

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

Jan-Tore Lium, MSc.

Department of industrial economics and technology management
Norwegian University of Science and Technology (NTNU)

Hallvard Lærum, MD, PhD.

Rikshospitalet University hospital, Oslo, Norway.

Tom Schulz, MD, PhD

Sørlandet hospital HF, Arendal, Norway.

Arild Faxvaag, MD, PhD.

Norwegian Research Centre for Electronic Patient Records,
Faculty of medicine
Norwegian University of Science and Technology (NTNU)

Corresponding author:

Jan-Tore Lium

Address:

Norwegian Research Centre for Electronic Patient Records

Medisinsk teknisk forskningscenter

7489 Trondheim, Norway

jan.tore.lium@iot.ntnu.no

Fax: +47 73 55 15 30

Phone: +47 900 83 085

Abstract

Objective: Many Norwegian hospitals that are equipped with an electronic medical record (EMR) system now have proceeded to withdraw the paper-based medical record from clinical workflow. In two previous survey-based studies on the effect of removing the paper-based medical record on the work of physicians, nurses and medical secretaries, we concluded that to scan and eliminate the paper based record was feasible, but that the medical secretaries were the group that reported to benefit the most from the change. To further explore the effects of removing the paper based record, especially in regard to medical personnel, we now have conducted a follow up study of a hospital that has scanned and eliminated its paper-based record.

Design: A survey of 27 physicians, 60 nurses and 30 medical secretaries. The results were compared with those from a previous study conducted three years earlier at the same department.

Measurements: The questionnaire covered the frequency of use of the EMR system for specific tasks by physicians, nurses and medical secretaries, the ease of performing these tasks compared to previous routines, user satisfaction and computer literacy.

Results: Both physicians and nurses displayed increased use of the EMR compared to the previous study, while medical secretaries reported generally unchanged but high use.

Conclusion: The increase in use was not accompanied by a similar change in factors such as computer literacy or technical changes, suggesting that these typical success factors are necessary but not sufficient.

Key words

Lium, Report from a near paperless hospital. Page 3 of 28

From MeSH: Medical Records Systems, Computerized; Hospitalists; Norway;

Questionnaires

Not from MeSH: Document Scanning; User Satisfaction; Clinical Work Practice

I. Background

It is widely acknowledged that the electronic medical record (EMR) has the potential to become the core electronic information and communication system in the health care sector ¹. With the assumption that EMR systems can improve both the quality and the effectiveness of health care delivery, numerous governments and health care provider organizations have invested in development and deployment of EMR systems. Despite these efforts, studies show both low adoption ² and failed initiatives ¹⁻⁶. In Norway, a large proportion of hospitals have implemented an EMR system. Hospitals and systems however differ with regard to use and the perceived impact of the EMR system on clinical work⁷.

Even though considerable achievements have been made in the spread of information technology in the health care service, widespread clinical use of EMR systems has not yet been achieved ⁸. The reasons for this lack of use are not clear, and may vary from site to site, but some possible explanations exist. These include for example computer skills ⁹⁻¹¹, the implementation process ^{3, 12, 13}, immediate benefit ¹⁴ and the impact on time efficiency ¹⁵. Elberg ¹⁶ raises the question of whether the EMR systems of today are too similar to the paper-based counterpart, focusing on automating existing routines rather than on innovations changing the way that things are done. Using an approximate electronic equivalent of the paper-based record may remove some of the advantages of the paper without taking advantage of the opportunities provided by a computerized system ¹⁷. This suggestion supports the insights by Ellingsen ¹⁸, who in a study of everyday interdisciplinary work in a hospital identified the EMR system as having reinforced existing routines rather than promoting new ways of working, noting the similarities between the document-based EMR and the paper-record as a possible explanation for the lack of process innovation.

The above factors may all contribute to the use or lack of use of EMR systems, but one important issue is yet to be mentioned: most hospitals, having implemented an EMR system, still use the paper-based medical record in parallel, leaving users with an option whether or not to use the EMR system¹⁹. This, in combination with an EMR system based on existing routines, may make extensive use of the EMR difficult to achieve. Also, parallel use can lead to inconsistency between the systems^{20,21} and to higher overall cost¹⁹; the ultimate goal should therefore be to assemble all data into an electronic record only²⁰. This is what has been achieved at Aust Agder hospital, Norway.

II. Basis for our study

In 2001 Aust Agder hospital was the first hospital in Norway, and to our knowledge one of the first hospitals in the world, to scan and eliminate its paper-based medical record. Studies by Lærum et al^{22,23} concluded that scanning and eliminating the paper-based record was feasible, but that the initial benefits were mainly obtained by the medical secretaries. Also, physicians and nurses reported low satisfaction with the features of the EMR relating to the use of the scanned document images. Lærum et al²² recommended that the images should be considered as an intermediate stage towards fully electronic medical records. Still, the results showed a greater degree of use than in comparable hospitals which used the paper medical record in parallel, especially in the retrieval of information.

