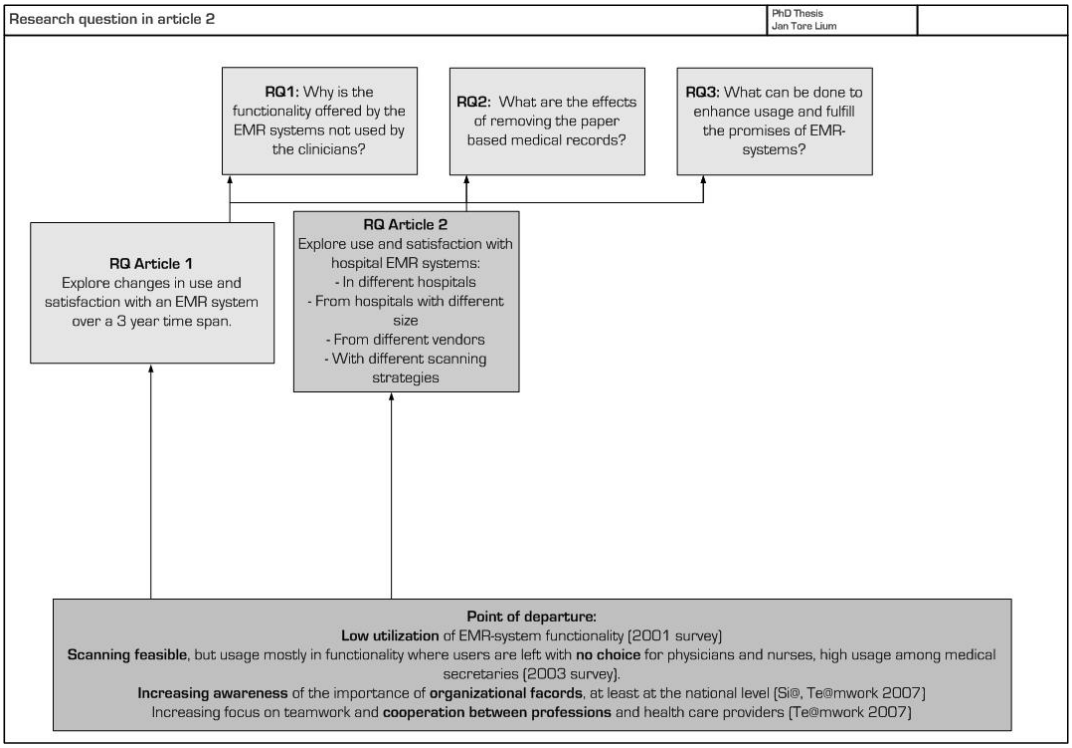

Figure 4: Research questions in article 2

After Arendal made the transition and removed their paper based medical record in 2001, several Norwegian hospitals have and many intend to in varying degree scan and stop updating or remove the paper based medical record from clinical workflow. The survey conducted at Arendal referred to above was therefore also conducted at departments from 5 other Norwegian working without the paper based medical record, representing hospitals of varying size and different EMR vendors. The effects of introducing an EMR system and removing the paper based medical record might depend on a range of factors such as the size of the hospital, nature of work at the department, functionality in the EMR system introduced and preparedness, ability and willingness of the hospital organization to adapt to the changes introduced. This conference paper presented some findings from this survey.

5.3 Research question in article 3

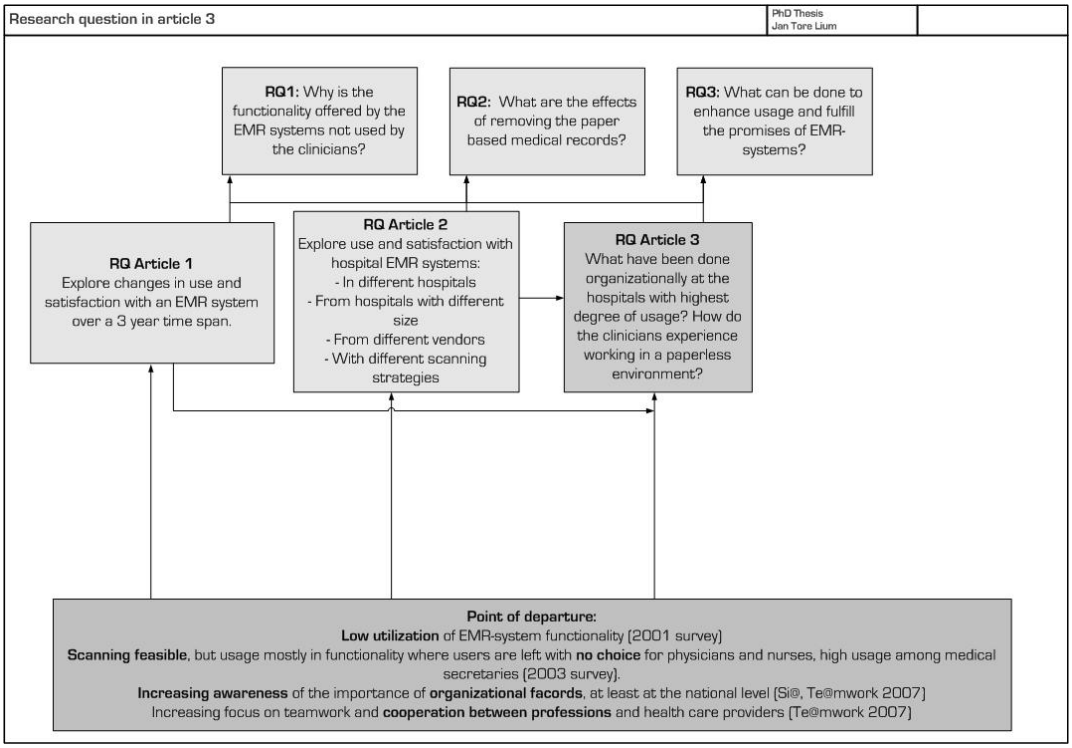

Figure 5: Research questions in article 3

This article was a follow up of the survey upon which article 1 and 2 were based. The survey revealed considerable differences between the various departments/hospitals. However, a few of the departments stood out. Respondents from these departments reported both broad and high use and a positive change of ease compared to the pre-EMR situation. In this article we wanted to learn more about what characterized the two hospitals with the highest reported use, and we conducted semi structured interviews with physicians to do so. Two main themes were of particular interest. 1: What had been done organizationally at the hospitals to achieve such high usage, and 2: How did the clinicians experience working in a paperless environment. To our knowledge this was the first qualitative study of clinicians working without the paper based medical record.

5.4 Research question in article 4

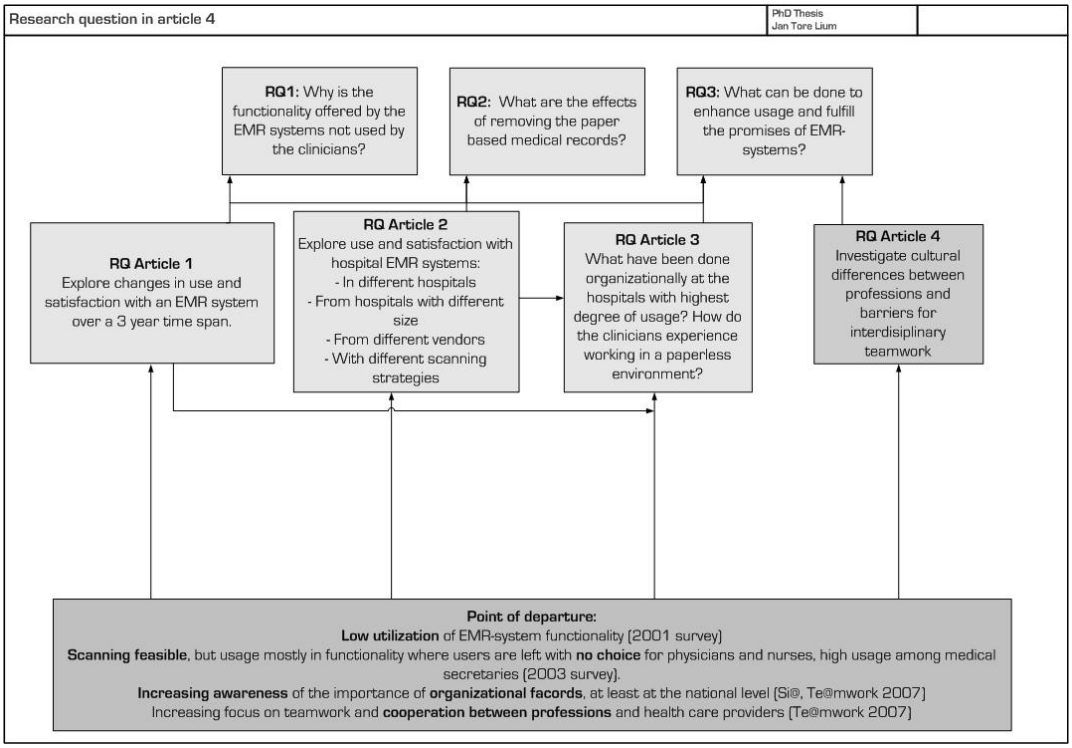

Figure 6: Research questions in article 4

In the previous three articles use of EMR systems had been explored. However, having and using an EMR system is, or at least should not, be a goal in itself. Rather it is supposed to help providing health services with higher quality in a more efficient manner. Another factor contributing to reach this goal is as outlined in the latest national action plan *teamwork*, both between institutions and between various professions, and the EMR system is often thought of as the hub of the cooperation. Still, some point out culture as a barrier to EMR implementations as for instance mentioned in chapter 3.4.6, and also to hinder interprofessional teamwork. The purpose of this article was to investigate cultural differences between professions in hospitals and discuss how these differences might influence the potential for effective interdisciplinary teamwork and change at hospitals.

6 Methods

The research questions posed in the last chapter calls for a range of methods. The methods used in the articles were a questionnaire survey and interviews. In addition an extensive literature review had been done as a foundation for the empirical studies, and a three week stay as a nursing assistant at a hospital department was carried out early in the process to experience first hand the area of research. However, no data from this stay was used in the articles and the ward itself is not part of any study conducted in this thesis. The following sections will briefly describe the methods involved in the various articles. For more details please refer to the specific papers.

6.1 Method in article 1 and 2

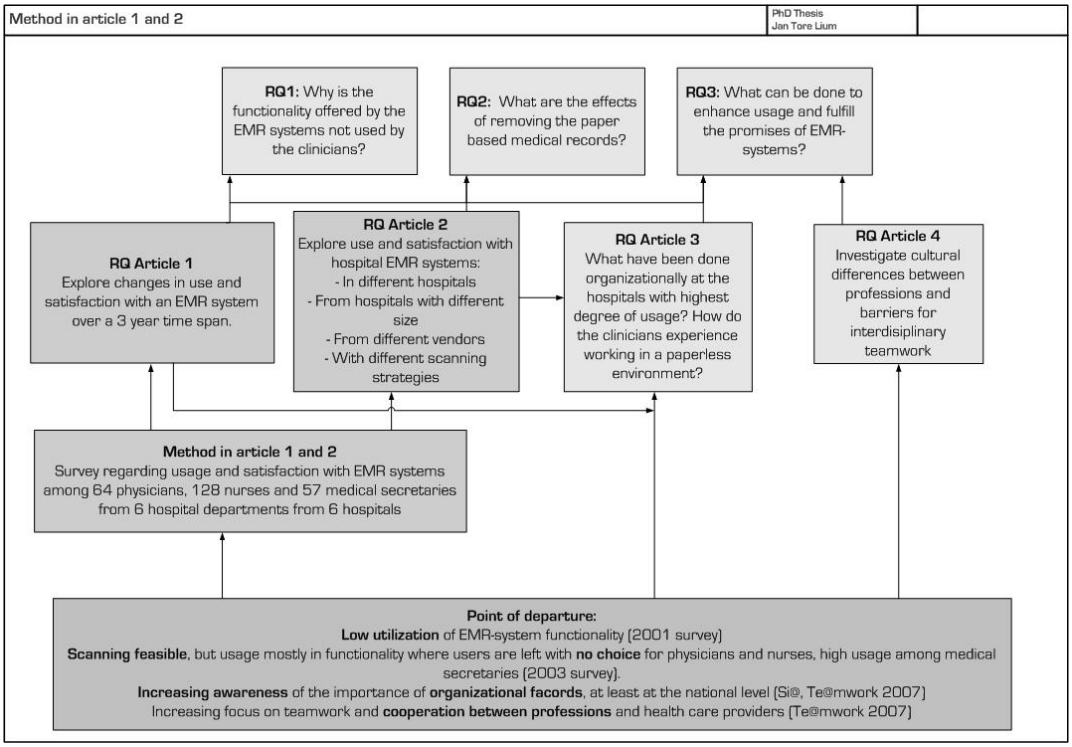

Figure 7: Method in article 1 and 2

The primary method in article 1 and 2 was a questionnaire[25] survey based upon the work of Lærum [7, 72] referred to several places above, particularly in chapter 3.3.

[25] Attached in appendix 1

Central to the questionnaire is a set of clinical tasks, attached in appendix 2. Not all hospitals had the same range of functionality available and a senior person from the various hospitals, usually the project manager for the EMR system in question, went through the list to see what was supported before the questionnaire was distributed. This was to avoid confusion amongst the respondents asking about non-existent functionality. Still, some confusion was reported, partly because some respondents were not aware of the full range of available functionality and partly because they were uncertain whether we were asking about a particular computer-system or system-independent functionality. Our view on this was made even clearer after we received the questionnaire from the first hospital, thereby largely avoiding confusion about the questionnaire at the rest of the departments.

6.2 Method in article 3

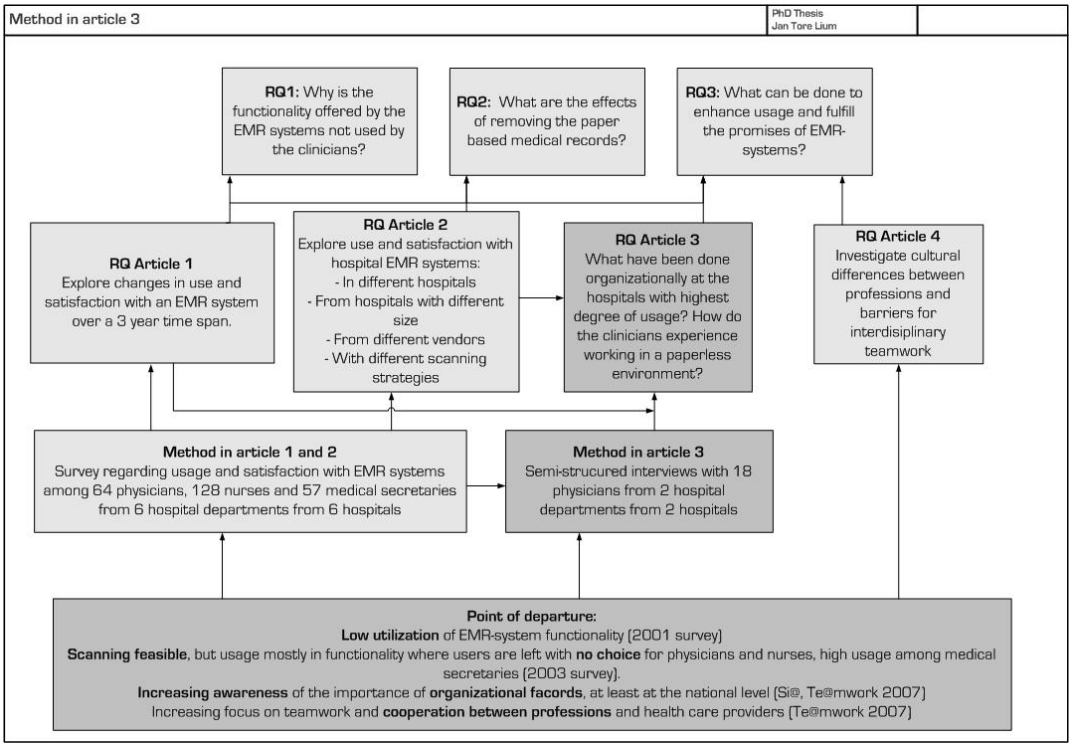

Figure 8: Method in article 3

Article 3 was based on interviews with 18 physicians from two departments at two hospitals in Norway deprived of the paper based medical record. As mentioned earlier

this was a qualitative follow up of the quantitative study in article 1 and 2. While a survey can say something about trends, use and satisfaction, it says less about why people are using/not using the system and so on. Thus by combining the two methods we got a deeper insight and could in a better way explain the results of the survey. The method is further described in the article, but it can be mentioned that it was semi structured based on the literature regarding EMR usage described in chapter 3.

