Effects of Scanning and Eliminating Paper-based Medical Records on Hospital Physicians’ Clinical Work Practice

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Abstract  Objective: It is not automatically given that the paper-based medical record can be eliminated after the introduction of an electronic medical record (EMR) in a hospital. Many keep and update the paper-based counterpart, and this limits the use of the EMR system. The authors have evaluated the physicians’ clinical work practices and attitudes toward a system in a hospital that has eliminated the paper-based counterpart using scanning technology.

Design: Combined open-ended interviews (8 physicians) and cross-sectional survey (70 physicians) were conducted and compared with reference data from a previous national survey (69 physicians from six hospitals). The hospitals in the reference group were using the same EMR system without the scanning module.

Measurements: The questionnaire (English translation available as an online data supplement at www.jamia.org) covered frequency of use of the EMR system for 19 defined tasks, ease of performing them, and user satisfaction. The interviews were open-ended.

Results: 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. However, 22% to 25% of the physicians found retrieval of patient data more difficult, particularly among internists (33%). Overall, the physicians were equally satisfied with the part of the system handling the regular electronic data as that of the physicians in the reference group. They were, however, much less satisfied with the use of scanned document images than that of regular electronic data, using the former less frequently than the latter.

Conclusion: Scanning and elimination of the paper-based medical record is feasible, but the scanned document images should be considered an intermediate stage toward fully electronic medical records. To our knowledge, this is the first assessment from a hospital in the process of completing such a scanning project.


The electronic medical record (EMR) is considered a prerequisite for the efficient storage, distribution, and use of patient data in hospitals. The development and implementation of EMR systems that have the capability of storing and presenting all the information contained in a typical paper-based medical record have, however, proven to be complex tasks. In Norway, systems with the ability of storing a proportion of the information in the paper-based medical record are implemented in most hospitals. Until recently, Norwegian legislation has made it necessary to maintain the paper-based medical records, resulting in a combined electronic and paper-based medical record best described as a hybrid (Fig. 1). In this situation, the EMR systems are of limited value to physicians.

A revised legislation, enacted in January 2001, defines criteria for how the patient data can be stored solely in an electronic format. However, to obtain a complete record, several paper-based sources of patient data must be converted to a digital format without loss of medical or legal information. This includes the paper-based medical record as well as paper documents that have been created by hand or that stem from diagnostic devices or information systems not integrated with the EMR system. In practice, it means that a complete EMR system must support scanning and storage of documents as images.

Having two complete copies of a medical record is superfluous, and the next logical step is an elimination of the paper-based medical record. Since no alternative system will be available to the physician in case of failure of the computer system, this can be considered a strategy of no return. Such a radical change in work methods carries a risk of full refusal by the clinical staff, as has been reported in previous studies. These aspects probably discourage hospitals from taking this next step toward computerization. Although scanning of paper-based medical records in hospitals has been described by others, the effects of eliminating them are not known. In

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this report, we have evaluated the effects of scanning and elimination by studying the physicians’ reported performance of clinical work tasks and their attitudes toward the system. The findings were compared with that of other hospitals that are using the same system but are not scanning or eliminating the paper-based medical records. To assess these variables, we have used questionnaires, group discussions, and interviews.

Methods

Brief Description of the Hospital and the EMR System

Aust-Agder Hospital is a 410-bed community hospital serving a population of 102,000 in Aust-Agder County, southern Norway, caring for 18,600 inpatients and 74,000 outpatients per year (1998). The patients are admitted by primary care physicians external to the hospital and followed up by the hospital physicians. The hospital is comprised of departments for psychiatry; general surgery; internal medicine; orthopedics; gynecology; ear, nose, and throat; and ophthalmology. Well funded, and with a strong commitment by the hospital administration, the hospital staff began implementation of DIPS 2000, a commercially available combined EMR and hospital administrative system (www.dips.com) in March 2000. In April 2001, all except the psychiatric department started to scan documents; hence, all new patient data were channeled into the EMR system in these departments. To handle the transition to EMR, a separate project organization had been recruited from the hospital staff. The project organization provided regular class-type training for the users and a network of super users (the most experienced users) among the ward staff. The system was available in 1,100 terminals throughout the hospital, except for the inpatients’ rooms.

Figure 1. Diagram of the medical records in most hospitals (left) and in Aust-Agder Hospital (right). In the former, the paper-based medical record dominates, being the only complete record. In the latter, there is a complex mix of fully electronic medical records and scanned images of text on paper (single documents and multiple documents in continuous sections).