Since 2002, several other Norwegian hospitals have, and many intend to, in varying degrees scan and stop using the traditional paper medical record. However, little research has been done about the effects of these changes, and exploring how medical personnel work in a paperless environment.

To expand this pool of knowledge, in the spring of 2005 we repeated the survey at Aust Agder hospital to explore changes in use and satisfaction in relation to the EMR. We were particularly interested in the changes among nurses and physicians, as they were the groups with 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. Lastly, studying a hospital with unique experience of being paperless, we wanted to see whether scanning is a feasible strategy in the moves towards implementing the EMR systems of the future. To our knowledge, this is the first longitudinal study of a hospital that no longer maintains a paper-based medical record.

III. Materials and methods

A. The hospital

Aust-Agder hospital, now part of Sørlandet hospital, is community hospital serving a population of about 100.000 in Aust-Agder County, southern Norway. The patients are admitted by primary care physicians external to the hospital and followed up by the hospitalists. The services the hospital provides is illustrated in table 1.

< Table 1 about here >

B. The EMR-system

The EMR-system in use (DIPS 2000) is both a hospital administrative system and an EMR system that support electronic workflow²⁴ (table 2). Only minor modifications have been done to the system since the last survey (for a description of the system also see Lærum.et.al²²). As for response time, we have no accurate data. However, a rough estimate at

the time of study was about 5 seconds to open a journal note, and up to 20 seconds to open a full journal (personal communication). Also, the EMR system had planned down time about three to four times a year, up to two 60 minutes, and one instance of server crash leading to a few hours of down time.

< Table 2 about here >

C. The EMR-system implementation project

Well funded, and with a strong commitment by both the hospital administration and the chief clinicians, the process of implementing DIPS started in March 2000. In April 2001, all except the psychiatric department started to scan documents (all departments were scanning at the time of study); hence all new patient data were channeled into the EMR-system in these departments. The decision to withdraw the paper-based medical record immediately after introduction of the EMR-system was made right from the start, based on a vision that the hospital should be 'paper free'. Partly explaining that bold decision, an undertaking previously not accomplished by a Norwegian hospital, key persons in the hospital management had undergone medical informatics education. The CEO of the hospital had previously occupied a central position in KITH, a national centre for informatics in health and social care, and thus one of the leading experts on EMR in Norway. So, the project was initiated with a clear intention of replacing the paper based medical record, and the administrative and clinical leadership convinced the rest of the organization to take part in this vision.

D. The Scanning process

Upon admission to the hospital, it is controlled 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*. As of early 2005 this process had to be done for 24% of the patients admitted to the medical department, the remaining either had this process completed at a previous encounter (63%) or simply did not have a paper based medical record (13%). 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 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).

E. The survey

Based on a questionnaire developed by Lærum²⁵, the survey was carried out in February and March 2005. Some 33 physicians, 88 nurses and 30 medical secretaries from the medical department were invited to participate in the study. The response rate was 82%, 68% and 100% respectively. Of these, 4 physicians and 10 nurses were excluded due to failing to complete the control questions, leaving the total sample for analysis at 23 physicians, 50 nurses and 30 medical secretaries. Corresponding to a response rate of 70%, 57% and 100%.

The questionnaire consists of eight parts: Part A covered staffing category and demographic data, part B was about computer experience, part C about availability of computers, part D about use of the EMR system during performance of central clinical tasks, part E about user satisfaction, part F about change in performance, part G about assessment of the system as a whole, and part H about organizational culture. Part H, as the only major change since the last survey, was deliberately located last so as not to interfere with the

validity of the questionnaire. Separate versions with the same structure, but a different list of tasks, were handed out to the members of the three professional groups involved. Examples of tasks included in the questionnaire for physicians are: 'Review the patient's problems', 'seek out specific information from patient records', 'write prescriptions' and 'complete sick leave forms'. There were 20 tasks for physicians, 19 for nurses and 23 for medical secretaries. For a complete list of tasks, see the online supplement.

F. Analysis

The questionnaire had previously been used in a national survey among physicians⁷ and in a local study at the same hospital as in our survey^{22,23}. To study the use of the EMR system as a function of time, questionnaire data obtained in the current study were compared with those collected from the same department in 2002. The department of internal medicine was chosen because a substantial proportion of its patients have chronic diseases, a history of multiple previous contacts and medical record documents. We believe the situation of the internists can be compared to that of other specialists and departments serving patient with chronic conditions. However, we cannot rule out that differences exist.

SPSS 12.0 for Windows was used for statistical analysis. The user satisfaction score was calculated by adding the response values of the 12 questions in this section (part E in the questionnaire) and converting the sum to a percentage of the maximum possible score. The analyses of the rest of the questionnaire were, as recommended by Lærum²⁵, performed separately for each question, using the Kruskal-Wallis or Mann-Whitney U nonparametric analysis. Correlations were calculated using Spearman's Rank Order Correlation.