6.3 Method in article 4

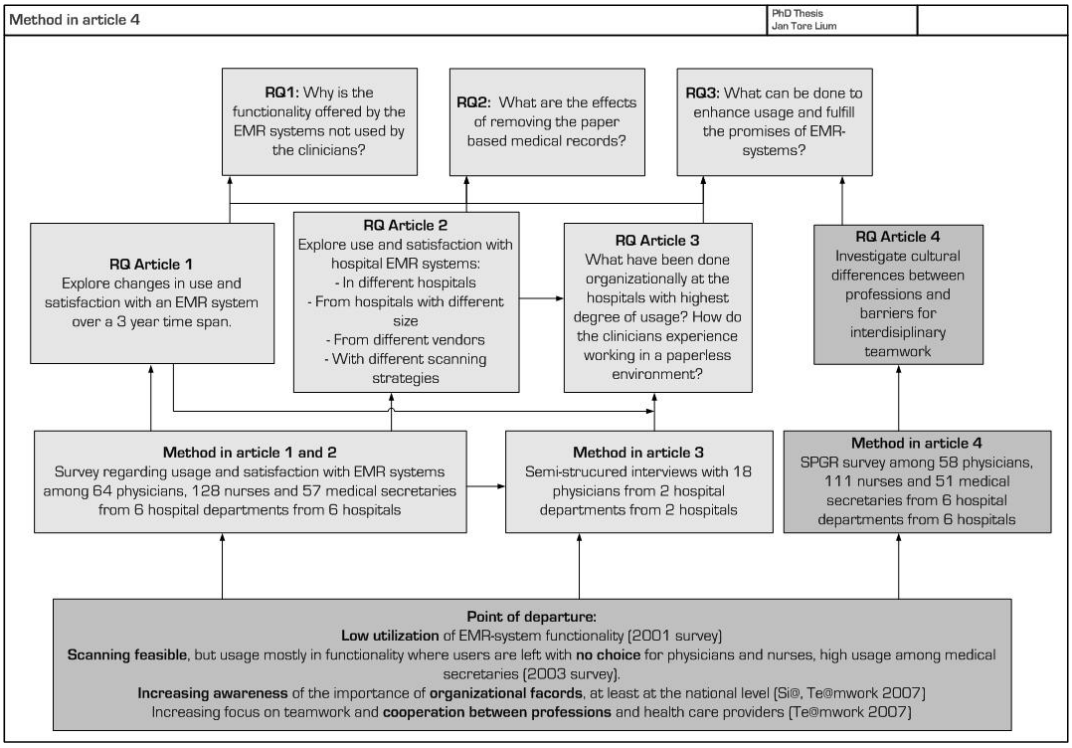

Figure 9: Method in article 4

In this article we based our discussion on the Systematizing Person-Group Relations (SPGR) measures. All SPGR measures are peer ratings that use the standardized SPGR behavior scale [73]. The SPGR instrument consists of a category system for observation of overt behavior in groups and several scales for self and peer ratings [73, 74]. This study was based on peer ratings using a 24-item scale where each item was rated according to whether the behaviors never or seldom occurred (1), sometimes (2), and often or always (3). The SPGR questionnaire was distributed together with the survey in

article 1 and 2, and was formatted accordingly to present a unified look and make it look like a single survey. It was also deliberately located last in the questionnaire, to avoid hampering the validity of the questions regarding EMR-system use and satisfaction.

6.4 Methodological reflection

Every method has its strengths and weaknesses, and every method can be misused if not applied or interpreted correctly. There have also been some methodological challenges during the work with this thesis, which have influenced the way conclusions have been drawn. As a guiding principle, and in line with the theoretical baseline, conclusions based on statistical relations has been underemphasized rather than put as an objective truth due to the "fact" that every influencing factor can not be put into account because of the inherent unpredictability and the nonlinearity of factors. This applies especially when it comes to comparing statistic data from the various hospitals, and the results have thus to a large degree been tied to the local context.

6.4.1 Reflection about the survey

The questionnaire used in article 1 and 2 had as mentioned been used in previous studies, and the questionnaire for physicians had also previously been validated. During the planning phase of article 1 and 2 it was considered to change the wording of some of the questions to make it less "time dependent". For instance to change "how has DIPS changed to performance of the following tasks in your department" to something like "how well does DIPS support you in performing the following tasks". Similarly are the questions regarding use of scanned document images dependent upon "when you expect", and can thus not be trusted to say for certain the amount of use of scanned document images versus regular electronic data. This is further elaborated in article 1. However it was decided to take these "shortcomings" into account when analyzing the data and thus be able to carefully compare with historical surveys with the same questionnaire, rather than change the questionnaire and loose this ability. A significant change of the questionnaire would also in theory require a new validation study. Thus the original questionnaire was maintained (except some changes regarding computer literacy), and as mentioned the local contexts and the "before situation" was brought in as important factors when interpreting the results.

Due to the methodological difficulties of comparing, the survey should not be used as a direct ranking of the different hospitals or as a ranking of EMR systems but as previously mentioned a starting point for more detailed exploration of possible reasons for use or not use. This is further supported by the fact that the hospitals involved in this study are deliberately chosen, and thereby not a randomized selection which would be necessary for a national study or some sort of ranking. Still, years of experience as well as previous surveys suggest that the results in this thesis give a fair picture of the EMR situation in Norway. A reflection about the transferability of the results is further elaborated in chapter 10.

6.4.2 Reflection about the interviews

The point of departure for the interview study was the two hospitals that stood out in regard to high reported use and satisfaction with the EMR system. The idea was to investigate what made these hospitals stand out. The interviews represent a good account of how physicians experience working without the paper based medical record at these hospitals, and illustrate for instance the importance of perceived usefulness in regard to EMR use. However, both hospitals/departments in study went straight from paper only to EMR only. Thus little can be said about the change for physicians going from parallel systems (EMR and paper record) to EMR-only. This was neither the intention of the study, but could be an important area to study for further EMR development.

The interview study was further as far as I know the first qualitative study of physicians working at a hospital that had removed the paper based medical records. Thus the study is rather broad in scope, which is argued to be important from a holistic point of view. Still, some findings warrant closer inspection as mentioned in the article, and the sample is too small to draw any definite general conclusions from the study.

6.4.3 Supplements to the ”formal methods”

The methods used in the articles were as mentioned several times a questionnaire study and interviews with physicians. These are valid methods for the research questions in the various articles, but rather limited for the high level descriptions in the thesis. Thus

for instance the relationship between clinicians and administrators etc. described in this text should only be interpreted as reflection from my part based on four years of studying hospital organizations. Still, the reflections are based on more than just the "formal methods". During the studies I have visited several hospitals and talked with "project personnel", personnel from the hospital administration, several physicians and nurses not formally interviewed, worked as a nurse assistant, joined EMR training sessions, joined EMR project meetings etc. In addition results and EMR development in general have been discussed with several different researchers with varying background including informatics, medicine, sociology, psychology, management etc. Thus the reflections and suggestions put forward in this thesis are heavily influenced by my general impression and discussions during the course of my work.

6.4.4 Alternative methods

This thesis has combined quantitative and qualitative methods, which is argued to be a sensible approach to study the posed research questions. However, alternative methods exist which can be especially valuable if one intends to follow up on this thesis. These include for instance participatory and non-participatory observation, more in depth interviews with a smaller scope etc. Generally I would argue for more qualitative methods for explaining non-use and finding the needs for EMR development, but statistical methods based on real usage data from the EMR systems could also be used for some purposes, particularly usage over time.

The last sentence above raises another question. That is, how should use be measured and how do we measure the success of EMR introductions? The guiding principle for this thesis has been to focus on the end users. To put it a bit simplified, if the end users report to be satisfied the introduction is regarded to be successful. However, end user satisfaction is closely tied to expectations and it could be sensible to measure success also against more "objective" business performance indicators. However, as mentioned in the discussion, clear indicators or goals do not seem to exist to a large extent today making such evaluations hard to achieve.

7 Results

This chapter presents the main findings from the articles, before the results are seen in connection, discussed and placed in a larger context in chapter 8. For more details please see the specific articles attached.

7.1 Main results from the study presented in article 1

Title: "From the front line, report from a near paperless hospital: Mixed reception amongst health care professionals" Published in Journal of the American Medical Informatics Association (JAMIA). [75]

- Increase in the physicians' use of the EMR system when performing clinical tasks related to the generation and storage of information. Significant increase in use for 11 of 19 clinical tasks compared to 2002. The majority in tasks where it was possible to avoid using the system.
- Nurses reported both increased use and improved performance compared to the 2002 study. Significant increase in use for 13 of 19 tasks, and reported higher change of ease for 14 of 19 tasks.
- Status quo for medical secretaries compared to 2002. However, medical secretaries reported high usage and satisfaction with the system both in 2002 and 2005.
- No decrease in use of scanned document images. However, regular electronic data was used significantly more than scanned document images.

7.1.1 Main contributions

- Shows quantitatively increase in use largely independent of technological facotors, highlighting the importance of organizational factors.
- Demonstrates that removing the paper-based medical record is feasible, although work practice has not changed considerably.

7.2 Main results from the study presented in article 2

Title: "Removal of paper-based health records from Norwegian hospitals: Effects on clinical workflow". Presented at MIE2006[26] and published in Studies in health technology and informatics, 2006.. [76]

- Some clinician reported diminished efficiency compared to the situation before the paper-based health record was removed. For instance reported respondents from three of the departments that getting an overview over the patients' problems and finding specific information about a patient was harder than before the removal of the paper based record.
- Large differences between physicians, nurses and medical secretaries with regard to EMR-use. Medical secretaries used the system far more than nurses and physicians, and large variances between departments/hospitals both in usage and satisfaction for physicians and nurses
- Generally positive attitude towards EMR-systems. Despite considerable differences both in use and perceived change of ease at the different hospitals, most of the respondents were positive when asked about the overall impact of the system at the various departments.

7.2.1 Main contributions

- Shows large variances between hospitals, suggesting that the positive effects might be more related to the introduction of an EMR system rather than the removal of the paper based record.
- Highlights some of the potential negative effects of removing the paper, especially in terms of case overview.

7.3 Main results from the study presented in article 3

Title: "No paper, but the same routines: A qualitative exploration of experiences in two Norwegian hospitals deprived of the paper based medical record".

[26] The 20th International Congress of the European Federation for Medical Informatics. Maastricht, Netherlands, august 2006

- Strong clinical involvement in the introduction processes. Both high level managers and clinicians strongly involved in the processes, clearly communicating the purpose of the project and involving end users.
- Larger benefits when everybody used the system. When both a broader range of functionality is used and people can trust the system being used by all and thereby up to date, larger benefits are achieved.
- Better support for inexperienced than experienced physicians. The systems today seems to support routine tasks in a better way than more advanced tasks, thereby supporting more inexperienced physicians better than the senior ones.
- EMR useful in regard to professional learning. Easier to mediate requests and follow the development of cases in which the physicians have been involved.
- Seniors stood for the initial system training. New users got a short introduction to the system when they started, and from there on learnt in an informal way.
- Young physicians reported different attitude than seniors. The young physicians often claimed to be more positive towards computers than seniors, but might have just as much to do with work tasks and experience than computer anxiety among the more experienced ones.
- Easier to produce text, but a potential for information overflow. Easy to produce journal notes, but the chronological structure of the journals in combination with little indexing of notes made it hard to find specific information from complex case histories.
- Little or no support for mobile work. Still no mobile solutions and the medical chart were still on paper and scanned upon discharge. However, not all interviewees perceived this as a problem.
- Still instances of down time. There were still instances of unplanned downtime, which made some skeptical towards a full removal of paper including the medical chart.
- EMR versus dual systems. None of the respondents, also those with experience from paper based systems and dual systems, wanted to reintroduce the paper based medical record into clinical workflow.

7.3.1 Main contributions

- Highlights the importance of close clinical-administrative collaboration and feedback loops during the introduction processes.
- Strong indications that the EMR systems only in a modest degree support the work of experienced physicians, downplaying the role of age as an EMR system use indicator.
- Highlights the shortcomings of todays way of structuring the EMR, pointing to a potential for decreased quality and efficiency if the development does not change direction.

7.4 Main results from the study presented in article 4

Title: "Barriers for interdisciplinary teamwork in hospitals: The myth of professional cultures". Submitted to Healthcare Management Review.

- Findings suggest that there are little or no cultural differences between professions in Norwegian hospital organizations. Thus health professions may have the same perception of the task or problem at hand, although they may disagree on what they are supposed to do or which responsibility they have. The barriers to interdisciplinary teamwork might therefore be both graspable and well understood, and consist of more structural than cultural barriers.

7.4.1 Main contribution

- No deep cultural differences between professions. Thus, the potential or foundation for interdisciplinary teamwork is present but structures, both technological and organizational, limits the potential.

8 Discussion

In chapter 5 three broad research questions were outlined before the specific research questions from the four articles were described in section 5.1 to 5.4. In this chapter the three main research questions returns and are discussed in light of both the theoretical remarks in chapter 4 and the findings from the articles. However, in line with the theoretical traditions underlying this thesis, no definite answers can be given although valuable insights can be gained. The aim is thus to provide a multitude of factors affecting and affected by these questions from empirical studies at the various hospitals rather than presenting a check list or guide to successful introduction of EMR systems.

In 2001 Lærum et.al.'s [16] national study showed that a lot of the available functionality in the EMR-systems were not utilized by the hospital physicians, and a 2003 study [17, 18] indicated that scanning and eliminating the paper based medical record was feasible but that the medical secretaries were the group that got the immediate benefits. This was the situation at the start of this thesis, and article 1 and 2 of this work sat out to see if this was still the case. The conclusion in the articles was that despite promising results from some of the hospitals involved, widespread clinical use of EMR systems is still not the normal case in Norway even though almost all hospitals now have an EMR system available, several are in the process of removing their paper based medical records from clinical workflow[27], and the range of available functionality is increasing. Based on the studies some possible explanations can be outlined.

8.1 Why is the functionality offered by the EMR-systems not used?

8.1.1 Paper and electronic records still exists side by side at most hospitals

A starting point for explaining the apparent limited use of EMR systems is the existence of parallel systems, i.e. electronic and paper-based records existing side by side. The

[27] As mentioned earlier, all departments involved in this thesis had removed their paper based medical records from clinical workflow. However some still updated their paper records for security purposes.

first hospitals to introduce EMR-systems in Norway ran their EMR-systems in parallel with the paper based medical records leaving users to choose which medium to use. Until Aust Agder hospital Arendal eliminated the paper based medical record in 2001, as they started to use their recently implemented EMR system, all hospitals having an EMR-system had in addition been using paper based medical records as a supplement. Results from this thesis suggest that hospitals that have moved straight from paper only to EMR-only have benefited more from their EMR implementations, at least in terms of use. However, it should also be noted that these also benefited from the experiences of the first hospitals that implemented EMR systems, and those pioneers had no choice but to have parallel solutions to their EMR systems for such a critical part of the operations at hospitals as the medical record. Still, results indicate that those pioneers have lagged somewhat behind the hospitals introducing EMR systems at a later stage in terms of EMR utilization, which in itself is not an unusual phenomena as Utterback describes [77]. However, this might be more complex than that the hospitals have not paid attention to the development, but rather be related to for instance established work practices and traditional routines as well as the EMR system itself. Also, as further described in 8.2, it might be that the gains are primarily related to the introduction of EMR and not so much the removal of the paper based record.

The demand to have paper print-outs from the EMR-system to update the paper based record and thus maintain parallel systems is not only argued to have hampered EMR adoption among clinicians, but also to have influenced the development of the systems and to have contributed to today's document based format of all major EMR systems in Norwegian hospitals. This again, as argued above and in line with Elberg [26] could have dampened EMR adoption. So the development seems to have been more or less trapped in a negative feedback manner and hence the benefits mostly related to automating existing practice[28]. Some of this, for example ordering and receiving radiology and laboratory tests electronically have become commonplace at most hospitals and is regarded very useful. Still, automating the routines of the past will not lead to the huge quality and efficiency gains EMR-systems are thought to contribute to.

[28] It should be noted that there is now an increasing awareness of this as for instance mentioned in chapter 2.3

This also implies a critique of the somewhat naive belief that quality and efficiency is to be automatically achieved by an EMR-system introduction.

8.1.2 Usefulness not visualized enough

As demonstrated in article 1, use of non-mandatory EMR-functionality had increased significantly largely independent of technological factors. The reason for this, based on the interviews in article 3, was largely because of word of mouth and a gradual incorporation of the EMR system as a natural part of everyday work. This increase in use had however taken almost three years, and despite that all users were very satisfied with having information available at all time, the EMR had not contributed to large quality gains and the work was reported to be performed in more or less exactly the same way as before.