Figure 2. Contents of the EMR at Aust-Agder Hospital at the time of the investigation, structured according to the standards defined by the Norwegian Board of Health (<www.helsetilsynet.no>). Essential patient data are repeated commonly in several places, typically in the continuous textual medical record (B). Document types of special importance to physicians are emphasized in bold type. The bars are equal in height and thus do not reflect the relative volumes of the actual content in the EMR.
The patient data in the EMR are stored either as searchable text and numbers or as document images. The former, called regular electronic data, essentially consist of the chronologic, text-based medical record integrated with laboratory data in numerical form and textual radiology reports (Fig. 2). The latter are divided by structure into two categories, as follows: upon admittance or consultation, the documents in the old paper-based medical records are scanned into the system as digital images in TIFF format. Each image contains all the sheets of one main section of the paper-based record and, hence, corresponds to a whole document group (groups A-J in Fig. 2). These images are called scanned multiple documents. Searching in them is essentially done by reading the contents, aided by the dates appearing on the documents (Fig. 3E). Upon patient discharge, various paper sheets accumulated during the stay (e.g., the medical treatment form, printouts from diagnostic devices) are scanned, dated, and labeled by document type singularly (Fig. 2). The resulting images are called scanned single documents. Searching in them is assisted by their date labels and the hierarchy of document types. This makes it easier to locate specific information in the scanned single documents than in the scanned multiple documents. In summary, the patient data are stored as regular electronic data, scanned multiple documents, and scanned single documents. They all appear in the hierarchical list in the “medical record explorer” window (Fig. 3A), but are treated separately in this report because of their difference in structure, indexation, and functionality.

After scanning, the paper-based record is destroyed. However, at the time of the investigation, about 50% of inpatients in the surgical department, 75% in the medical department, and 15 to 20% of patients in other departments still had their paper-based medical records intact (Fig. 4). This is because preparing and scanning them was more time-consuming than expected. Hence, elective patients were prioritized, supplemented by a systematic scanning of the archives. Since most patients in the medical department are admitted acutely, more patients in the medical than in the surgical department had their paper-based medical records intact. However, the information found in the paper-based medical records were at least one year old as the study was carried out, as no new information was channeled into them after the onset of the scanning routines. Furthermore, essential information from them (e.g., previous diagnoses, implants, and surgical operations) was cited frequently in textual summaries in the EMR.

The Survey
A questionnaire previously used in a national survey was modified according to the functionality offered by the EMR system in Aust-Agder Hospital in cooperation with physicians at the hospital. The questionnaire contained sections on use of EMR for specific tasks, ease of performing the tasks, and user satisfaction concerning detailed aspects of the system and the system as a whole. The essential modifications were omitting questions regarding tasks for which no functionality was implemented in the hospital and providing two full sets of questions on detailed user satisfaction regarding regular electronic data and scanned document images separately. (The questionnaire is available as an online data supplement at www.jamia.org.)
February through April 2002, the 80 physicians in the medical, surgical, and other departments received the questionnaire. Of these, 70 physicians responded (respectively, 27, 22, and 21), for a total response rate of 88%.

**The Reference Group**

As a reference group, we selected the responses of all physicians working in hospitals using the same EMR system as that of Aust-Agder Hospital in a national survey.

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**Figure 5.** Reported frequency of use of the regular EMR for various clinical tasks in Aust-Agder Hospital, compared with that of the hospitals in the reference group. The blue color tones in the figure represent frequent use, and the red color tones represent infrequent use. The error bars show the upper confidence interval limit of the proportion of physicians answering “always or almost always”; the remaining error bars are hidden for clarity. *Data for task 19 are not available in the reference group.*

**Figure 6.** Performance of clinical tasks using the EMR system as a whole (including the scanned document images) compared with previous routines. The tasks are placed in upper or lower sections by whether they are mainly related to retrieving information or to generating and storing information, respectively. The tasks are sorted by average response values in descending order within each section. The blue color tones in the figure represent physicians responding that the task has become easier using the system, and the red color tones represent those responding that the task has become more difficult. The error bars show the upper confidence interval limit for the proportion of physicians responding “significantly easier”; the remaining error bars are hidden for clarity.

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*Figure 5 and Figure 6 images are not provided here but should be included in the actual document.*

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February through April 2002, the 80 physicians in the medical, surgical, and other departments received the questionnaire. Of these, 70 physicians responded (respectively, 27, 22, and 21), for a total response rate of 88%.
performed in 2001.6 The hospitals belonging to the reference group were neither scanning nor eliminating their paper-based medical records. The reference group consisted of 69 physicians from six hospitals, equally distributed between medical, surgical, and pediatric departments (respectively, 20, 24, and 25 physicians), and the response rate in this group was 72% (69 of 96). The reference data regarding use of the EMR system was limited to the respondents for which the defined task was reported as implemented.

Analysis and Presentation
We used Teleform for data acquisition and SPSS 11.0 for Windows for statistical analysis of the survey. One-way analysis of variance was used for comparisons involving the detailed user satisfaction score.11 This score was calculated by adding the response values of the 12 questions in this section and converting the sum to percent of maximum possible score. The analyses for the rest of the questionnaire were done separately for each question, using the nonparametric analyses Kruskal-Wallis or Mann-Whitney U. These analyses rely on ranks, which are not easily presented. To present the magnitude of the differences without using ranks, we have shown directly in the figures the frequency of each response in every question (Figs. 5–7), providing complex but structured figures.