IV. Results

A. Reported use and effect of the EMR system on the performance of important tasks

1) Further increase in the physicians' use of the EMR system when performing clinical tasks related to the generation and storage of information

Compared with data from 2002, just after the hospital had embarked on the project to remove the paper-based medical record from clinical workflow, the physicians now (2005) report a further, significant increase in the use of the EMR system for 11 of 19 clinical tasks, many of which are related to the active generation and storage of information (figure 1). In 2002, only a minority of the physicians reported using the EMR system when performing tasks belonging to this group. Back then; the system was mainly used for information retrieval. As figure 1 clearly depicts, physicians now report to use the EMR system for a broader, more complete spectrum of the tasks. The exemptions are that the EMR system seldom is used to produce data reviews for specific patient groups, or to provide written general (not patient-specific) medical information to patients.

In contrast to the reported changes in the use of the EMR system, there were no significant differences between 2002 and 2005 with regard to perceived change of ease in performing individual tasks when using the EMR system compared to previous (paper-based) routines. As in 2002, the respondents were generally positive about the effects of the EMR system for most tasks. Both now and in 2002, a substantial proportion of the physicians reported that a few but important tasks had become more cumbersome after the withdrawal of the paper

medical record, and thus that the EMR system failed to support these tasks effectively. For instance, 22.7% of the physicians reported that to review the patient's problems had become more difficult. 40.9% reported that to order ultrasound, CT or X-ray investigations had become more difficult, and as for writing prescriptions and sick-leave forms, 31,8% and 36,4% respectively reported a decrease in performance.

< Figure 1 about here >

2) Nurses reported both increased use and improved performance

Compared to the 2002 study, nurses reported increased use of the EMR in 13 of 19 tasks (Figure 2; Mann-Whitney U; $p < 0.05$ in 5 tasks, $p < 0.01$ in 2 tasks and $p < 0.001$ in 6 tasks), and reported that the performance of 14 of 19 tasks had become more effective (Mann-Whitney U; $p < 0.05$ in 3 tasks, $p < 0.01$ in 6 tasks and $p < 0.001$ in 5 tasks). In contrast to physicians, nurses reported a general increase in EMR system use both for tasks associated with information retrieval and tasks related to the generation and storage of information. Nurses were the professional group with the lowest overall use in the 2002 survey, but now seem to have adapted to the EMR system and started to include its use into daily work routines. Accordingly, nurses report that the use of the EMR system has eased the performance of tasks compared to previous routines, the highest negative score being 6,1% for any task.

< Figure 2 about here >

3) Status quo for medical secretaries

Medical secretaries reported increased use of the EMR system for the performance of three tasks (task 2, 16 and 17) and decreased use in two, compared to the previous study. As in 2002, medical secretaries were the group with the highest overall level of use. The median

response for 18 of the 23 tasks was “most occasions” or more. The two tasks with decreased use (“locate the patient’s paper documents” and “register referrals”) can probably be explained by the diminished use of paper documents in general.

4) No decrease in use of scanned document images

Despite more regular electronic data available, the physicians reported use of scanned document images (scanned single documents or scanned multiple documents) remained unchanged. In fact, nurses and medical secretaries indicated an increased use of scanned documents when performing certain tasks. However, for all tasks, physicians and nurses reported using regular electronic data significantly more often than scanned document images. Also, scanned single documents were used more often than scanned multiple documents. This indicates, unsurprisingly, that recently obtained patient data are used more frequently than (older) medical record data obtained before the introduction of the EMR system.

B. Users are most satisfied with the use of routine electronic data

As in 2002, physicians were significantly less satisfied with the use of patient data archived as scanned images compared with the use of routine electronic data (Figure 3). This difference was also noted among the nurses, but not the medical secretaries (Figure 3). Secretaries were the group that was most satisfied with the system both now and in 2002. Physicians reported similar levels of user satisfaction to those in 2002, and were the professional group that displayed least satisfaction. Nurses reported an increase in satisfaction with both the features dealing with scanned images and those using routine electronic data from 2002 to 2005.

<Figure 3 about here>

As for overall satisfaction with the system, no significant change was found compared to the 2002 survey, and the same tendencies continue to apply: Medical secretaries report to be more satisfied than nurses or physicians (figure 4). In all three professional groups surveyed, a considerably larger proportion of respondents were positive rather than negative about the effects of the EMR system.

<Figure 4 about here>

A possible contribution to the differences in satisfaction between the professions as discussed by Lærum et al²³ was that physicians reported being more delayed or hindered due to computer errors or the slow working of the system than nurses and medical secretaries. This was also the case in our study (Mann-Whitney U; $p < 0.01$ and $p < 0.001$ respectively).

However, both nurses and physicians reported being less hindered by computer problems now than in 2002 (Mann-Whitney U; $p < 0.01$). Still, the difference in satisfaction between professions was unchanged. Furthermore, we found no clear relationship between factors regarding availability and problems with computers and use, performance or satisfaction. Nor did we find any relationship with computer skills, which were unchanged for all professions compared to the 2002 survey, but fairly high. Still, due to the limited scope of our survey, we cannot rule out that such relationships might exist.