It is little doubt that having information instantly available through an EMR-system when needed is highly valued, in addition to the automation of some tasks. However the supplemental or optional functionality of EMR systems seems to require a learning process. As seen in article 1, it took time before a large proportion of functionality in regard to generation of information was utilized. Partly because the EMR was not institutionalized as part of medical practice and thus not prioritized, and partly because old familiar ways of doing work got the job done. When the familiar alternative is available, this learning process might take even longer time or get less priority. Also, by having an EMR similar to the paper based ancestor, the EMR will always be compared to the paper-based counterpart. Thus the usefulness of switching to a medium resembling the old method might be hard to see, and the investment in time needed to learn to use the new medium in an efficient way might be hard to prioritize without seeing clear benefits. The paper has also some valuable properties, and with the document based structure of the EMR it is unclear whether it is a clear improvement over existing practice[29].

[29] It is clear based on the results that an EMR system is a clear improvement for clinicians. However, as further described in the next section, it is unclear whether having only an EMR-system is superior to maintaining both paper based and electronic systems.

As described in chapter 4, this process of incorporating the EMR into everyday work practice and thus attributing it a significant role not just for documentation, but throughout the medical process, might be easier if medical personnel is more involved in the EMR construction process. This does not mean just the technical "construction" of the EMR system, but also the "construction" of how EMR are thought to be a part of daily practice.

8.1.3 The experienced physicians are not necessarily resistant to change

Age has often been mentioned as a factor in relation to seeing the value or usefulness of EMR-systems, at least during informal talks. Often it is said (informally) that change at hospitals is made almost impossible by the old stubborn senior physicians that fear change, at least when the change involves work practices. The role of senior physicians was also a factor in the studies in this thesis, and during interviews new or inexperienced young physicians often told that they felt there was a gap in EMR use and satisfaction between younger and more senior and experienced physicians[30], suggesting that younger users might have a more natural relationship and be more used to using computers. However, articles 3 suggest that there are clear indications that this might have more to do with knowledge of old routines and the clinical gain of using the EMR system than computer knowledge and stubbornness by the senior physicians. Thus while experienced physicians report large gains by not having to request the paper based record to answer short questions regarding previous patient encounters or when asked to give an expert opinion, more routine tasks are well drilled and they often work faster using previous well rehearsed methods than doing the same using a computer system. In contrast, inexperienced physicians such as interns and fresh residents might have used an EMR system from the very beginning, thus being the method of choice and the method they are familiar with. The EMR systems today seem thus to support routine tasks better than the more complex needs of the experienced physicians with department-wide responsibility. However, senior physicians seem often to be the ones who perceive the largest potential gain of the EMR-systems, but this in combination with other changes. For instance a closer integration between EMR- systems and

[30] No significant differences were found in relation to age or experience in article 1 and 2. However, due to the somewhat limited material a possible relation can not be ruled out.

patient-logistic systems. So it seems like senior physicians are not negative towards EMR systems per se, or quite the contrary. However, to date the EMR systems does for most tasks not offer a superior alternative to the existing practice.

8.1.4 Do the technology provide what the clinicians need?

The last section pointed to a factor that has gradually emerged during the work with this thesis. That is; for most clinical tasks the EMR systems does not offer a superior alternative to the existing practice. This does not mean that EMR systems contribute negatively to medical practice, but that the rational reason to invest in the necessary learning processes involved in using an EMR system efficiently does not exist. The results in this thesis suggest that it is time to acknowledge that EMR systems to date are first and foremost electronic document handling systems. Thus they do only to a limited degree support the goal or promises of EMR systems outlined in chapter 3.2.

It might therefore be time to renegotiate what an EMR system really is and adjust the expectations and goals accordingly. Maybe introductions goes more smoothly if the projects are termed as introduction of electronic document handling and not as an all embracing clinical system. If EMR-systems, and scanning in particular, are meant to be central part of clinical work the clinical goals should be explicit. This seems to lack today and none of the physicians involved in this thesis expressed that the EMR system introductions had changed their medical practice.

8.1.5 Technology still the primary factor

The development to date has as described above strong resemblance with a view treating technology as the dominant factor, expecting large effects once the technology is introduced. The benefits of EMR systems are first and foremost thought to be in relation to an increase in quality and efficiency in the delivery of health services. Thus the EMR should support the users in performing their tasks, not being a goal in itself. Large efficiency gains are primary reached by performing tasks in new ways, not automating existing practice. Still there is no doubt that the EMR has been a valuable contribution to the Norwegian health sector. However, the full range of functionality in EMR systems is still not a superior alternative to the paper based solutions, resulting in clinicians choosing the latter for a large proportion of their tasks if they have a choice.

8.2 What are the effects of removing the paper based medical records?

The above section described a situation where clinicians had a choice of using the EMR-system or not. So what happens if the paper-based medical records are removed? The results shows that medical secretaries are still the ones who benefit the most from removing the paper based medical record. Still, even though reported use of a large proportion of functions for nurses and physicians were fairly low, especially at three of the hospitals, most respondents reported to be positive towards EMR in general and perceived the future to be paperless. However, the three hospitals with lowest reported utilization and lowest user satisfaction had previously been operating with an EMR-system and paper based records in parallel. It is thus a question whether it is the removal of paper or the introduction of EMR systems that make some of the hospitals involved stand out with both a high reported utilization of functionality and high reported user satisfaction with the changes brought in by the EMR system. The two hospitals that stood out with high reported utilization and satisfaction with their EMR-system had previously been using only the paper-based medical record. Hence it may very well be that the positive aspects of having information instantly available by having an EMR system might overshadow the advantages with the paper at these hospitals, while those used to both an EMR and paper might previously had the best of both world from the clinicians point of view.

By scanning the paper-records it can be argued that the strengths of the paper have been removed without replacing it with other strengths. Still, physicians interviewed with both paper, dual, and EMR only experience said to prefer EMR only, not having to juggle between various systems and always knowing that the information they sought was up to date. This is in line with Miller and Sim [78] who found that quality improvements depended heavily on physicians using EMR rather than paper for most of their daily tasks. It should also be noted as article 1 suggested, and also as Sequist et.al notes [79], that it might take some time before clinicians appreciate the benefits of the EMR, or at least adapts it as a natural part of daily practice (ref learning processes in 8.1.2). In this respect larger degree of force and mandatory functionality might work as

the results from one of the hospitals indicated. This is again dependent on a close administrative-clinical partnership as will be further outlined in the next section. Having an administration dictating clinicians how to do their medical practice will not work, and probably should not work either. Still, expanding the focus from the effects in regard to a single clinician to a hospital-wide focus might be worthwhile to attempt. An understanding of usefulness, both for the individual and for the organization, is argued to be a key factor for system usage.

Despite that removing the paper based medical record in itself does not seem to give large effects in line with the similarity to the paper based routines previously mentioned, it is nonetheless an important step towards an EMR enabling the quality and efficiency gains portrayed in the promises. By not having to update the paper based medical record the document based structure and the similarity of the EMR-systems and paper based records might be easier to break. Thus further development is argued to be easier when not being forced to comply with legacy paper systems. Possibly by learning from department specific systems [37] and preferably in close cooperation with clinicians as suggested in the next section. New ideas should be valued, without rejecting all old practices just because they are old. However, new technology creates new possibilities and just because today's way of doing thing might be close to optimal based on the properties of the paper, it might not be the way of doing things in the digital domain. Work practices and technology should be aligned as previously suggested several times, and scanning and removing the paper based record is just the first and enabling step in this process. As Litvin et.al says [19] (p.63): "The mere presence of an EMR cannot necessarily be associated with high quality of care". Similarly, mere scanning and removing the paper-based medical record cannot necessarily be associated with high efficiency and quality of care. On the contrary, results from thesis indicate that technology can even decrease performance when introduced to replicate existing practice, illustrated for instance by the growing anxiety about information overflow caused by today's EMR structure.

8.3 What can be done to enhance usage and fulfill the promises of EMR systems?

As previously mentioned introductions of EMR-systems in Norwegian hospitals have led to small changes in work routines, and there is still limited utilization of the systems with a few notable exceptions. It was argued in chapter 4 that both the approach to introductions and the historic relationship between clinicians and the administration contributed to the technology centric solutions. The challenge then is to embark upon an approach to EMR treating technology and organization as equal partners jointly influencing each other and challenging existing practice.

8.3.1 Strong user/clinical involvement essential

An obstacle to this approach, as argued in chapter 4 and mentioned in chapter 3.4.5 is what can be termed a socially constructed split between administrators and clinicians at hospitals. In chapter 4 organizations was described as the result of social interaction among members (as well as with certain non-members) which does not necessarily follow the organizational blueprint. From this it follows that projects such as EMR introductions and development should involve a range of diverse actors that can jointly challenge each other to create better solutions. This was to some degree the case at the most successful hospitals involved in this thesis, but the hard choices regarding medical practice was to some degree unaddressed there as well. Based on the view of power and the dual leadership outlined in chapter 4.4 “avoidance” is argued to play a part directing the development. According to Skjørshammer [80], health professionals, when in conflict[31], tends to use three major approaches to handle the situation; Avoidance, force and negotiation (usually also in that order). Even though Skjørshammer talks about interprofessional conflict, it is argued here that the same strategies apply for the clinician-management relationship. Thus to get something done old formally agreed upon solutions is the foundation for new development (the organizational blueprint) avoiding a complex and sometimes exhausting negotiation process. However, according to Cohn et.al. [81], this is not the best choice of strategy for handling conflict. Actually it is regarded as the worst and is regarded as a lose-lose situation as the conflict is not

[31] Conflict should be interpreted in a gentle way, more like perceived conflicting interest. It is not like administrators and clinicians hate each other.

resolved (and the negotiation process could be a source of innovation). In the literature there has for years been argued what is needed for the clinical-management relationship to function (e.g.[82-85]). That is, broadly speaking, mutual understanding and trust, cross functional involvement in decision making and generally communication and interaction. The challenge is to reframe the question of power and in line with a more relating-driven approach jointly develop organization and technology. Introduction of EMR systems should not be regarded as a management challenge, but as a health care challenge[32]. Only then can the intended benefits of the EMR systems begin to flourish[33].

This implies that clinicians and administrators no longer should be seen as two opposing forces and neither as two homogenous groups. The challenge should not be regarded as how to trick clinicians to use the system, but to work together towards designing and implementing a system that supports the main task of the hospital. That is, basically, to give patients high quality cure and care in an efficient way. As Anderson and McDaniel [86] say, managerial practices that isolate professionals from each other and attempt to constrain professional behavior through rules and policies will not encourage improvisation but will lead to protectionism, i.e., reinforce the conflict relation and established work practice. Traditionally strivings for increased quality have been attributed to clinicians and efficiency with administrators. But as argued above this need and should not be the case. By involving relevant actors from the beginning a broader range of interests can be taken into account. However, this means more than involving just the head physicians. Data from some of the hospitals involved in this thesis indicated true involvement of both clinicians and administrators from the very beginning of the projects. Here both top administrators and head physicians worked together, created a common understanding of their goals and communicated and involved their various subordinates in the process. Some of the issues raised by both clinicians and administrators were not taken into account in the final solution, but they had one important principle: Every issue communicated to the project staff was treated seriously and given a response. So people got a straight response of why or why not their concerns were taken into account, creating an understanding that their inputs and

[32] Still the uniqueness of the situation at hospitals should not be overemphasized as described in 8.3.2
[33] The intended benefits should also be clearer as further described in 8.3.4

expertise were valued. In short, a culture valuing change continually challenging the status quo should be strived for.

8.3.2 Deconstruct “Doesn’t apply to us”

It has previously been argued that different groups of actors at hospitals through construction processes have created stereotypes resulting in an avoidance of challenging the hard questions for instance in regard to work practices. Throughout the work with this thesis another form of construction has been observed. That is; “doesn’t apply to hospitals”, or in other words; “we are special”. This not only in regard to hospitals versus other organizations, but also as large hospitals presenting themselves as different than smaller hospitals demanding different solutions. However, what is so special about hospitals?

What characterize hospitals is that their in the business of medical practice. That puts some restrains in terms of adding and removing services etc, but in terms of ICT introductions this thesis has confirmed that the challenges involved generally mimic familiar challenges from organizations in general. As mentioned in chapter 4.2 some authors have argued for a four stage strategy where stage four is developing specific methods for health organizations. Based on the studies in this thesis this might be contradictory and instead contribute to construct hospitals as more complex and special than they might be. Instead, or at least first, the known issues should be addressed in a better way, including challenging existing practice.

8.3.3 Challenge existing practice

By having an organization valuing change in a collaborative fashion, moving away from traditional routines will also be easier to achieve. Introduction of EMR systems should as mentioned not be regarded as a health management challenge, but a health care challenge. By no longer being “forced” to uphold the routines from the past by fear of annoying the clinicians changes might be easer to achieve and an important change of approach can be made. The challenge is to reframe the key question from ‘what do we do today?’ to ‘what do we want to do in the future?’. Only by making this change of mind can true innovations be achieved and the EMR system change from being a pure documentation system, as is the case in most hospitals today, to a system supporting the

work of both clinicians and administrators in a better way. In that regard it is interesting to note that Hospital North described in article 3, which of the hospitals involved in this study had done the largest extent of routine changes, had both the highest degree of EMR use and the largest satisfaction with their EMR system. Still, the effects on medical work were only modest and the system was still more of a documentation system than a clinical tool. To reach the promises outlined in chapter 3.2, the structure of the EMR has to move away from the paper based document-based narrative way[34]. This stands in contrast to what for instance Steven Ford wrote as a comment to Hendy's article [14] about sociocultural challenges: "…Existing paper records are no longer ideal for many reasons, but they did evolve into their present form for sound reasons. Heed should be taken of that evolutionary process when devising a digital replacement. The end product should, in appearance and functionality, generally mimic the old familiar systems" ([87], p. 516). The last part of the citation above illustrates well the situation in Norway. However, although valuable insights can be gained by looking at old practices, it is based on the findings in this thesis strongly argued against uncritically mirroring these old solutions into new technology.

By loosening the established structures (also in terms of work practices) new ways of cooperating can also be achieved, and results from article 4 indicate that there is a potential for interdisciplinary teamwork at hospitals. Still, teamwork across professional boundaries is relatively rare, and the structure of the EMR as well as non-integrated systems is argued to play a vital part upholding the boundaries. Both between different departments, between different providers, and between different professions Sharing of data and enabling cooperation both within and across organizational boundaries is traditionally one of the major strengths of ICT systems and one of the areas where EMRs can really stand out from the paper based record. This, in combination with a different EMR structure and a closer integration between EMR-systems and patient-logistic systems could be a huge step towards the expected benefits of EMR-systems[35].

[34] However, the narrative way is a central part of medical work today. Caution should be made when attempting to change this and some degree of free text has to be allowed for. How this should be done must be worked out in an evolutionary manner and in close cooperation with clinicians. Standardization should also be strived for.

[35] However not a small task to accomplish

The largest gains concerning EMR will be reached when the whole chain of processes are seen in relation, not just internally at the various hospitals. For instance could a shared constantly updated medication list be of great value. As mention in chapter 2 teamwork between various actors is now emphasized and a national health network established, and a project concerning the medication list is under way. However in line with previous argumentation in this thesis it is strongly argued that the previous paper based solutions should not be the norm for the development.

8.3.4 Establish clear goals

One of the factors this chapter has focused on so far is the importance of involving both clinical and administrative personnel. This increases both the number of relations and the diversity of actors, thereby increasing the chance for innovation and also makes challenging existing practice easier. Although the local context is regarded as very important, the importance of deconstructing the complexity and learning from other fields has also been highlighted. What is left is how to overcome the perhaps most important challenge to enhance use: That is to demonstrate or create an understanding of clinical usefulness which through human relating is spread throughout the organization. This can be partly achieved by involving a broader range of actor, but one part that to some degree seems to be missing is clear goals of what should be achieved.

This does not mean a detailed map of what should be done, but a vision or main goal concrete enough to later be judged achieved or not. Also, if the promises in chapter 3.2 are to be achieved, the purpose or goals should have clinical significance. A vision without a detailed long term map is also more in accordance with the implicit unpredictability of change projects. As part of this goal seeking process the role of EMR-systems should also be renegotiated as mentioned previously. Maybe the all embracing EMR system that seems to be the goal today might not be the best way forward. Instead it might prove easiest to adhere to the simple definition from KITH referred to in chapter 3.1 and let the EMR-system only be the master for patient information. Another option can be to let EMR-systems be an enabling infrastructure tying together other modules. The different modules can then represent different project with clearly established goals (like the department specific systems) build upon a

common infrastructure with establish standards. Module based systems and service oriented architecture (SOA) seems to be the way forward for EMR vendors. It remains to see whether the inherent business/organizational focus of SOA gets transferred over to the hospital sector or the technology remains at the forefront.

9 Implications

In this thesis there has been some critique of the EMR introductions in Norwegian hospitals, arguing they have largely been based on previous paper based routines thus limiting the potential. Even though studies [16-18, 75, 76] support this critique as just there should also be mentioned that a lot has been achieved across the Norwegian health and social sector in regard to ICT development, and it is easy to be critical in hindsight. Thus, the situation should not be described too negative, and as seen in the articles some hospitals are starting to experience large benefits with the help of their EMR systems. When writing a thesis like this it is also easy to forget the restraints the hospitals work under, and resource constraints often makes the situation a lot more challenging.

The national government is the owner of the Norwegian hospitals while the running of the various hospitals is left to five regional health enterprises. Still, the government plays a vital part as they decide the constraints the enterprises work under. In regard to ICT, the government plays an active role for instance through national strategy plans as described in chapter 2. In chapter 2 the increasing focus on EMR systems and organizational development was also described and even though the importance of the topics is highlighted, especially organizational development is often getting out of focus when restraints such as budget and time become critical. Thus it might be wise to demand plans for organizational development in addition to technological factors when new projects are launched. Still, it is important that this is not introduced as a new layer of bureaucracy and becomes a new set of documents that nobody follows or looks at, but an integrated part of the development process. There has been enough projects where technology is introduced and the benefits are tried to be identified later to warrant the investment.

Even though the national government and the regional health enterprises sets some constraints, the responsibility for ordering, implementing and not least getting the

benefits from the EMR systems are largely left to the various hospitals[36]. According to the promises and as seen in the national strategy plans, EMR's are thought to increase quality and efficiency and support new ways of cooperating. EMR systems are now implemented, and as article 4 showed there are no large cultural differences between professions. Still, interprofessional teamwork is still uncommon and the large quality and efficiency effects are yet to take place. Rather, as mentioned several times before, pre-existing routines seem to be reinforced. Based on the theoretical study and results from the articles some considerations for stakeholders can be outlined:

- **High EMR-system diffusion is not enough**. Having an EMR system is a prerequisite for reaching the gains EMR systems are supposed to contribute to. However it is not enough as stressed several times in this thesis. The focus should shift towards how EMR systems can contribute, and dismiss ones and for all the belief that EMR system introductions automatically lead to huge gains. EMR-system development should be based on clear organizational (including clinical) goals. Organizations and technology are argued to mutually influence each other, and should thus not be seen as separate processes.
- **Scanning alone does not lead to improvements**. The existence of parallel paper and electronic solutions has been mentioned as a major barrier to exploiting the potential of EMR-systems. However as mentioned earlier in this thesis, scanning alone does not seem to give large advantages. On the contrary, just replacing the paper with scanned document images might be counterproductive.
- **Acknowledge the limitations of the document-based structure of the EMR-systems**. Todays EMR is very similar to the old paper-based medical record. The paper based record has gone through several evolutionary stages and is the result of several decades of experience. Valuable insights can be gained from this record and not all elements should necessarily be dismissed. However, setting restraints for the old solutions has always been the paper. New technology open new possibilities and it is not necessarily true that the old way

[36] Still, there is an increasing tendency that the decision of what EMR vendor to use is taken at the regional level

works best under new circumstances. As mentioned above just digitalizing the paper will not lead to huge improvements but instead be a potential factor for decreasing both efficiency and quality of clinical practice.

- **Factors for success might be important, but should not be used as a blueprint**. Factors of success reflect elements that have been critical for successful introductions elsewhere. These reflect important points, but often the processes behind these factors can be argued to be more important than the factors per se. Thus just implementing a "best-practice" solution will often not live up to the expectations. Hence it is argued that valuable insights can be gained by learning from other projects but their approach should not necessarily be used as a blueprint for further introductions. Every setting is unique, and adaptations have to be made to fit the local context. Still, there is also a danger of portraying its own situation as too unique, complicating more than what might be the case.
- **Acknowledge limitations of detailed long-term planning**. It is impossible to predict the future in detail and plans detailed to reach a specific future stage should be avoided. This does not mean abandoning all planning, but acknowledge that unforeseen issues and surprises will occur. If the future was possible to predict, the factors of success would ensure success something experience show is not the case. Thus a more agile development framework is recommended to better cope with changing demands.
- **People, people, people**. Even though an external objective reality might exist, it is argued that we can never know if we really know it or not. Thus the world as we see it is socially constructed and people are involved creating their own and others future. Technology is also man-made and thus socially constructed; even though it might seem as black boxed and thus something else for people without technological background. Still, this implies than intended users and other stakeholders should be involved in the technology development process. It also implies that there is no objective best technological solution. The focus should be on how the technology can support the organization and the people within it.

- **Close clinical and administrative collaboration vital for successful introductions.** In the case of EMR, as a clinical-administrative information system, interest of both clinicians and hospital-administration should be taken into account. This during both the planning and introduction phases and both through direct involvement and through communication and feedback loops. The essence to establish a culture for change with a common striving towards better efficiency and quality of health services. Clinicians and administrators might often have different opinions and thereby conflicting interests. However, this does not have to be negative phenomena. It is through diverging opinions that new solutions emerge, and the easy way out by focusing on previously agreed formal routines should not be followed without critical reflection. Going digital should not be used to trick greater degree of control into the previously established processes. It is easy for instance to force users to fill out check boxes in a computerized system, but this should be weighted against usefulness of the system. Also, clinician and administrators should not be seen as two homogenous forces, but as interrelated people with great variances also internally in the two groups. Thus a relational view on power should be taken and it should not be forgotten that some physicians are great champions in relation to EMR development.
- **Importance of informal relationships**. The 'life' in an organization does not always follow formal ways or the organizational chart. Decisions are often made elsewhere and changes of formal routines do not always lead to change in actual work practice. Thus the point of departure for changes should be actual work practice and not formalized flow charts often made by people distanced from the actual work practice. This implies involvement in the development processes, both technological and organizational. It also implies that organizational and technological structures should encourage communication and teamwork, both within and across organizational boundaries. As shown in article 4 of this thesis there is no cultural differences between professions large enough to hinder change. However, historic structures hinder new connections between people and the EMR systems today seem to reinforce this, hardening for instance interdisciplinary teamwork.

10 Transferability

The articles in this thesis have displayed considerable differences in reported EMR use and satisfaction between various departments/hospitals, especially between departments from large university hospitals and the rest. The question then becomes if the results from this study are usable for the hospital landscape at large? It is argued that they do, but the results from this study also raises some possible further complicating issues at large, more specialized hospitals, compared to the relatively small ones that have been most in focus in this thesis.

As for the implementation processes not all clinicians can be involved in the processes and some are probably not interested either[37]. However, information and feedback on proposals are just as important and the department heads are probably key actors for a successful process to take place. Still, as pointed out earlier, there is no blueprint for a successful project to come through and the local factors have to be taken into account. Due to a larger workforce, and thereby less personal relationships between the various actors, thorough preparation of the organization and resources put aside for organizational work might be even more important at the large hospitals, although as seen, important also in the smaller.

The university hospitals might also have some larger challenges when it comes to the EMR systems itself. As mentioned the EMR systems in Norway today are mostly documentation systems and some physicians have pointed out that there can be challenging to get a thorough overview of complex case histories. In addition, the system seemed to support interns better than senior physicians. This might be an even larger problem at the university hospitals, which in general get the most complicated cases and are more specialized than the smaller ones. These hospitals have also for years been using EMR systems in parallel to the paper based records and have a larger number of custom made clinical department systems than the smaller ones. Thus, even

[37] Nor is there feasible to involve all actors formally in the processes. However as mentioned earlier, channels for proposals should be opened and suggestions valued and answered.

though a positive system for the hospital at large, the gain by going paperless for the various clinicians might be smaller at these large specialized hospitals. A different structure of the EMR providing a better overview of the stay might be necessary before the EMR becomes superior to the paper based record. Still, the large hospitals might not be as special as some people seem to portray them, and the same major challenge is present. That is: Overcome ‘paper thinking’, i.e. the routines of the past.

11 Further studies

The focus in this thesis has been rather broad and raises a lot of questions worth further research. Some of these questions, or focus areas, are briefly described below.

- This thesis has focused on the development internally at various hospitals. Some of the findings indicate that the largest benefits might be achieved when healthcare is seen in a larger context. Focus on the whole "value chain" would then be an interesting area of study. For instance from a patients first contact with his GP through his stay at the hospital back to follow up from the GP. Another example could be to follow an emergency admittance, for instance from a car accident, from the ER throughout the hospital stay to further follow up outside the hospital. Focus could be for instance sharing of information (e.g. medicine list), or more socio-economic considerations. The degree and the content of electronic interaction could also be of interest. Broadly speaking this area is thus about cross-organizational cooperation and coordination from both a clinical and economical point of view.
- Related to the above, how can EMR support cross organizational cooperation? Or, cross organizational teamwork?
- Hospitals have a range of department specific systems where a considerable proportion includes patient related information which to some degree overlaps with the EMR. With increasing demand of information safety and more and more ambitious EMR systems the position of department specific systems might be in danger. However, contrary to the EMR, department specific clinical information systems are almost always developed from a concrete clinical need and have strong champions within the medical professions. It would thus be interesting to study in more detail the interplay between these systems and the EMR system, how they might interplay in the future and how EMR introduction processes could benefit by learning from the department specific systems. Also, a discussion whether the systems should be included as part of an all-embracing EMR or integrated in a more module based way with for instance the EMR as master for patient related information could be worth studying. This not only

from a technical point of view, but also for instance how the clinical ownership to the various systems is affected by a more centralized approach.

- Partly related to the above, and as mention in this thesis, the future role of EMR could be an area of study and thus also a clearer definition of EMR. Maybe the definition offered by KITH as referred in chapter 3.1 is the best one after all. That is, EMR as a collection of patient related data. EMR can then be viewed more like a centralized content management system more in line with the situation today. The promises outlined in chapter 3.2 can then be viewed as related to the HIS, and possibly include flexible integration with various clinical department specific system.
- The structure of the future EMR and the interplay with decision support systems is also an area of interest. The EMR is still based on free text documents with little metadata besides document-date in a chronological structure. Although the existing structure should be treated with respect, and changed only for sound reasons, it might be time to challenge it with the emergence of new technologies and take advantage of the technology in the best way possible.
- Further it would be interesting to study in more detail the goals driving EMR development and IT introductions at hospitals in general. What is to be achieved by using EMR systems? Is it content/document management or something more? The processes involved in establishing these goals would also be of interest. For instance who is involved? Who makes the decisions? How are the goals communicated? How are they followed up? Further to what degree goals or drivers coincide between various actors and organizations. For instance are there corresponding goals at the departmental (owner), hospital, department and individual levels? How are the goals reinterpreted at the various levels? How do human relating and conversations at various levels influence the perceived goals? How do power structures influence the agreed goals?
- The above mention the goal development process as an area of study. Partly related, the organization of IT-projects and IT governance could be an interesting area of study. For instance who is involved in the projects? What projects are prioritized? How is the end-users involved? How are the projects

followed up? Further, IT-development in general are now being more and more business driven for instance through the increasing focus on service oriented architecture (SOA). What consequences this has for hospitals and project organizing could also be of interest. An interesting research project could be to investigate the potential for BPM (Business process management) and SOA at hospitals.

- Closely related to goals and the project is the topic of power at hospitals. As suggested in this thesis it may seem like different group of actors have constructed opposing fronts limiting the potential of EMR and routine changes. Further studies could investigate this in more detail, and if such structures exist, suggest strategies for deconstructing this split.
- To investigate possible differences between various actors SPGR investigations could be of great value. It would for instance be interesting to investigate how administrative and clinical personnel view each other. Within the clinical group, it could also be interesting to investigate for instance how nurses and physicians perceive each other. In relation to EMR projects it could be very interesting to use SPGR to see how different actors or groups of actors perceive each other. Especially periodic studies during the course of the project.
- As mentioned in the thesis there were considerable differences in use between the large and small hospitals involved. Possible differences and the effect on EMR could be investigated in more detail, perhaps with focus on how personal relationships across borders and a more intimate setting might influence introduction processes. This thesis has also focused on the hospitals that seem to have succeeded the most with their implementations. Valuable insights could be gained by studying hospitals with less apparent success. In relation to scanning and removing the paper based medical record it would also be very valuable to study in more detail hospitals that previously have maintained dual systems. Also, in hospitals still maintaining dual systems, it would be valuable to study what medium clinicians use and the reasons why.

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Article 1:

From the front line, report from a near paperless hospital: Mixed reception amongst health care professionals

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Published in Journal of the American medical Informatics Association

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Article 2:

Removal of paper-based health records from Norwegian hospitals: Effects on clinical workflow

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Removal of paper-based health records from Norwegian hospitals: Effects on clinical workflow

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Abstract. Several Norwegian hospitals have, plan, or are in the process of removing the paper-based health record from clinical workflow. To assess the impact on usage and satisfaction of electronic health record (EHR) systems, we conducted a survey among physicians, nurses and medical secretaries at selected departments from six Norwegian hospitals. The main feature of the questionnaire is the description of a set of tasks commonly performed at hospitals, and respondents were asked to rate their usage and change of ease compared to previous routines for each tasks. There were 24 tasks for physicians, 19 for nurses and 23 for medical secretaries. In total, 64 physicians, 128 nurses and 57 medical secretaries responded, corresponding to a response rate of 68%, 58% and 84% respectively. Results showed a large degree of use among medical secretaries, while physicians and nurses displayed a more modest degree of use. Possibly suggesting that the EHR systems among clinicians still is considered more of an administrative system. Among the two latter groups, tasks regarding information retrieval were used more extensively than tasks regarding generating and storing information. Also, we observed large differences between hospitals and higher satisfaction with the part of the system handling regular electronic data than scanned document images. Even though the increase in use among clinicians after removing the paper based record were mainly in tasks where respondents had no choice other than use the electronic health record, the attitude towards EHR-systems were mainly positive. Thus, while removing the paper based record has yet to promote new ways of working, we see it as an important step towards the EHR system of tomorrow. Several Norwegian hospitals have shown that it is possible.

Keywords: Medical Records Systems. Computerized/*utilization

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1. Introduction

Whatever the cause might be, the health care sector in a few, small European countries have achieved a remarkably high degree of penetration of electronic health record (EHR) systems. In Norway more than 90% of primary care physicians and 90% of the hospitals have implemented an EHR [1, 2]. Furthermore, an increasing proportion of lab reports, referral and medical discharge letters are exchanged via the National health care network [3, 4]. The propulsion towards increased electronic storage and communication of health data and further integration of EHR systems in clinical workflow is nurtured and closely watched by the Norwegian directorate for health and social affairs in concert with national standardization bodies, the national IT-healthcare industry, health informatics communities in Norwegian universities and the health care sector itself [4].

In a hospital, the health record should be considered both a tool for health personnel and a legal document which use is strictly regulated by law. Implementing an EHR system is a necessary, but not sufficient step towards replacing the legal, paper based health record with an electronic version. To avoid loss of clinically important documents which only exist on paper, these must be reproduced and stored in the EHR. The process of scanning paper health record documents and making these available to clinicians via the EHR is now being enacted at numerous Norwegian hospitals. In a study from the first Norwegian hospital to take this step, physicians reported that removal of the paper-based health record and subsequent total dependence on the EHR system alone had made a few clinical tasks more cumbersome but others more effective. In this study, most physicians were satisfied with the use of the system as a whole, but some physicians reported a negative impact on the performance and the quality of the department's work. Despite some unwanted, negative effects Lærum concluded that the process of removing the paper-based health record was possible without a major negative impact on clinical practice [5].

The effects of introducing an EHR system and removing the paper-based electronic health record might depend on the size of the hospital, nature of work at the department, functionality in the EHR system introduced and preparedness, ability and willingness of the hospital organization to adapt to the changes introduced [6]. Based on an assumption that it is more cumbersome to use an EHR system to introduce organizational changes at larger compared to smaller hospitals we have followed "paperless hospital" projects throughout the Norwegian hospital landscape. We here bring the preliminary results from a survey conducted to

explore the use of EHR-systems at selected hospital departments deprived of the paper-based record.