V. Discussion

In this study we have found a further increase in the use of a hospital EMR system by both nurses and physicians over a three year time span. This suggests that clinicians may need

more time to include the system into everyday work than medical secretaries, but also that it is possible to achieve increased use of the system by physicians and nurses. So, even though the recognition of immediate benefits is important to accelerate use¹⁴, the system is not doomed to failure if the full range of functionality is not immediately utilized. Still, we see it as important that at least some features of the new system provide an immediate return, as was the case in the 2002 study^{22, 23}. Also, we argue, time alone is not enough to accelerate use.

Despite the increase in use, there was no significant increase in factors such as computer skills, access to computers, etc. between the two surveys. Nor have there been any major changes in the system itself. Thus, the increase in use among clinicians seems to be independent of typical “hard” factors. Still, it should be noted that most respondents in both this and the previous survey had adequate computer skills and good access to computers. However, our findings support the conclusion that factors such as computer skills, training, and a well functioning system are necessary but not sufficient factors for success. This is in line with Berg¹³ who argues against focusing overly on such factors. Instead, we support Berg’s proposal that the introduction of EMR systems should be seen as a mutual transformation process whereby the technology is affected by the organizational dynamic and vice versa.

As Lærum et al²³ indicated, medical secretaries were the group that primarily got the immediate benefits of the EMR system. However, our results suggest that in time, and with continuing organizational focus, the EMR has also become a more accepted part of the everyday working context for clinicians. By removing the paper based medical record from clinical workflow, clinicians are forced to adapt to at least parts of the EMR system. This is

especially the case in regard to retrieving information. While the 2002 survey indicated a high level of use by physicians in tasks regarding information retrieval, our survey displayed increased use in tasks relating to the generation of information, tasks they are not necessarily forced to perform by the removal of the paper based record. For instance, a large proportion of physicians write short notes in the EMR-system even though they can dictate and have medical secretaries do the transcription. Also, an increased proportion writes sick leave notes and prescriptions using the system while they still have an option to use paper-forms.

So, our findings indicate that while scanning has been the main factor behind the increase in tasks regarding information retrieval, strong organizational commitment and focus is important to accelerate use in tasks regarding the generation of information. This does not mean that organizational focus is less important in any part of the implementation process, nor that brute-force will lead to both high usage and a well functioning system. Rather, it illustrates that turning the EMR into an integral everyday part of clinicians work is a complex process that requires both a functioning technology and an organizational development process. Also, it should be stressed again that the technology and organizational development should not be seen as separate processes.

As physicians, nurses also displayed a split between generating and retrieving information, but instead of having expanded their range of use, as the physicians did, there seemed to be a more widespread adoption of the system among nurses. Even so, they continue to be the group with the lowest overall use of the system. There may be several reasons for this, including the fact that nurses are primarily concerned with direct patient care and so they may consider the EMR system to be interrupting rather than supporting their primary task. However, there is also the possibility that process issues may have contributed to their lower

rate of use compared to the medical secretaries and physicians. The organizational focus at the beginning of the implementation process was directed towards the physicians and medical secretaries rather than towards the nurses. Also, many of the tasks relevant to nurses' documentation have only recently been converted to electronic routines. For a long time after the inception of the EMR system, many of the nursing documents continued to be paper-based, though subsequently scanned into the EMR system.

So, from our point of view, the organizational efforts towards expanding the nurses' engagement with the EMR have lagged behind the attention given to the other professions, although increasing lately. We therefore anticipate a further increase in the use of the EMR among nurses in the future. This expectation is supported by the fact that nurses perceive most tasks as being easier to perform using the EMR system, and they have a positive attitude towards the EMR system as a whole. Also, we observe a national impetus to increase the status of the nursing profession, which has the corollary that nursing documentation is becoming a more central part of everyday work.

As for scanned document images, we expected a decrease in use as more routine electronic data became available. To our surprise, the results indicated no decrease among physicians, and an actual increase among nurses and medical secretaries. So, it seems inevitable that a minimum level of historical data are needed to obtain a proper overview of a patient's case history, and we expect the use of scanned multiple documents to be greater for patients new to the physician. In addition, data coming to the hospital from external sources, for instance referrals from general practitioners and external lab results, often come in the form of paper and are scanned as single documents upon arrival. As for nurses, the increase in their use of scanned documents is probably due to their later transition to fully electronic data than in the

case of the physicians and medical secretaries. Also, another possible explanation for our finding may be due to a weakness in the design of the questionnaire. The wording of the question about the use of scanned data says “when you expect to find information in the part handling scanned documents...”. The results may therefore illustrate use when respondents expect to find relevant information, rather than relative differences between use of scanned and regular electronic data. Still, our results illustrate that historic information remain important for several years after the transition to a fully electronic system. This might imply that simply halting the updating of the paper-based medical record when implementing an EMR system is a less desirable alternative to scanning at least part of the record.