2. Material and methods

2.1. The survey

An adapted version of a questionnaire developed by Lærum et al was used in the study [7]. The main feature of the survey is the description of a set of tasks commonly performed at hospitals (24 clinical tasks for physicians, 19 for nurses, and 23 tasks for medical secretaries). For each task, the respondent is asked to rate the degree of use and performance compared to previous routines. Examples of tasks for physicians are: “Review the patient’s problem”, “seek out specific information from patient record”, “write prescriptions” and “complete sick leave form”. Also included in the survey are questions about demographical data, self rated computer experience, availability and problems with computers, detailed user satisfaction, and an assessment of the system as a whole.

The respondents included physicians, nurses and medical secretaries from three medical, one surgical and three dermatology departments from six different hospitals in Norway. At all departments the paper based medical record was removed from clinical workflow, and all three different hospital EHR-systems in Norway was represented. The time since the paper-based medical record had been removed differed among the hospitals. One having eliminated its paper based record in 2001, while others were in the process or just had started working paperless. In total, 64 physicians, 128 nurses and 57 medical secretaries responded. The response rate was 68%, 58% and 84% respectively.

2.2. Analysis

We used SPSS 12.0 for windows for statistical analysis of the survey. The analyses of the questionnaire were performed separately for each question, using the nonparametric analysis Kruskal-Wallis or Mann-Whitney U. Correlations were calculated using Spearman’s Rank Order Correlation.

3. Results

3.1. Some physicians reported diminished efficiency compared to the situation before the paper-based health record was removed.

In general, respondents from the 3 dermatology departments reported lower degree of use than the other departments. The dermatology departments belonged to three large university hospitals that also had implemented a different EHR-system than the other hospitals participating in the survey. When inquired about change of ease compared to previous routines the dermatology departments scored considerable lower at least for certain tasks. For instance, while the EHR-system among physicians in all departments where used routinely to both review the patient's problems and seek out specific information from the patient records, more than 50% of the respondents from the dermatology departments reported a negative impact on the performance of their work compared to previous routines (figure 1). In contrast, only a small proportion of the non-dermatology respondents from other hospitals reported a decrease for either task. This difference was not due to differences in computer skills or access to and problems with computers. Also, the various EHR systems had to a large degree the same functionality supported.

3.2. Large differences between physicians, nurses and medical secretaries with regard to EHR-use

Even though a detailed comparison can not be made due to different tasks and the nature of the work, the overall impression was that medical secretaries used the EHR system far more than both physicians and nurses. When asked about use, the median response by medical secretaries was always or most of the occasions for 19 of 23 tasks. Also, when asked to rate the performance of completing the tasks compared to previous routines, medical secretaries overall responded highest.

As for physicians, the results indicated a difference between tasks regarding *generating* information and tasks regarding *retrieving* information. While the EHR system was used extensively to retrieve information, they were generally utilized to a limited degree when it came to generate and store information. The main exception being entering daily notes, where 85% reported to use the EHR system always or most of the occasions. Still, despite varying degree of use, for most tasks the majority of physicians were positive to the change of ease of performing tasks compared to previous routines. However, as we have seen, exceptions exist.

Nurses were the group that reported the lowest degree of use. Still, we noticed the same tendency as for physicians. Tasks regarding information retrieval were used more than tasks regarding generating and storing information. For example, tasks regarding obtaining various tests results were used routinely. In contrast, only 23% reported to use the EHR-system more than half of the occasions to keep a list of short notes about each patient. Still, despite reporting a modest degree of use, nurses generally were positive to the changes imposed by the EHR-system.

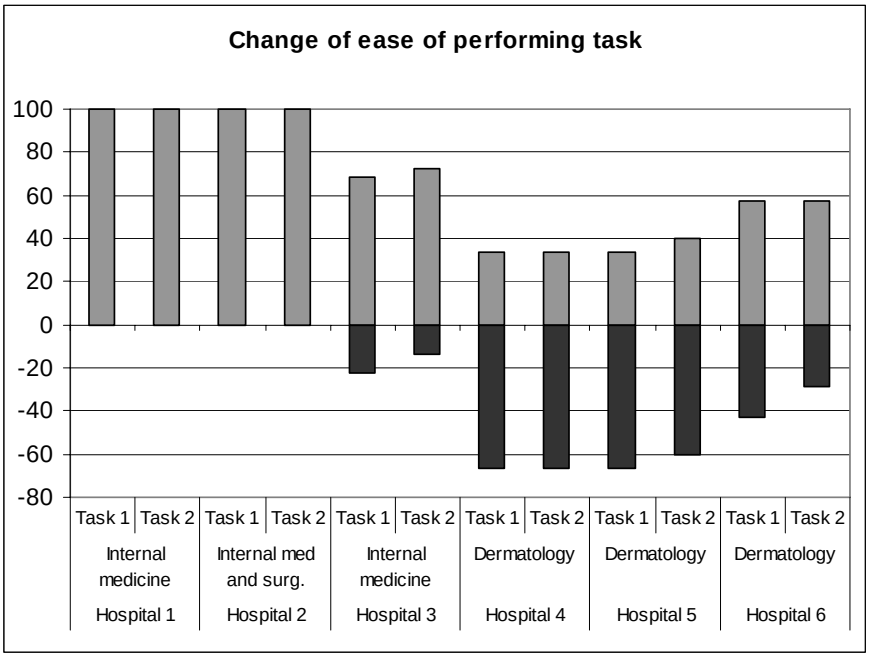

Figure1: Change of ease of performing the tasks compared to previous routines. The positive part of the bar represents percentage of respondents that reported an increase in performance, the negative part percentage that reported a decrease. Task 1: Review the patients' problems. Task 2: Seek out specific information from the patient records

3.3. Generally positive attitude towards EHR-systems

Despite considerable differences in both use and perceived change of ease at the different hospitals, most of the respondents where positive when asked about the overall impact of the system at the various departments. However, when asked about system-specific user satisfaction, respondents where much more satisfied with the part handling regular electronic data than scanned document images (Wilcoxon Signed Rank Test; $p<0,001$).

4. Discussion

In this report we have presented preliminary results from a survey among Norwegian hospital departments working without the paper based medical record. The results show considerable differences both between professions and among hospitals. While the medical secretaries display extensive usage for most tasks, physicians and nurses generally report high usage in tasks regarding retrieving information. Tasks they have to perform using the EHR system since the paper based medical records are not available. The reasons for this are not clear. However, a possible reason might be that the functionality offered by the EHR systems in Norway to date is more directly relevant for medical secretaries than physicians and nurses. So, while working with the EHR-system is directly relevant to the job of medical secretaries, it is mere a support for the main task of physicians and nurses. That is, curing and caring. Thus, despite the ambitions, our results suggest that to date the EHR-systems is still more of an administrative system than a system supporting the main jobs of clinicians. Hence, in line with Lærum et.al [8], our results do not indicate any major change of routines compared to the days of the paper based medical record. The lack of an electronic medical chart in the EHR systems, a function much wanted by clinicians, is a possible explanation.

As for the different hospitals, we observed large differences in use and perceived change of ease of performing the different tasks. Still, even though the three departments that displayed lowest degree of both use and satisfaction use a different EHR system than the others, we argue that pointing the blame to the system is too simplified. Instead, we argue in line with Berg [7] that the introduction of EHR-systems, and likewise removing the paper based medical record, should be seen as a mutual transformation process where the technology and the organization influence each other. Thus, we do not rule of the technology as an influencing factor, but argue that focusing solely on the system will lead to inferior explanations. A possible reason for the hospital differences might be the time since going paperless and the before-situation. For one of the hospitals in this study, a similar investigation was carried out in 2002 [3, 6]. Based on data from 2005 contained in this report, both physicians and nurses' use of EHR have increased. The majority of the remaining hospitals in our survey had just embarked in the process of becoming paperless. The three hospital departments that displayed the lowest degree of use were dermatology departments from large university hospitals. There may be several reasons for this, one being that they use a different EHR system than the other hospitals. The observed difference might also be due to differences in the nature of the medical work, and of the speed at which the EHR-system has

been implemented. The university hospitals had for years been using EHR in parallel with a paper based record, while the hospital that displayed greatest degree of use more or less went from a paper based record only to an EHR-system only. Thereby, going through a greater degree of change and getting the benefits of an EHR system by constant access and so on. On the other hand, the university hospitals had previously, from the clinicians' point of view, had both the strengths of the paper record in addition to the advantages of a computerized system. So, while the clinicians at hospitals that went straight from a paper-based record to a fully electronic EHR system gained an important tool, the clinicians at the university hospitals lost their paper-record. Possibly leading to a positive focus on what they have gained amongst the first, and correspondingly a negative focus about what they have lost amongst the latter. This suggests that the situation before removing the paper-based health record may be more important than the time since implementing an EMR, and may also to some degree explain why one of the hospitals that most recently implemented an EHR and went paperless displayed the highest overall degree of use. Supporting this view, recently gathered qualitative data from one of the hospitals point to word of mouth as an important influencing factor for use of mandatory functionality amongst clinicians. Still, another factor might be that the dermatology departments typically have more patients with complicated case-histories, and thereby have greater need of historical data. Thus, having to work more with scanned images which is regarded as more cumbersome than regular electronic data.

5. Conclusion

Even though the intention of achieving higher efficiency, quality and new ways of delivering health care remains to be fulfilled, our results lend support to the conclusion that removal of the paper-based health record is feasible. The results obtained from the university hospital departments are however worrying and warrants more thorough analyses.

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Article 3:

No paper, but the same routines: A qualitative exploration of experiences in two Norwegian hospitals deprived of the paper based medical record

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No paper, but the same routines: A qualitative exploration of experiences in two Norwegian hospitals deprived of the paper based medical record

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Abstract

Background

It has been shown that implementation of electronic medical records (EMR) and withdrawal of the paper-based medical record is feasible, but represents a drastic change in the information environment of hospital physicians. Previous investigations have revealed considerable inter-hospital variations in EMR system use and user satisfaction. The aim of this study was to further explore changes of clinicians' work after the EMR system implementation process and how they experienced working in a paper-deprived information environment.

Methods

Qualitative study based on 18 semi-structured interviews with physicians in two Norwegian hospitals.

Results

Ten different but related characteristics of work within the EMR-based practice were identified; (1) there was closer clinical and administrative cooperation during the implementation processes; (2) there were greater benefits when everybody used the system; (3) systems supported freshmen better than experienced physicians; (4) the EMR was useful in regard to professional learning; (5) new users were given an introduction to the system by experienced; (6) younger clinicians reported different attitudes than senior clinicians, but this might be related to more than age and previous experience with computers; (7) the EMR made it easier to generate free-text notes, but this also created a potential for information overflow; (8) there is little or no support for mobile work; (9) instances of downtime are still experienced, and this influenced the attitude towards the system and (10) clinicians preferred EMR-only compared to combined paper and electronic systems.

Conclusions

Despite the removal of paper-based records from clinical workflow (a change that hospital clinicians perceived as highly useful), many of the old routines remained

unchanged, limiting the potential of the EMR system. Thus, there is a need to not only remove paper in the physical sense, but also to established routines to fully achieve the benefits of an EMR system.

Background

For decades the electronic medical record (EMR) has been described as having the potential to increase both quality and efficiency of health care delivery[1]. In many countries, EMR systems are however not widely disseminated. Furthermore, EMR system vendors appear to face almost the same challenges now as decades ago[2]. In Norway, as well as in some other small European countries, most general hospitals have finally implemented and started to use EMR systems. For these hospitals, there is now a continuous struggle to realize the expected and desired benefits of EMR's, mainly related to removing its paper-based ancestor and changing the time-consuming routines that were necessary as long as the records were physical paper folders. A national cross-sectional study about hospital physicians' use of EMR's revealed that substantial proportions of the available EMR system functionality were not used by the physicians[3]. A possible explanation being the fact that the EMR systems have existed in parallel with paper based medical records, leaving the physicians to choose which medium to use.

After a change in regulations in 1999 that allowed for the possibility for hospitals to replace their paper archives with EMR's, several Norwegian hospitals embarked on a process to become paperless. Based on our studies of EMR system implementations in Norwegian hospitals[4], this can be described as a four stage process (table 1).

Table 1 - The different stages in eliminating the paper-based medical record

Stage	Paper based medical record	Electronic medical record
I	Present and updated	Absent
II	Present and updated	Present
III	Present, **not** updated	Present, and supplied with **scanned** documents
IV	Absent	Present, and supplied with **scanned**

		documents

Today only one general hospital in Norway remains at stage I. The majority are at stage II, while a few have eliminated their paper based record and now only archive patient data in an EMR system (stage IV). Some hospitals have gone directly from stage I to IV, others appear to have stalled at stage II, some of these for more than five years[4]. The first hospital to reach stage IV was the subject of a study in 2002. This study revealed large variations between health professionals' use of the EMR system. While medical secretaries reported to be very pleased with, and used the system extensively, physicians and nurses used the system mostly for tasks for which they had no choice but to use the system due to the lack of a paper based record [5, 6]. In a 2005 follow-up we found a large increase in EMR system use among physicians and nurses that largely were independent of technological factors, possibly indicating that physicians and nurses had adapted to the EMR system [7].

To broaden our understanding of EMR system implementation processes and the impact of eliminating the paper-based medical record on the work of hospital employees, we extended our study to include physicians, nurses and medical secretaries from six different Norwegian hospitals [4]. This study revealed considerable differences between the various departments/hospitals both with regard to reported use of the EMR system and whether the EMR system eased the performance of clinical tasks. Some departments stood out: Here the physicians both reported an extended use of the EMR system and a positive attitude to the changes imposed on them. In this study we have elaborated further on physicians' use of the EMR system in hospitals deprived of the paper-based medical record. We have conducted semi-structured interviews with hospital physicians from the two hospitals reporting to have the highest use of EMR and inquired about a) which organizational factors that may have led to such a high utilization of the EMR system and b) clinicians' experiences of working in a paperless environment.

Methods

The hospitals

We chose to interview physicians from two hospitals reporting to have the higest use and physician satisfaction with the EMR system [4]. Hospital North and South are community hospitals serving a population of about 40.000 and 100.000 respectively. Hospital North, with about 115 beds, is located in northern Norway and Hospital South, with about 245 beds, in southern Norway. Hospital South was also the focus of a previous study published in 2006 [7].

The EMR systems

Both hospitals had an installation of DIPS-EMR [8], which is both an EMR system and a patient administrative system. The system also supports the ordering of X-ray examinations and laboratory tests, and will accept and store radiology and laboratory reports. Nursing documentation was also electronically implemented at both hospitals. None of the hospitals had a large-scale decision support system. Both departments included in our study had removed their paper-based medical record from clinical workflow. Hospital North and South made this move when they implemented their EMR systems in 2002 and 2001 respectively. The EMR has status as a legal document. Thus, both these hospitals went straight from paper only to EMR only.

The scanning processes

Since the paper-based medical record is no longer available, historical data have to be included in the EMR by scanning relevant parts of the old paper-based medical record. The scanning processes were very similar in both hospitals involved in our study. Upon admission to the hospital, it is checked whether the patient has an old paper-based medical record. If so, the majority of its content is scanned and made available through the EMR as *scanned multiple documents*. That is, image-files with multiple pages, sorted according to broad categories (table 2).

Table 2 – Scanning categories. The number of subsections within the categories and the degree of *scanned multiple documents* versus *scanned single documents* varies between the hospitals.

Category	Examples
Summaries	E.g. Index of consultations and admissions, Discharge reports, Discharge reports from

	other hospitals.
Textual medical record	E.g. Continuous textual medical record (admission reports, surgery reports etc.), Referrals within the hospital
Lab results – tissue and body fluids	E.g. clinical biochemical/ immunol./pharmacol. Investigations
Organ functions (incl. photographs)	E.g. cardiovascular function, lungs and respiratory function
Radiology and other imaging	E.g radiological investigations, CT, MRI, ultrasound.
Treatment, observation and anestesia forms	E.g. patient chart summary and treatment forms.
Nurses' documentation	E.g. nurse's admission reports and notes
Other health personnel	E.g. physical therapist, occupational therapist
Correspondence	E.g. admission request forms
Certificates/notifications	E.g. various public certificates, forms and notifications

In addition to *routine electronic data* (searchable data entered directly into the EMR) and *scanned multiple documents*, an EMR might also contain *scanned single documents*. These are new documents either coming to the hospital in the form of paper (e.g. a report from an external laboratory or a referral letter written by a GP that does not transmit these electronically) or are paper documents produced during the stay (e.g. the medical chart).