A. Is scanning a sensible strategy?

Despite being at the forefront of development, as the first hospital in Norway that eliminated its paper-based medical records, the results from Aust Agder hospital did not indicate a radical change in routines compared to traditional work routines at hospitals. A possible negative contributing factor might be that the medical chart, the core tool for managing inpatients, still only exists in paper format and is scanned and incorporated in the EMR system after the patient has left the hospital.

The results of this study therefore indicate, in line with previous research^{7, 8, 18, 22, 23} that there is still a considerable way to go before EMR systems contribute to the development of radical new ways of working and communicating in hospitals. Still, Aust Agder hospital in Norway has demonstrated the achievement of an important milestone in our quest towards the EMR of the future: It is perfectly possible to have a well functioning hospital with an electronic medical record only.

In our opinion a major obstacle has been eliminated by ending the use of the paper-based medical record, and we argue that having a workforce familiar with working in a computerized environment makes further improvements easier to achieve. By eliminating the need for document-based print-outs for a paper record, an obstacle to the design of new EMR systems has been removed. Still, scanning alone does not lead to more innovative solutions other than eliminating the need for the paper record. As mentioned above, workflow is more or less unchanged, and the EMR-system has more or less the same structure as the traditional paper record. We argue that to further exploit the potential of information technology in health care, we have to move away from the traditional structure of the chronological paper record, toward more tailored and structured data. This is especially important because of the ease of entering large amount of data into an EMR system, potentially causing information overload. We perceive the EMR of tomorrow as consisting of data tailor made to the specific context, combined with decision support systems. Scanning historical data and thereby eliminating the need for a paper journal is a step in this direction, but an EMR-system composed to a large part of scanned images is in our opinion limiting its potential. Therefore, even though it can sometimes not be avoid, we urge to have recently added data in a fully electronic form, not scanned images. Scanning the paper-based medical record is a potentially fast way to become paperless, and is necessary for historical data, but we will reach the true potential of EMR-systems first when all contemporary patient data is produced electronically.

B. Further studies

This study has demonstrated an increase in the use of a hospital EMR system over time, and indicates that organizational factors are the main explanation for this increase. However, what exactly may be implied by the term 'organizational factors' is less clear. Further qualitative studies are needed to get a deeper insight in of how the organization has adapted to and integrated the EMR system into the daily work routines among health personnel. Also, in a

broader context, it would be interesting to look into how EMR has affected performance and quality in terms of hospital administration.

VI. Conclusion

A follow-up study at a hospital that has scanned and eliminated its paper-based medical record displayed increased use of EMR among clinicians, suggesting that they may need a longer time to include the system into everyday work than medical secretaries. However, no significant differences were found in factors such as computer literacy, access to computers, etc. which are often said to affect system usage. Nor have there been any major changes in the EMR system itself. This suggests that the core factors are merely necessary but not sufficient factors of success. What is needed, in addition to training and a well functioning system, is a continuous organizational focus on utilizing the system. Despite a fairly high level of use, the EMR system has only to a modest degree contributed to new and innovative ways of working. However, we suggest that having a workforce familiar with a computerized environment and not restricted to the paper-based medical record makes future innovations easier to achieve.

Acknowledgment

This investigation was funded by the Central Norway Regional Health Authority through the project effective use of information and communication technology in hospitals, at the Norwegian University of Science and Technology. The investigation was performed in cooperation with the Norwegian Research Centre for Electronic Patient Records.

Competing interests: None declared

Table 1: Departments, number of employees and number of beds at the time of study.

Services	Employees			Beds
	Physicians	Nurses	Med. secretaries	
Somatic				
Patient Hotel		8		23
Surgery	16	50	19	45
Orthopedic	7	15	7	31
Gyn/Obst	9	19	13	26
Medicine	33	88	30	86
Pediatric	8	31	11	19
Neurology	6	Sharing with medicine		13
Rheum	6	“		0
ENT	6	6	2	1
Ophthalmologic	5	4	1	1
Sum	96	221	83	245
Psychiatric	35	120	61	105

Table 2: Key capabilities of the EMR system. For a more thorough overview of the system, contact DIPS (www.dips.com)

Capabilities	Short description
EMR/Patient administrative system, basic module	Integrated system for patient administration and electronic medical record
Psychiatric	Expanded version of above product for psychiatric departments and units
RIS, basic module	Laboratory system.
Nursing documentation	Integrated system for treatment plan, patient administration and electronic medical record for nurses.
Workflow system	System for electronically workflow. By defining different work groups, the hospital has the opportunity to create processes independent of organizational structure. Tasks are delegated to the different groups partly automatically and partly manually by sending (electronically) documents to a work group or a specific person. Tasks can be marked "urgent" and can be given a deadline
ECG integration	Integration of ECG from Medit. Possible to start, assess and store recordings from DIPS.
Operation planning	
Journal documentation integration	System for accessing documents in external systems, for instance PACS (imaging). Data from other systems are stored as a journal object in the patients journal, in the same way as for example regular text documents
PACS	Picture Archive and Communication System. Independent, but integrated with DIPS.

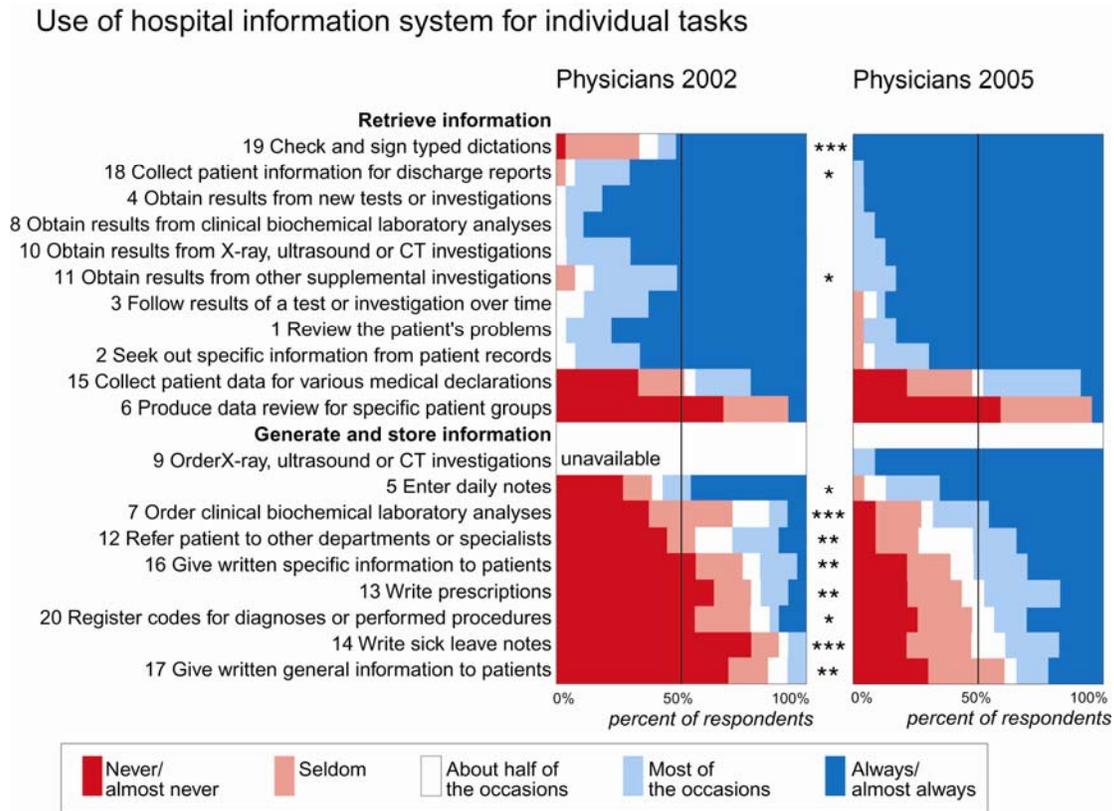


Figure 1: Reported frequency of use among physicians in 2005 (left) and 2002 (right). Blue color tones represent frequent use and red infrequent. Asterisks represent a significant change in use. * $p < 0,05$, ** $p < 0,01$, *** $p < 0,001$.