The interviews

18 semi-structured interviews among physicians at the medical departments were conducted in May-June 2006. At Hospital South, 11 physicians were interviewed. 4 interns, 4 residents and 3 seniors. At Hospital North, 1 intern, 3 residents and 3 senior physicians were interviewed. Nurses, physiotherapists and other professionals also use the EMR systems. However, to limit the already broad scope of the study, those were excluded. The interviews, which lasted from about 25 to about 45 minutes, were conducted by the first and third author at Hospital South, and the first author at Hospital North.

The background for the interview study was, as mentioned, a survey that both departments in question had participated in [4, 7]. Based on that survey and inspired by literature regarding both EMR usage [3-7] and introduction of information technology more in general [9, 10], an interview guide was developed. The structure was limited to the areas we wanted to address (such as the implementation process, how the training was organized, the ease of using the system, functionality that was especially valued or missed etc.), and within these areas the conversation was largely unrestrained. Thus, there were none specific questions and we were also ready to pursue other themes that the respondents brought up during the interviews.

The interviews were taped and later transcribed by the first author. An inductive analysis was supported by the use of QSR NVivo 7 software for qualitative analysis, by sorting out specific themes that occurred in the interview transcripts. That the analysis was inductive means in this case that themes (or nodes in NVivo terminology) were identified in the transcripts regardless of their occurrence in the interview guide, very much influenced by a grounded theory approach [11]. Especially, we emphasised themes that repeated themselves across the respondents. The themes were thereafter matrix-coded and analyzed according to department, the experience of the physicians etc. to identify potential systematic relations in our empirical material. Since our material is fairly limited, our aim has not been to test significance of such relations, but rather to explore physicians' experiences with EMR with their individual background in mind.

Analysis

Ten different but related themes could be extracted from the interviews; (1) the implementation processes (what did they do and so on); (2) larger benefits when everybody used the system; (3) the systems supported freshmen better than experienced physicians; (4) EMR is useful in regard to professional learning; (5) seniors standing for the initial system training, new users learning from those with experience, (6) younger users reporting different attitude than seniors, but might be related to more than age and computer experience; (7) easier to produce text, but a potential for information overflow since complex case histories are hard to browse

through; (8) little or no support for mobile work, with few or no handheld devices; (9) instances of downtime, which influence the attitude towards the system and (10) aspects regarding the EMR-only situation compared to maintaining dual systems.

We will now discuss in more detail these themes[1].

The implementation processes

Both hospitals involved in this study had a similar approach to the introduction of their systems, and both went from paper based medical records only to EMR only. Hospital South was the first in Norway to withdraw the paper based medical record from clinical workflow, and Hospital North began their approach by learning from Hospital South.

> *"I guess we were the hospital that sort of adopted the largest amount of functionality in the shortest period of time. We had been down at Hospital South and looked at what worked and what didn't work down there, and tried not to make the same mistakes" (Hospital North, senior 3)*[2]

One important factor for the apparent success, as reported by physicians from both hospitals, was that both clinicians and key personnel from the management were strongly involved and enthusiastic about the project. There was a strong common understanding that the EMR had the potential of becoming a useful tool, and this point of view was broadly communicated throughout the organization.

> *"The director and chief physician took a lot [of decisions]. It became sort of an enlightened kingdom where decisions were made and then [people in] the rest of the organization were informed why they had been made. […] So that, during the introduction [of the system], I think it's important that you have a strong and clear leadership that says: 'Boys, this is the way it's going to be!' And then we had to sit down and figure out how to do it". (Hospital South, senior 1)*

[1] The themes that emerged during the interviews were overall very similar at both hospitals. Thus, if not otherwise specified in the text, the descriptions apply to both hospital South and hospital North.
[2] All citations translated from Norwegian to English by the authors

”It came mostly from me and those who, worked with the introduction of DIPS [to introduce as much functionality as possible…] But we quickly got acceptance when, the department leadership committed to the idea, and that was important for us”. (Hospital North, senior 3)

In both hospitals the decisions were mainly made by the chief management and clinical leadership, especially with regard to which system-functionalities should be mandatory, as well as the rationale behind the decisions which was communicated extensively. During these presentations input from staff at all levels was accepted and appreciated.

”Generally, I think the information was good. Especially the [coordinator] and the local IT department did a good job. It’s important when you are about to introduce an EMR system that you do like we did here, you strengthen the IT department and, they had plenty of local IT consultants and had an adequate number of administrative resources to do the scanning of the old paper based records”. (Hospital North, senior 1)

“We had a marvellous coordinator. She [..] is excellent [and] did a great job. Went everywhere and always kept staff informed and so on. But the decisions.., everybody was involved in the process, but the decisions were made up there [chief level]. And it was very clear that it was the director who made the decisions. And then you could be involved in the processes. So there were very orderly and clear lines [of communication or decision-making?], which I think is very important”. (Hospital South, senior 1)

As described above, even if only a few actors were involved in making the initial decisions, involvement and engagement spread among staff as the implementation project continued. Physicians from both hospitals reported that they had good contact with the implementation personnel and local IT departments; project managers were especially praised. The local IT departments were described as having positive attitudes during the process and willingness to go to great lengths to respond to requests from users.

”I think that our IT department, relatively regularly [..] had meetings with us and heard our requests, and we saw that if [these] did not come through we got feedback about why they could not be done.[…] So, we were straightforward with regard to evaluation in the period after introduction,[and it] made people feel that they had some degree of influence”. (Hospital North, senior 1)

Physicians received very prompt and thorough feedback if their requests not could be met due to technical issues or because of budget limitations. Thus, they were left with the impression that their inputs where of value and taken into account, even though their suggestions did not always lead to changes in the system. The local IT departments continued to play a vital role also after system launch, in that users got very rapid help if they had any questions regarding use of the system.

Despite very similar approaches to implementation, there were some differences between the two hospitals. A leading physician from Hospital North stated that Hospital South had granted their physicians too much freedom during the implementation process in that it was up to each physician to decide whether or not to use the system for tasks where the previous, paper-based routine was still an alternative (e.g., write prescriptions, fill out paper-based sick-leave forms, etc.). In contrast, Hospital North enforced the change of routines to a larger extent: physicians had no choice but to use the system for the majority of tasks. However, they pointed out some important factors that made it possible for them to do so.

As mentioned above, the physicians at both hospitals were well informed before the systems were implemented. This did not result in all clinicians being overly positive or optimistic about the project, but there was no evidence that ambivalent clinicians made attempts to sabotage the system. One chief physician at hospital North attributed this to their organizational culture. Physicians who did not support a particular view were encouraged to raise their objections and were listened to, but once a final decision was made, they did their best to adapt.

“Well, I guess we didn’t have any particular expectations, but maybe that.., it would be harder to navigate and more difficult to get an overview and so on,

but it's not like that. That's because the records are pretty complete. […] I have to say it has worked out far better than expected. A lot of the objections we had to begin with have been proved wrong". (Hospital North, senior 2)

As illustrated above, the physician was initially reluctant regarding use of the system, but nonetheless tried to cope with the change and in the end adopted the EMR system as a useful tool.

Another difference between the two hospitals was that Hospital North to a larger extent had combined the EMR system implementation with attempts to change clinical routines to exploit the advantages of electronic workflow. These changes were not very extensive, but as we will come back to in the next section, they were enough to highlight the importance of regarding organizational and technological changes as interrelated issues.

Greater benefits when everybody used the system

For some system functionality usage varied from department to department, but it also varied between individual physicians in the same department. At hospital South, where physicians had the greatest degree of freedom, use of the system for writing prescriptions or sick-leave notes varied considerably.

"I find it much faster to write prescriptions by hand. And sick leave notes too […] Can't be compared. It takes half the time". (Hospital South, resident 3)

"The usual stuff like sick leave notes and prescriptions are very easy to write [using the EMR system]. Sick leave notes go very fast, a lot of the information that has to be there comes up [automatically]" (Hospital South, resident 1)

The physicians cited above come from the same department, yet they describe the perceived usefulness of a given functionality in completely opposite ways. Both those in favor of the system and those who preferred pen and paper reported that their method was the most effective. Those who had started to use a particular function in the system reported doing so on their own initiative, whereas those who preferred

paper said there was strong organizational pressure on them to start using the EMR system.

At Hospital South, as mentioned in the introduction, there had been a significant increase in the use of these optional functionalities over a three-year time span. The reason, as suggested by the physicians, was a 'natural adaptation' to the system. As the EMR system gradually became an integral part of everyday work, physicians more often got the opportunity to observe other colleagues using the system and to discuss EMR system functionality with their peers. Everyday use of the EMR system also became a learning environment where users' EMR system skills spread between physicians. Some physicians also reported to have benefits from always being logged on to the EMR system. Seen in isolation, a particular task might be easier to do with the use of pen and paper (i.e. logging into the system to conduct the task was more cumbersome), but if one had the EMR on the screen in the first place, the task was much faster to perform with the EMR.

Hospital North, as mentioned above, had a slightly different approach than Hospital South in that it left users with fewer choices regarding whether or not to use the system. These constraints on the freedom of physicians did not have a negative impact on physician satisfaction with the use of the system, as Hospital North physicians were more satisfied with the use of the EMR system compared to their colleagues in South.

> *"As long as I've been a physician here I've used DIPS so I don't know about other systems at all. I did my internship at another hospital that also had DIPS , but they didn't use all the functionality we do here [at Hospital North]. And it was definitively things I missed at that hospital which I use here. For instance, we didn't enter medications in DIPS and didn't write medical charts notes in the same way" (Hospital North, resident 1)*

Accordingly, some of the physicians had very little experience in using tools other than the EMR system, which might also influence their attitudes towards the system. As for the tasks of writing prescriptions and sick-leave notes, physicians from the selected department at Hospital North mentioned one important factor they thought

had contributed to the ease of performing these tasks in their department: they used the medication module offered by the EMR system. Despite not having an electronic medical chart available, Hospital North had changed their admittance and discharge routines slightly to take advantage of the possibilities offered by the medication module. The admitting physician at Hospital North always updated the patient's medication list, and a paper medical chart with this information was printed. During the stay the paper-based medical chart was updated, but was scanned upon discharge. Also, during discharge, the medication module was updated once again, and according to physicians, this greatly improved the ease of writing for instance prescriptions and sick leave notes.

> *"If the medication-stuff had worked it would have been very useful to have it in DIPS you know - which drugs the patient is on - if a new patient is admitted you look at previous arrival notes […] If you had a system that was continually updated […] You've got it today, but it doesn't work […] It's not so good that I trust it […]. It may have changed, you can't be certain that it's updated". (Hospital South, intern 3)*

At Hospital South, the use of the medication module was optional. Only a fraction of the physicians used the module to create and update the patient's medication list. A physician could therefore not rely on the electronic medication list being updated, slowing down the previously mentioned tasks.

As reported from Hospital North, one reason for high EMR usage was that the management required the physicians to use the system and that the physicians obeyed this requirement. By applying an EMR system with a broad range of functions, and knowing that everybody used the system, the hospital achieved a 'use economy of scale. One of the strengths of computer systems is the way they can facilitate re-use of information, particularly when information is represented as structured data. One of the key factors for Hospital North's ability to maintain a high degree of use and satisfaction with the EMR system seemed to be the fact that nearly all information was entered into the system, with the key ingredient being the updated medication list in the medication module.

The systems supported freshmen better than experienced physicians

Interns described their role, humorously, as being the departments' "medical record slaves". The interns typically have the first contact with the patients, at least for patients in need of emergency treatment, and in that situation the interns often need a lot of information very quickly. They reported great usefulness in having a complete EMR available, where they could quickly accessed notes from previous encounters, discharge reports, and the medication lists from the last hospital stay. In addition, they could order laboratory tests and x-ray examinations from the same system.

Residents also generally had a very positive attitude towards the system. The EMR system helped them gain a better overview of the patients on the ward before they presented them at the morning briefing. As one of the residents said:

> *"Logging onto the EMR system is the first thing I do when I come to work. To check which patients have arrived at the ward, I can read up on the patients before I go to the morning briefing, read the arrival notes, I can read the nurses report if I want to. [...] Various test results [and] medications I get from the arrival note, but I can check [in the EMR] if I want to" (Hospital North, resident 1)*

Senior physicians generally reported the same advantages with the EMR systems as interns and residents. However, they also described tasks that the EMR system not did support, and highlighted that the EMR systems basically was a documentation system with modest support for electronic workflow. Among the many responsibilities of senior physicians are the tasks of assessing referral letters and monitoring the overall medical quality of the department. While senior physicians reported that getting an overview of the patient and evaluating referral letters had become easier with an EMR system with electronic workflow, support for patient logistics was at best modest. Extraction of data for developing quality indicators was also cumbersome. Respondents suggested specific tasks that deserved better support by the EMR system:

” if you eventually could have an electronic system that calculated time needed, and booked automatically […] x-ray examinations, blood samples, all the things you now have to do manually, when the patients arrived. [.. some sort of] planning tool”. (Hospital South, senior 3)

“What annoys me somewhat is that you have very limited influence on the system, and limited ability to generate reports yourself. How many [patients] with [a certain disease] have been admitted this year and so on. It’s not good enough. Then you could browse through and, yes, now I've got a question about how many new [diseases] you have had this year. And then I could see, but you can’t do that using DIPS, because you don’t register if a diagnosis is new or old, you can only see how many we’ve had with [this disease]. So, a good report generator. That is very much missed by most of us”. (Hospital South, senior 1)

The senior physicians emphasized the lack of ability to generate data reports, with which they could, for example, get overviews on diagnoses, complications, procedures performed, etc. These issues were now mainly handled manually or through separate department-specific systems, which were rarely integrated with the EMR. So, while the interns, residents and chief physicians mainly saw the same advantages with a paperless EMR system and electronic workflow, we also got the impression that the more senior and responsible physicians were, the less support they received and the less usefulness they perceived from the EMR system.

An EMR system is useful in regard to professional learning

All physicians involved in this study regarded their EMR system as useful for professional development, but some functionality was missed. Interns are enrolled in an educational program at the hospital, and both interns and their supervisors concluded that the EMR had improved the assessment of the interns’ documentation skills. However, few supervisors systematically used the EMR system to control the interns’ documents, both due to time pressures and the fact that they also had regular face-to-face meetings with their interns during which these issues were discussed. If an intern was uncertain of what to do about a particular case, the EMR system made it easy to either call a chief physician who could look up the patient’s case history in the

EMR, or (in less urgent cases) send an electronic note to a chief physician who would see the memo in his work-list and could look up the case when he had time. Further, if someone needed a specialist to interpret an x-ray image and the physician in question was in the operating theatre, the picture could be displayed on screen in the theatre. So, in the same way as the EMR system was useful when answering external calls about inpatients, it also facilitated electronic communication between professionals within the hospital.

Physicians highlighted two categories of functionality that they especially valued: Collaborative work, at least mediating of questions as described above, and functionality summarizing an individual's or a whole department's work in various reports (i.e., generating data reports). While the first to some degree was supported in the EMR, the latter was supported to a very limited degree at both hospitals. Interns and residents missed the ability to go back in time and read documents of previous patient encounters to recall and learn from interesting cases. Chief physicians missed the ability to generate reports about procedures, complications etc. as described above.

New users were given an introduction to the system by experienced users

Before the launch of the system, all physicians from both hospitals went to training sessions to be able to efficiently use the system once installed. In addition, there was increased manpower in the support section of the local IT departments during launch. After a while, as the system became more of a part of everyday work at the hospitals, this changed.

> *"When we arrived, a resident at the surgical department gave us a short introduction to DIPS. This was nice, since a lot of us didn't know anything about the system to begin with. And then it becomes sort of gradual.., you sit next to someone who knows a lot, and suddenly.., things go even smoother [in regard to using the system]". (Hospital South, intern 1)*

New users were given a short (between 30 minutes and one hour) introduction to the basic functionality of the system during their first days at the hospital. From then on, they were largely left to learn the system be themselves, but were aided by more

experienced users when needed. Still, the physicians we interviewed reported that this arrangement worked adequately. They were quickly able to use the most important functionality, and could deal with the system in a short period of time. However, some physicians said this arrangement made training and the general attitude towards the system somewhat person-dependent. Several interns said they were influenced by how their supervisors and close colleagues used the system, and most of them also pointed out several additional functions in the system that could be useful, but due to time pressures they had not prioritized spending more time learning the system. Some physicians also wanted better follow-up instruction after they had worked with the system for a period of time. For instance, having a system expert joining them in their work a few hours a year, providing them with clues in how to improve their use of the system and suggestions on how to perform tasks they felt cumbersome in other ways. At the same time, this process could help further development of the system by providing valuable feedback to system developers.

The juniors reported different attitude than seniors

As described above, recently employed physicians usually got an introduction to the basics of the system from more senior physicians. However, when it came to more advanced or optional functionality, most interns and residents reported of a difference in attitude between junior and senior physicians. While all physicians used the EMR systems for tasks where they more or less had no choice (e.g., finding specific information) senior physicians - according to the younger ones – tended not to use the system if they had a choice (e.g. write sick-leave notes or prescriptions). As one intern said:

> *"We youngsters might catch certain computer issues faster than they do [senior physicians]. That's just the way it is. However, it's nice to have the advantage there compared to a lot of other stuff..". (Hospital south, intern 3)*

When it came to learning how to master more advanced use of the EMR system, roles were inverted: The younger, more computer-savvy clinicians assisted and supervised senior clinicians when needed, in a manner identical to senior physicians' assistance and supervision of interns and residents in issues of medicine and healthcare. This did

however not seem to bring additional tension in the relation between senior and junior physicians.

Easier to produce text, but a potential for information overflow

Most respondents reported that it was easier to generate text, such as journal notes, in the EMR system than in the previous paper-based medical records. All respondents reported typing short journal notes, while longer notes (e.g., outpatient department notes and discharge reports) were dictated and later transcribed by medical transcriptionists. Some physicians had also begun to write discharge letters on their own, reusing data from the system to ease the process. Further, the reduced effort of producing text had increased the communication aspect of the medical record. Often, physicians wrote a small note in the EMR system to update the physician scheduled to be on duty the next morning. Thus, more updated information was available, also during weekends, when it could take a long time from the time of dictation to when the notes were transcribed.

> *"For the patients who have been at the ward for a long time there are a lot of documents named journal notes. And that could be anything from those two lines beginning with [medication] because of this or that, to long comprehensive notes that are very useful. […] The thing with DIPS is that for patients moving in and out the hospital a lot, it's hard to find what you look for. You get these long lists of notes. And journal notes are hard to find, so then the paper journal might be easier, because you often have a summary up front. And yes, you browse faster through paper compared to opening note after note on the computer, which also might be a slow one..". (Hospital South, intern 2)*

> *"You get a lot of documents for certain patients in DIPS, and then, if you don't know how to filter out a lot of those documents, you can end up spending a lot of time trying to find what you want". (Hospital North, resident 4)*

As illustrated above, the increased ease of documenting and the chronological structure of the EMR come at a cost; an increased amount of free text in the medical record. Several informants reported that the increased number of short notes and the

lack of structure made it more cumbersome to get an overview of patient cases. The physicians missed the ability to filter out what they regarded as insignificant documents. They wanted to be able to highlight documents that carried important information. For instance, physicians were not generally interested in notes describing that a lab test had been sent to an external laboratory, or in letters to patients reminding them of a forthcoming encounter.

Hence, the respondents wanted better ways to filter documents, or another way of structuring the record so that they could more easily access relevant and important information. In that respect, it was also reported that the use of scanned document images should be kept to a minimum. Images are at the outset not searchable, and therefore more cumbersome to use than electronic data represented as text and numbers. In addition, if the scanned documents are hand-written, they are often more illegible after they are scanned than they were in their original form. So, even though historic data have to be scanned to get a complete EMR, new information should, to a large extent, be entered as searchable data. This was also the case at the time of this study, as physicians reported far less use of scanned documents as time passed by.

Little or no support for mobile work

Despite electronic workflow and complete EMR systems, the medical records of the departments involved in this study were not completely paper-free. For instance all departments kept a paper-based medical chart that was scanned after patient discharge (the vendor is currently developing an electronic chart). Physicians also regularly printed parts of the EMR to keep some information about the patients in their pockets when they not were in front of a computer. However, printouts of large parts or the whole EMR were very rare.

> *”Well, it’s often, like when you do your rounds on the ward there are several times it would be useful to be able to look at the patient's journal, because you get questions - has that test result arrived? etc. - and you might need to quickly browse through the case history or something…”. (Hospital South, intern 4)*

"If you have done a proper job in advance you don't need [a mobile medical record] ". (Hospital North, senior 2)

As for mobile platforms, both departments had previously tested the use of laptop computers with wireless networking. However, physicians reported that walking around with laptops hindered, rather than, supported their work, so such solutions were rarely used. Also, they said that as long as the medical chart was still at least in part on paper, mobile solutions afforded only modest benefits. They emphasized that a mobile electronic medical chart, which they thought would be introduced shortly, had to be very easy to use and preferably in a format that could be easily carried around. Last, some physicians were skeptical to an electronic version of the medical chart, as the daily operation of the ward then would become even more sensitive to EMR system downtime (that should be non-existent, but nonetheless happens).

Still instances of downtime

All departments involved in our study had experienced incidents of EMR system downtime. Mostly, these were planned so that the affected departments could be prepared accordingly, but short incidents (e.g., those lasting up to one hour) of unplanned or sudden downtime had also occurred. None of the physicians in our study had experienced patient-related problems associated with system downtime. However, they reported that such instances were very hectic and troublesome, and should be avoided. Also, not having information available might in certain cases jeopardize patient safety, even though it had not been reported as the case so far.

"At nights, if you take those half hours when the EMR system is down and compare it to those nights - which was almost every night - when you run around looking for the paper-based medical record, we are now approaching 100% access to patient information - while you at night with the paper record had maybe 80-90% access. So I think 10-20% of [the] missing information is now reduced to a couple of percents, maybe one. Less I guess". (Hospital North, senior 1)

As demonstrated, physicians frequently lacked access to the medical record in the era of paper-based medical records. Still, downtime was a scary thought to most

respondents. Also, as some respondents stated, unplanned system downtime created scepticism towards transferring the medical chart to an electronic format. Hence, the physicians were sensitive to system downtime, but were able to cope with those few and brief instances.

EMR only versus dual systems

Of the physicians in this study, none had extensive experience working with both a paper-based medical record and an EMR system in parallel (dual systems). Some had experience from other hospitals and senior physicians had experience from the days of the paper records, but interns and residents from these hospitals had mostly worked with EMR only.

> *"Well, I like to focus on the positive aspects, so I think that life.., by having the information available at any time, that's, it's a completely new life. I mean, as a specialist, in an area with a lot of patients, you get a lot of questions from physicians out there [GP's etc.], and by not having to request the paper medical record, but having the information instantly, it's a totally different situation, a completely new world". (Hospital South, senior 1)*

What became clear from the interviews was that no physicians missed the time when they had only paper-based medical records and a paper-based workflow. A few of the residents at Hospital North had some experience with dual systems (EMR system and paper records in parallel), though the EMR systems in question had less functionality. These residents told us that in these periods they missed the all-embracing, highly functional EMR system they were used to, and could not understand how the physicians at other hospitals could be satisfied with their solutions. On the other hand, physicians in these hospitals were used to parallel systems and could not understand why visiting physicians were complaining, as they were quite happy with the way things worked. Still, as physicians from Hospital North and South told us, the real benefits, and the real joy of using the system, was when almost all information they needed could be accessed through the system without the need for multiple logins, everybody were using it and could communicate through the system and trust that the person they were trying to reach also used the system. Even when we challenged them during interviews by arguing for some benefits of the paper (e.g., ease of browsing,

familiarity, portability, etc.) most of the physicians did not agree. If they really wanted to, they could always print what they needed. Of the 18 physicians interviewed at Hospital North and South, only one missed having a paper based medical record available, but only during a single patient's stay.

Discussion

The effect of strong clinical involvement on the outcome of the implementation processes

When looking at the implementation projects in Hospital North and South, both sought to benefit from the 'traditional' factors of success [12]. These include informing and engaging end users, being aware of and having a strategy for handling organizational resistance, creating ownership at all levels and by all groups, getting support and participation from the management and having a proper training program [9, 10, 13, 14]. Including these factors in project plans does not, however, automatically lead to success. Berg [15] points out that the danger of focusing too strongly on critical success or failure factors in the implementation of a patient care information system (PCIS). Unintended consequences are prone to emerge [16, 17], and the danger, according to Berg, is believing that a focus on critical success factors, as a part of a plan based on assumptions and intentions of control and prediction, will solve the personal and organizational issues, eliminate unintended consequences, and ensure success. Instead, he argues for an acceptance of the fundamental unpredictability in such projects, due to the inherent complexity of the mutual relationship between organizational and technological issues. Thus, we will argue that one of the main reasons for the apparent success of the EMR introductions in our two case hospitals is that these factors were accepted as interrelated, handled according to the local contexts, and not treated as a blueprint towards a static future state.

Both the hospital leadership and leading physicians must be committed to the EMR system implementation project for such a project to achieve its goals. The relationship between hospital administrators and clinicians has often been described as problematic (e.g. [18]), where clinicians have been said to be preoccupied with medical excellence and the hospital leaders with budget, economy and accounting (e.g. [19, 20]). Often, EMR system introductions have been attributed to the

administrative part of the hospital organization. Therefore, one of the greatest challenges, and - as we see it – a prerequisite for the success of a hospital-wide EMR system implementation project, is for both administrative and clinical leadership to be strongly involved and enthusiastic about the project. However, enthusiasm is not enough in itself, and the organization must be prepared to allocate the necessary resources, not only for the technical implementation, but also for the preparation and involvement of relevant parts of the organization before, during and after the implementation.

Without an organization that is willing to undergo changes not much change will take place. We believe that a key factor is to create engagement among the leaders of the clinical departments, something that was achieved in the hospitals involved in this study. From there, the challenge is to establish a common vision and then start committing the rest of the organization. The employees must understand why a change is required, and the concept of envisioning an immediate gain as argued by Berg [21] therefore becomes important. As we were told during the interviews, clinicians generally accepted changes once they saw that the change eased the workload and/or improved the quality of their work. The above point also illustrates the importance of not solely focussing on the EMR system's ability to support individual users conducting single tasks, but also emphasizing the potential effect of the EMR system on clinical workflow - i.e. how the system may facilitate the exchange of responsibilities and tasks between members of the multidisciplinary healthcare team. This approach may however be challenging because of the established professionally centred focus of clinicians [19, 20], but still possible as demonstrated especially by hospital North.

Learning from best practice

Organizations often refer to best practices when introducing new technology such as EMR systems. This is arguably a correct approach, since it may be helpful to gain experiences from relevant successful and unsuccessful projects. Of the hospitals involved in study, the first step in the EMR implementation project in Hospital North was to collect experiences from the corresponding project in hospital South. Valuable insights were obtained by visiting the other hospital. However, they deliberately decided not to make their project a blueprint of that in hospital South, but modified

their plans to adapt them to their own unique situation. The EMR system vendor also provided advice based on their experiences as vendor to Hospital South. Based on the lessons from Hospital South, Hospital North formulated a vision of implementing the maximum amount of functionality in the least possible time.

Achieving collective benefits from organizational change

The contrasting use of the medication module in the two study hospitals is an example of how adjustment of routines in conjunction with the introduction of technology may lead to gains in the chain of processes. Hospital North developed new routines for writing prescriptions, sick leave forms and discharge reports concomitant with the implementation of the EMR system. As a result, the corresponding EMR functions were used extensively and physicians found out that everybody benefit from an updated medication list. Hospital South took a different approach, and chose not to change routines. In our opinion, the unwillingness to change the relevant routines in hospital South largely explains physicians persisting reports of underuse and cumbersomeness when trying to use these EMR functions. Because only a fraction of the physicians used and updated the medication list, physicians could not fully rely on the medication data and therefore did not benefit from re-use of the data when writing encounter notes, prescriptions and discharge summaries. In hospital South, the negative focus on these central EMR system functions also influenced on the physicians' attitude to and reported benefits from the EMR system as a whole. In the absence of beneficial effects of the collective use of the system, the physicians tended to rate their EMR system on the basis of the number of clicks, time to complete tasks and other usability aspects. Thus, we found - in line with Berg [22] - that an EMR system implementation have more profound effects if it also is accompanied by organizational changes. What we have shown is that a relatively small organisational change can have a relatively profound effect.

The need for organizational change may have become more obvious upon the completion of an EMR system implementation project. Accordingly, it may be more difficult to get acceptance for organizational changes during planning of the project. What characterized the respondents from Hospital North was that they described their colleagues as very loyal to the decisions, once these had been made. Thus, when a decision was implemented, clinicians complied by adapting their practices as much as

they could. It was considered important, however, that people were encouraged to voice their opinions, both positive and negative, before the decisions were taken. In our opinion, involving clinicians during all phases of the project as well as developing a culture that prepares the department for change are important factors. A culture for change does not imply that decisions must be followed blindly; but rather encourages raising and discussing various alternatives. However, once decisions are made, nobody should try to undermine but instead do their best both for the hospital and their department. Still, since changes are likely to occur also later, openness around the strengths and weaknesses of the decisions should be valued and used to suggest further improvements. In this way an EMR system implementation is not a one-time phenomenon, but a continuous process for IT-supported healthcare activities.

Poorer support from the EMR system for the work of more experienced physicians

During the interviews two interesting themes emerged; (1) the systems supported freshmen better than experienced physicians, and (2) young users reported to have a different attitude towards the EMR system than more senior users. Both junior and senior physicians agreed that that the EMR system was better at supporting the professional development of junior physicians that those with senior expertise. Senior physicians were supported by the EMR system in their role as supervisors, but not in their role as responsible for quality assessment and quality improvement.

The second theme however might be more complex than it seems. As demonstrated by the American sociologist W. I. Thomas, and later termed the "Thomas theorem," "…what is defined as real is real in its consequences" [23]. In this case, the *idea* that one, as a young physician, should have less problems with the use of computers and information systems, might lead to stubbornness with regard to the task of acquiring new information system skills and patience when it comes to older physicians' asking for IT assistance. A large proportion of the interns and residents in our study had never worked with a paper-based medical record and had therefore never got accustomed with paper-based routines. In contrast, senior physicians that became specialists before the age of EMRs became drilled in paper-based work routines as part of their training. Additionally they seemed to rely more on their own memory

instead of that of the computer. As a consequence, they used the computers for fewer tasks than their juniors (according to the juniors). Senior physicians reluctance to the use of computers does therefore not fully explain why they use EMRs less, that old habits die hard (and might be just as effective) and that seniors have slightly different responsibilities at the ward also is part of the explanation.

The legacy of the paper

As argued, large benefits from implementing an EMR system can only be achieved if they are accompanied by organizational changes. So far, few hospital management teams have dared to impose profound changes in information-handing routines when implementing an EMR system [3, 5, 7]. This might partly be explained by the legacy of the paper: Even if electronic workflow, ordering of lab results or other functionality has been introduced, the core components of Norwegian EMR systems are still electronic documents containing clinical narratives, bearing strong resemblance to its paper ancestor. Since the paper metaphor has survived the transition from the paper-based medical record to EMRs, paper is still very much alive in Norwegian hospitals. We describe this phenomenon as “paper-thinking”.

Our overall impression is that to this day, EMR system implementations in Norway have focused on gradually automating existing manual processes rather than supporting more radical changes. From the perspective of physicians, some complex but crucially important senior clinical tasks have poor support. For these tasks, custom built quality registries and other clinical departmental systems are used [24]. In our opinion, paper-thinking now increasingly is becoming an obstacle to the further development of EMR systems in Norway.

We strongly believe that an EMR that builds on the paper metaphor does not fully leverage the potential benefits of Information and Communications Technologies (ICT). As pointed out by Nelson and Winter (p. 135)[25], “Firms may be expected to behave in the future in ways that resemble the behaviour that would be produced if they simply followed the routines of the past”. An EMR system technology that replicates established work routines reinforces this tendency. When clinicians accustomed with paper are left with a choice of using paper or a more cumbersome electronic paper-equivalent, the result is more or less given. At Hospital South, it

took almost three years before the majority of physicians started to utilize optional functionalities, even though they were encouraged to use them.[7]

Conclusion

In this study we have demonstrated that many physician users perceive benefits from the EMR systems, but that the legacy of the old paper-based routines and structures still prevails. The challenge now, in our opinion, is to remove paper not just physically, but also to overcome the paper shadow of the past, slowing down the pace of organizational changes. The explicit goal of going paperless should be to streamline processes and improve quality, rather than to save money by not having to maintain a paper archive.

Competing interests

None declared

Authors' contributions

JTL designed the study, participated in all the interviews, transcribed the interviews, analyzed the data and drafted the manuscript; AT participated in the design of the study, helped analyzing the data, revised and helped to draft the manuscript; AF participated in the design of the study, participated in the interviews at hospital South, revised and helped to draft the manuscript. All authors read and approved the final manuscript.

Acknowledgements

This research was funded by the Central Norway Regional Health Authority through the project “Effective use of information and communication technology in hospitals”. The investigation was performed in cooperation with the Norwegian Research Centre for Electronic Patient Records.