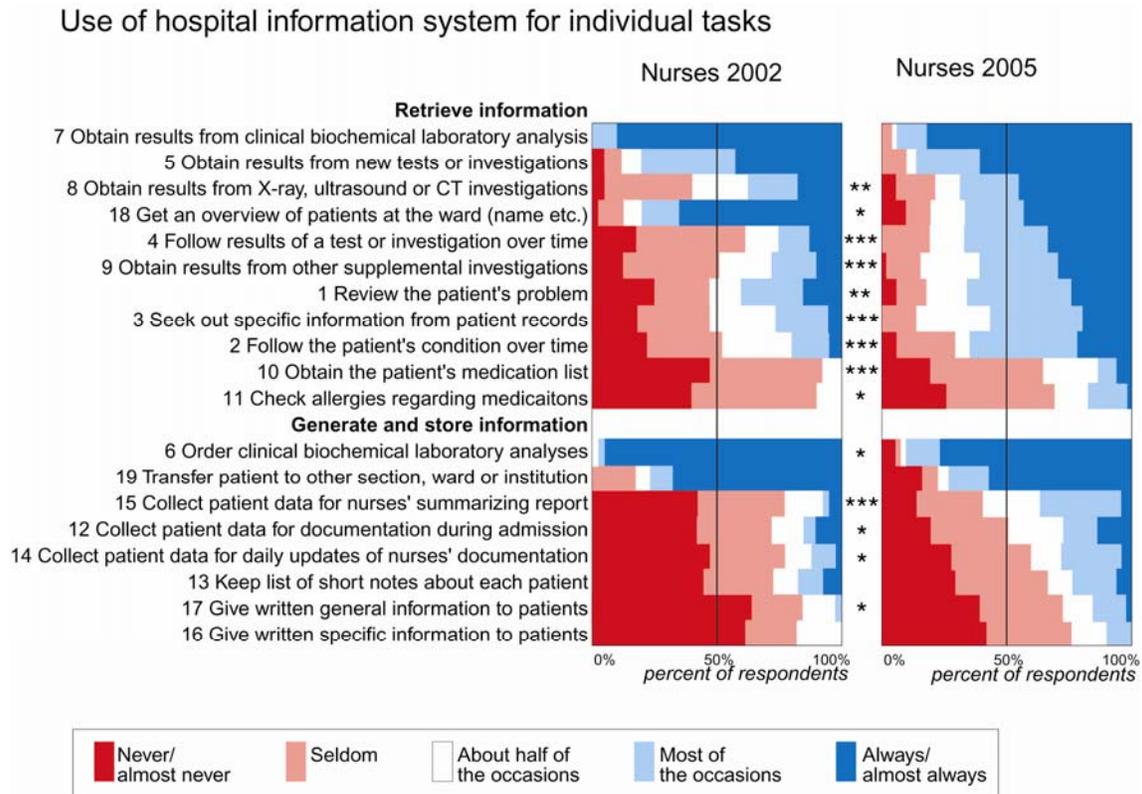


Figure 2: Reported frequency of use among nurses in 2005 (left) and 2002 (right). Blue color tones represent frequent use and red infrequent. Asterisks represent a significant change in use. * $p < 0,05$, ** $p < 0,01$, *** $p < 0,001$.

User satisfaction with the hospital information system

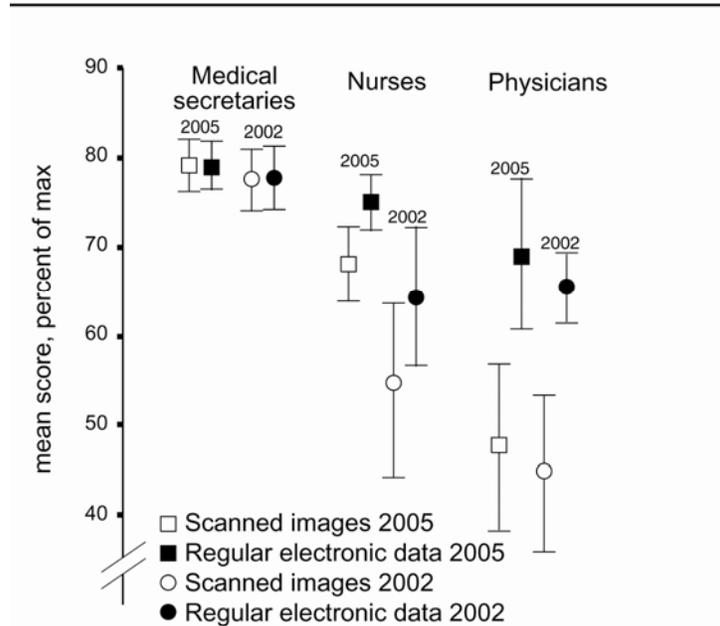


Figure 3: User satisfaction with use of the system regarding the two forms of EMR, as scanned document images and as regular electronic data.

User satisfaction with the hospital information system as a whole

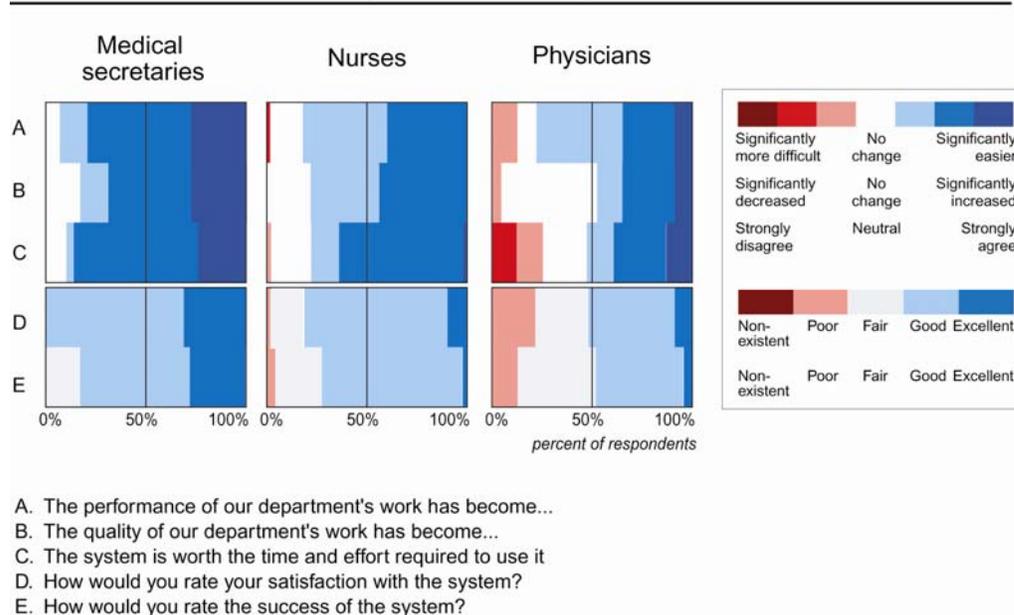


Figure 4: User satisfaction with the EMR system as a whole

References

1. Ball MJ. Hospital information systems: perspectives on problems and prospects, 1979 and 2002. *International journal of medical informatics*. 2003;69(2-3):83.
2. Ash JS, Gorman PN, Seshadri V, Hersh WR. Computerized physician order entry in U.S. hospitals: results of a 2002 survey. *Journal of the American Medical Informatics Association: JAMIA*. 2004;11(2):95.
3. Southon G, Sauer C, Dampney K. Lessons from a failed information systems initiative: issues for complex organizations. *International Journal of Medical Informatics*. 1999;55(1):33.
4. Littlejohns P, Wyatt JC, Garvican L. Evaluating computerised health information systems: hard lessons still to be learnt. *BMJ*. April 19, 2003 2003;326(7394):860-863.
5. Benson T. Why general practitioners use computers and hospital physicians do not - Part 1: incentives. *BMJ*. November 9, 2002 2002;325(7372):1086-1089.
6. Benson T. Why general practitioners use computers and hospital physicians do not - Part 2: scalability. *BMJ*. November 9, 2002 2002;325(7372):1090-1093.
7. Laerum H, Ellingsen G, Faxvaag A. Physicians' use of electronic medical records systems in hospitals: cross sectional survey. *BMJ (Clinical research ed.)*. 2001;323(7325):1344.
8. Berner ES, Detmer DE, Simborg D. Will the wave finally break? A brief view of the adoption of electronic medical records in the United States. *Journal of the American Medical Informatics Association: JAMIA*. 2005;12(1):3.
9. van der Meijden MJ, Tange H, Troost J, Hasman A. Development and implementation of an EPR: how to encourage the user. *International journal of medical informatics*. 2001;64(2-3):173.

10. Ammenwerth E, Mansmann U, Iller C, Eichstädter R. Factors affecting and affected by user acceptance of computer-based nursing documentation: results of a two-year study. *Journal of the American Medical Informatics Association: JAMIA*. 2003;10(1):69.
11. Dansky KH, Gamm LD, Vasey JJ, Barsukiewicz CK. Electronic medical records: are physicians ready? *Journal of healthcare management / American College of Healthcare Executives*. 1999;44(6):440.
12. Aarts J, Doorewaard H, Berg M. Understanding implementation: the case of a computerized physician order entry system in a large Dutch university medical center. *Journal of the American Medical Informatics Association: JAMIA*. 2004;11(3):207.
13. Berg M. Patient care information systems and health care work: a sociotechnical approach. *International Journal of Medical Informatics*. 1999;55(2):87.
14. Berg M, Langenberg C, Berg vdI, Kwakkernaat J. Considerations for sociotechnical design: experiences with an electronic patient record in a clinical context. *International journal of medical informatics*. 1998;52(1-3):243.
15. Poissant L, Pereira J, Tamblyn R, Kawasumi Y. The impact of electronic health records on time efficiency of physicians and nurses: a systematic review. *Journal of the American Medical Informatics Association: JAMIA*. 2005;12(5):505.
16. Elberg PB. Electronic patient records and innovation in health care services. *International Journal of Medical Informatics*. 2001;64(2-3):201.
17. Van Der Meijden MJ, Tange HJ, Troost J, Hasman A. Determinants of success of inpatient clinical information systems: a literature review. *Journal of the American Medical Informatics Association: JAMIA*. 2003;10(3):235.
18. Ellingsen G. Information Systems support for interdisciplinary teams: Everyday interdisciplinary work in hospitals in an actor network perspective. Paper presented at:

Proceedings of the 25th Information Systems Research Seminar in Scandinavia, 2002; Bautahøj, Denmark.

19. Haux R. Health information systems - past, present, future. *Int J Med Inform.* 2005.
20. Stausberg J, Koch D, Ingenerf J, Betzler M. Comparing paper-based with electronic patient records: lessons learned during a study on diagnosis and procedure codes. *Journal of the American Medical Informatics Association: JAMIA.* 2003;10(5):470.
21. Mikkelsen G, Aasly J. Concordance of information in parallel electronic and paper based patient records. *International journal of medical informatics.* 2001;63(3):123.
22. Laerum H, Karlsen TH, Faxvaag A. Effects of scanning and eliminating paper-based medical records on hospital physicians' clinical work practice. *Journal of the American Medical Informatics Association: JAMIA.* 2003;10(6):588.
23. Laerum H, Karlsen TH, Faxvaag A. Use of and attitudes to a hospital information system by medical secretaries, nurses and physicians deprived of the paper-based medical record: a case report. *BMC medical informatics and decision making [electronic resource].* 2004;4:18.
24. DIPS ASA. www.dips.com. Accessed 16.03, 2006.
25. Laerum H, Faxvaag A. Task-oriented evaluation of electronic medical records systems: development and validation of a questionnaire for physicians. *BMC medical informatics and decision making [electronic resource].* 2004;4:1.