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Article 4:

Barriers for interdisciplinary teamwork in hospitals:

The myth of professional cultures

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Submitted to Health Care Management Review

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Appendix 1: The Questionnaire

Below the questionnaire used in article 1, 2 and 3 is attached. The list of tasks in section D2 and F of the questionnaire, as well as the tasks regarding scanning in section D1 was modified according to the available functionality and the scanning strategy at the various hospitals, as described in section 6.1. This particular questionnaire showed here was for Aust Agder hospital Arendal, and thus is modified to that particular hospital. The available functionality at the various hospitals is shown in appendix 2. The questionnaire below is for physicians only. However, the questionnaire for nurses and medical secretaries had the same structure, but different list of tasks. The task-list for nurses and for medical secretaries is attached in appendix 2.

1201

EMR evaluation form physicians
jan.tore.lium@iot.ntnu.no

IDnr 1 11a

Doctors

Check like this: ☒
not like this: ☐

A. About your work position

1 Do you regularly work with patients in this hospital? ☐ Yes ☐ No

2 Have you been working for more than three months in this hospital? ☐ Yes ☐ No

If your answer was "no" to any of these questions, you dont have to complete the rest of this questionnaire. Still, we would very much like you to return the questionnaire in the enclosed envelope.

3 Gender: Male ☐

Female ☐

4 Age

20-29	30-39	40-49	50-59	>60
☐	☐	☐	☐	☐

5 Clinical position: ☐ Intern ☐ Resident ☐ Consulting physician

B. About your experience with computers

	Lowest		Average		Highest	Not relevant
1 How would you rate your computer skills in general?	☐	☐	☐	☐	☐	
2 How would you rate your computer skills in ...						
a) Dips	☐	☐	☐	☐	☐	
b) PACS	☐	☐	☐	☐	☐	☐

C. About the availability of computers at your working place at the hospital

	Yes	No
1 Do you have a computer in your office?	☐	☐

	Never	Less frequently than monthly	Monthly	Weekly	Daily
2 About the computers installed in the ward, at the outpatient clinic offices, investigation rooms, etc: How often are you prevented from or delayed in using them because others are using them?	☐	☐	☐	☐	☐
3 How often do you miss having a computer available where you do patient-related work?	☐	☐	☐	☐	☐
4 How often are you prevented from or delayed in using a computer due to computer errors, system crashes or other machine-related problems?	☐	☐	☐	☐	☐
5 How often are you prevented from or delayed in using a computer due to password problems?	☐	☐	☐	☐	☐
6 How often are you prevented from or delayed in using a computer because the system is working too slowly?	☐	☐	☐	☐	☐

D. About your use of DIPS for clinical tasks in the hospital

At Aust-Agder Hospital an electronic medical record (DIPS 2000) is installed, consisting of "purely" electronic data and scanned paper records. The latter contains mainly older documents from the patient record, but also some newer information (external lab tests, referrals, etc.) Since the part of DIPS handling the scanned information differs so much from the rest of the system, we are keeping it separate in this questionnaire.

D1. When you expect to find the information in the scanned part of DIPS, how often do you use it for the following tasks:

	Never/ almost never	Seldom	About half of the occasions	Most of the occasions	Always/ almost always
1 Review the patients problems					
a. from documents scanned in sections ("bulk")	☐	☐	☐	☐	☐
b. from documents scanned one sheet at a time	☐	☐	☐	☐	☐
2 Seek out specific information from patient records					
a. from documents scanned in sections ("bulk")	☐	☐	☐	☐	☐
b. from documents scanned one sheet at a time	☐	☐	☐	☐	☐
3 Follow the results of a particular test or investigation over time					
a. from documents scanned in sections ("bulk")	☐	☐	☐	☐	☐
b. from documents scanned one sheet at a time	☐	☐	☐	☐	☐
4 Obtain the results from clinical biochemical laboratory analyses					
a. from documents scanned in sections ("bulk")	☐	☐	☐	☐	☐
b. from documents scanned one sheet at a time	☐	☐	☐	☐	☐
5 Obtain the results from X-ray, ultrasound or CT investigations					
a. from documents scanned in sections ("bulk")	☐	☐	☐	☐	☐
b. from documents scanned one sheet at a time	☐	☐	☐	☐	☐
6 Obtain the results from other supplementary investigations					
a. from documents scanned in sections ("bulk")	☐	☐	☐	☐	☐
b. from documents scanned one sheet at a time	☐	☐	☐	☐	☐
7 Obtain the results from new tests or investigations *(always scanned on sheet at time)*	☐	☐	☐	☐	☐

D2. The scanned document images notwithstanding, how often do you use DIPS to assist you with the following tasks:

		Never/ almost never	Seldom	About half of the occasions	Most of the occasions	Always/ almost always
1	Review the patients problems	☐	☐	☐	☐	☐
2	Seek out specific information from patient records	☐	☐	☐	☐	☐
3	Follow the results of a particular test or investigation over time	☐	☐	☐	☐	☐
4	Obtain the results from new tests or investigations	☐	☐	☐	☐	☐
5	Enter daily notes	☐	☐	☐	☐	☐
6	Produce data reviews for specific patient groups, e.g. complication rate, distribution of diagnoses.	☐	☐	☐	☐	☐
7	Order clinical biochemical laboratory analyses	☐	☐	☐	☐	☐
8	Obtain the results from clinical biochemical laboratory analyses	☐	☐	☐	☐	☐
9	Order X-ray, ultrasound or CT investigations	☐	☐	☐	☐	☐
10	Obtain the results from X-ray, ultrasound or CT investigations	☐	☐	☐	☐	☐
11	Obtain the results from other supplementary investigations	☐	☐	☐	☐	☐
12	Refer the patient to other departments or specialists	☐	☐	☐	☐	☐
13	Write prescriptions	☐	☐	☐	☐	☐
14	Complete sick-leave forms	☐	☐	☐	☐	☐
15	Collect patient information for various medical declarations	☐	☐	☐	☐	☐
16	Give written individual information to patients, e.g. about medications, disease status	☐	☐	☐	☐	☐
17	Give written general medical information to patients	☐	☐	☐	☐	☐
18	Collect patient info for discharge reports	☐	☐	☐	☐	☐
19	Check and sign typed dictations	☐	☐	☐	☐	☐
20	Register codes for diagnosis or performed procedures	☐	☐	☐	☐	☐

E1. About your satisfaction with DIPS, the part handling the scanned paper records

*Here we would like to learn your opinion of the part of DIPS handling the **scanned** paper records*

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
1 Content					
a How often does the system provide the precise information you need?	☐	☐	☐	☐	☐
b How often does the information content meet your needs?	☐	☐	☐	☐	☐
c How often does the system provide reports[1] that seem to be just about exactly what you need?	☐	☐	☐	☐	☐
d How often does the system provide sufficient information?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
2 Accuracy [2]					
a How often is the system accurate?	☐	☐	☐	☐	☐
b How often are you satisfied with the accuracy of the system?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
3 Format					
a How often do you think the output is presented in a useful format?	☐	☐	☐	☐	☐
b How often is the information clear?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
4 Ease of use					
a How often is the system user-friendly?	☐	☐	☐	☐	☐
b How often is the system easy to use?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
5 Timeliness					
a How often do you get the information you need in time?	☐	☐	☐	☐	☐
b How often does the system provide up-to-date information?	☐	☐	☐	☐	☐

[1] *"Report" may be interpreted as a selection or resume of information shown on the screen or printed*
[2] *E.g. that correct journal, patient and document type is displayed; that the information (e.g. blood pressure) is presented having the right name; that the values are correct, etc.*

E2. About your satisfaction with DIPS, the part handling the regular electronic data

*Here we would like to learn your opinion of DIPS, **regardless of** the part handling the scanned paper records*

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
1 Content					
a How often does the system provide the precise information you need?	☐	☐	☐	☐	☐
b How often does the information content meet your needs?	☐	☐	☐	☐	☐
c How often does the system provide reports that seem to be just about exactly what you need?	☐	☐	☐	☐	☐
d How often does the system provide sufficient information?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
2 Accuracy [1]					
a How often is the system accurate?	☐	☐	☐	☐	☐
b How often are you satisfied with the accuracy of the system?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
3 Format					
a How often do you think the output is presented in a useful format?	☐	☐	☐	☐	☐
b How often is the information clear?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
4 Ease of use					
a How often is the system user-friendly?	☐	☐	☐	☐	☐
b How often is the system easy to use?	☐	☐	☐	☐	☐

	Never/ almost never	Seldom	About half of the time	Most of the time	Always/ almost always
5 Timeliness					
a How often do you get the information you need in time?	☐	☐	☐	☐	☐
b How often does the system provide up-to-date information?	☐	☐	☐	☐	☐

[1] *E.g. that correct journal, patient and document type is displayed; that the information (e.g. blood pressure) is presented having the right name; that the values are correct, etc.*

F. In your opinion, how has DIPS changed the performance of the following tasks in your department:

		Significantly more difficult	More difficult	Slightly more difficult	No change	Slightly easier	Easier	Signifi-cantly easier
1	To review the patients problems has become	☐	☐	☐	☐	☐	☐	☐
2	To seek out specific information from patient records has become	☐	☐	☐	☐	☐	☐	☐
3	To follow the results of a particular test or investigation over time has become	☐	☐	☐	☐	☐	☐	☐
4	To obtain the results from new tests or investigations has become	☐	☐	☐	☐	☐	☐	☐
5	To enter daily notes has become	☐	☐	☐	☐	☐	☐	☐
6	To produce data reviews for specific patient groups (eg. complication rate) has become	☐	☐	☐	☐	☐	☐	☐
7	To order clinical biochemical laboratory analyses has become	☐	☐	☐	☐	☐	☐	☐
8	To obtain the results from clinical biochemical laboratory analyses has become	☐	☐	☐	☐	☐	☐	☐
9	To order X-ray, ultrasound or CT investigations has become	☐	☐	☐	☐	☐	☐	☐
10	To obtain the results from X-ray, ultrasound or CT investigations has become	☐	☐	☐	☐	☐	☐	☐
11	To obtain the results from other supplementary investigations has become	☐	☐	☐	☐	☐	☐	☐
12	To refer the patient to other departments or specialists has become	☐	☐	☐	☐	☐	☐	☐
13	To write prescriptions has become	☐	☐	☐	☐	☐	☐	☐
14	To complete sick-leave forms has become	☐	☐	☐	☐	☐	☐	☐
15	To collect patient information for various medical declarations has become	☐	☐	☐	☐	☐	☐	☐
16	To give written individual information to patients, (e.g. about medications, disease status) has become	☐	☐	☐	☐	☐	☐	☐
17	To give written general medical information to patients has become	☐	☐	☐	☐	☐	☐	☐
18	To collect patient info for discharge reports has become	☐	☐	☐	☐	☐	☐	☐
19	To check and sign typed dictations has become	☐	☐	☐	☐	☐	☐	☐
20	The register codes for diagnosis or performed procedures has become	☐	☐	☐	☐	☐	☐	☐

G. Global assessment of DIPS

Finally, we would like to know your opinion about the electronic medical record in your department, all considered.

		Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly disagree
1	How much do you agree with the following statement: EMR is worth the time and effort required to use it	☐	☐	☐	☐	☐	☐	☐

		non-existent	poor	fair	good	excellent
2	All considered, how would you rate your satisfaction with DIPS in your department?	☐	☐	☐	☐	☐

3 All considered, to what extent has EMR changed these three aspects of your own department?

		Significantly more difficult	More difficult	Slightly more difficult	No change	Slightly easier	Easier	Significantly easier
a	The performance of our departments work has become	☐	☐	☐	☐	☐	☐	☐
b	The performance of *my own* tasks has become	☐	☐	☐	☐	☐	☐	☐

		Significantly decreased	Decreased	Slightly decreased	No change	Slightly increased	Increased	Significantly increased
c	The quality of our departments work has become	☐	☐	☐	☐	☐	☐	☐

		non-existent	poor	fair	good	excellent
4	All considered, how would you rate the success of the EMR system installed in your department?	☐	☐	☐	☐	☐

H. Comments

In your opinion, are any of the functions in DIPS particularly useful? If so, please explain

In your opinion, are any of the functions in DIPS not very useful? If so, please explain

Do you miss any functionality in DIPS? If so, please explain

Were parts of the questionnaire unclear or ambiguous? Other comments?

Appendix 2: List of tasks and available functionality

Below the list of tasks in the questionnaires is attached. Grey cells represent available functionality, and white unavailable as reported from the hospitals. It should be noted that some functionality might have been added since the time of the studies. Also, all hospitals have additional computer programs offering different functionality. However, the table represent basic functionality in an EMR-systems defined by Lærum [72]. The column names of the tables have the following meaning:

- DIPS1: Aust Agder hospital Arendal. Also named hospital South in article 4.
- DIPS2: Hospital North in article 4.
- DL1: Dermatology department from a large hospital using the DocuLive EMR system.
- DL2: Dermatology department from a large hospital using the DocuLive EMR system.
- DL3: Dermatology department from a large hospital using the DocuLive EMR system
- Infomed: A medical department from a medium size hospital using an EMR system from Infomedix.

Physicians

		DIPS1	DIPS 2	DL1	DL2	DL3	Infomed
1	Review the patient's problems						
2	Seek out specific information from patient records						
3	Follow the result of a test or investigation over time						
4	Obtain the results from new tests or investigations						
5	Enter daily notes						
6	Obtain information on investigation or treatment procedures						
7	Answer questions concerning general medical knowledge (e.g. concerning treatment, symptoms, complications etc.)						
8	Produce data reviews for specific patient groups, e.g. complication rate, distribution of diagnoses.						
9	Order clinical biochemical laboratory analyses						
10	Obtain the results from clinical biochemical laboratory analyses						
11	Order X-ray, ultrasound or CT-investigations						
12	Obtain the results from X-ray, ultrasound, or CT investigations						
13	Order other supplementary investigations						
14	Obtain the results from other supplementary investigations						
15	Refer the patient to other departments or specialists						
16	Order treatment directly (e.g. medicines, operations etc.)						
17	Write prescriptions						
18	Complete sick-leave forms						
19	Collect patient data for various medical declarations						
20	Give written individual information to patients (such as medication lists, status of the disease, etc)						
21	Give written general information to patients about the illness						
22	Collect patient information for discharge reports						
23	Check and sign typed dictations						
24	Register codes for diagnosis or performed procedures						

Nurses

		DIPS1	DIPS 2	DL1	DL2	DL3	Infomed
1	Review the patient's problems						
2	Follow the patient's condition over time						
3	Seek out specific information from patient records						
4	Follow results of a test or investigation over time						
5	Obtain results from new tests or investigations						
6	Order clinical biochemical laboratory analyses						
7	Obtain results from clinical biochemical laboratory analyses						
8	Obtain results from X-ray, ultrasound or CT investigations						
9	Obtain results from other supplemental investigations						
10	Obtain the patient's medication list						
11	Check allergies regarding medications						
12	Collect patient data for documentation purposes						
13	Keep list of short notes about each patient (e.g. problems and diagnoses						
14	Collect patient data for daily updates of nurses' documentation						
15	Collect patient data for nurses' summarizing report						
16	Give written specific information to patients						
17	Give written general information to patients						
18	Review patients currently admitted to the ward (name, date of birth, room)						
19	Transfer patient to other section, ward or institution						

Medical secretaries

		DIPS1	DIPS 2	DL1	DL2	DL3	Infomed
1	Review the patient's problems						
2	Seek out specific information from the patient records						
3	Locate the patient's paper documents (including the paper-based medical record)						
4	Review the patient's contacts with the hospital						
5	Review the patient's list of medications						
6	Obtain or print out results from lab tests, radiological or other supplemental investigations						
7	Obtain information regarding address of patient or relatives						
8	Obtain information regarding name and address of patient's primary physician or local hospital						
9	Review inpatients in the ward (name, date of birth, room)						
10	Register referrals						
11	Register patients in waiting lists						
12	Book, rebook or cancel appointments for outpatient clinic or planned admissions						
13	Coordinate appointments for investigations with appointments in outpatient clinics or planned admissions						
14	Transfer patient to another ward or institution						
15	Send standard note to patient (letter for waiting list, admissions, preparation for investigations)						
16	Transfer documents for ratification of physician						
17	Transfer documents regarding internal communication in the hospital (e.g. referrals)						
18	Type dictations in textual part of the patient record						
19	Keep the documents in the paper-based or electronic medial record sorted						
20	Type documents that is not part of the running medical record (i.e. admission notes, daily notes and discharge notes, individual letters, requests)						
21	Make and send discharge notes						
22	Select and register codes for diagnoses and performed procedures						
23	Make or print out reports of aggregated data, patient list, etc.						