Group Discussions and Interviews with Users
After the system was implemented, a group of 15 physicians, nurses, and clerical staff from the medical department spent approximately 40 hours drawing workflow charts of how the clinical work is undertaken in the department. One of the authors interviewed eight physicians for 0.5 to 2 hours, discussing these charts and how the EMR system facilitated the work procedures described here. Comments concerning advantages and disadvantages of the system were noted during the interviews and group discussions, and these comments were summarized. Only the comments from the physicians are presented here.

Results
The survey and the interviews gave insight into the physicians’ use of the EMR system, the ease with which they were performing clinical tasks using the system, and their satisfaction with the system.

The Regular EMR Was Used Routinely for Information Retrieval
As should be expected, the physicians in Aust-Agder Hospital used the EMR system much more extensively than...
in other hospitals (Fig. 5; Mann-Whitney U; p<0.05 in 2 tasks and p<0.001 in 10 tasks), however, not for all tasks. The physicians used the system on a routine basis regarding most of the tasks related to information retrieval (Fig. 5; 9 of 11 tasks), but regarding the tasks related to generating and storing information, the system was used only for entering daily notes (task 5). For instance, the physicians preferred not to use the system for writing a prescription or completing a sick leave form, despite the fact that the system supported these tasks.

Tasks Regarding Information Retrieval Were More Easily Performed by Most Physician Groups

Although the use of the system is important, it is perhaps even more important whether the introduction of the EMR increases the efficiency with which the clinical tasks are performed. For each clinical task in the questionnaire, we asked the physicians whether performing the task in the department had become easier or more difficult using the system as a whole, compared with previous work routines. Regarding tasks related to information retrieval (Fig. 6), the performance of nine of 11 tasks had become easier. Regarding the tasks related to generating and storing information, the performance of only one of 11 tasks (task 5) had become easier. A considerable proportion of the physicians found that two tasks actually had become more difficult to perform (responding “more difficult” or “significantly more difficult” in tasks 1 and 2, respectively; 24.6% [17 of 69] and 21.7% [15 of 69]). Interestingly, the internists were more negative than the surgeons in these questions. For tasks 1 and 2, only 9.5% (2 of 21) and 4.8% (1 of 21) of the surgeons responded with these alternatives, respectively, while 33.0% (9 of 27) of the internists did so in both tasks (Mann-Whitney U, one-tailed Monte Carlo; p = 0.05 and p = 0.01, respectively).

Most of the Physicians Were Satisfied with the System

One might expect that eliminating the paper-based medical record and replacing it with an EMR would cause dissatisfaction among the physicians who have been using the former throughout their careers. However, most physicians in the survey were satisfied with the use of the EMR system, both when considering the system as a whole and when considering detailed aspects of the system. When answering the five questions regarding the system as a whole, the majority gave positive responses in all of them (Fig. 7). However, in three questions, the physicians in Aust-Agder Hospital scored significantly lower than in the reference group (questions 1 through 3 in Fig. 7, Mann-Whitney U; p = 0.045, 0.002, and 0.004, respectively).

When considering detailed aspects of the system, the physicians were satisfied with the part of the system handling regular electronic data (Fig. 9A-C), rating it equally to that of the reference group. In the interviews, this was supported by
the internists, who were commonly emphasizing the accessibility of EMR over paper-based medical records.

**Some of the Physicians Were Not Satisfied**

Although the majority of the physicians were relatively satisfied with the system, a significant proportion were not satisfied. For instance, 22.1% (15 of 68) found that the quality of the work in the department had become lower after the introduction of the EMR system (Fig. 7, question 1). Further, 19.4% (13 of 67) found that the ease with which the department's work was undertaken was decreased (Fig. 7, question 2). Regarding the detailed aspects of the system, the internists were significantly less satisfied with the part of the system handling regular electronic data than physicians in other specialties (Fig. 9, part B, analysis of variance; p = 0.04). Some explanation to this was found in the interviews, in which many internists considered the time required to navigate in the EMR as a significant problem. This was believed to have a negative impact on the time available for direct interaction with the patient and could subsequently lead to failure in locating necessary information due to lack of time.

**The Scanned Documents' Images**

The physicians were considerably less satisfied with the use of the scanned documents' images than with the rest of the system (Fig. 9, part A, paired t-test p < 0.001 in every factor). Perhaps as a consequence, this part of the system was much less frequently used than the part that contained regular electronic data (Fig. 8, left), particularly concerning the scanned multiple documents (Kruskal-Wallis; p < 0.001 in every task). The internists were even less satisfied with them than that of the surgeons and the physicians from other wards (Fig. 9, part B, ANOVA; p = 0.003). During the interviews, the internists explained that navigating in the scanned multiple documents was particularly time-consuming.

**Discussion**

In this study we have shown that the introduction of an EMR that contains the paper-based medical record as document images is possible without a major negative impact on reported clinical practice. As could be expected from an EMR system that precludes the users from the paper-based medical record,13 the frequency of use of the EMR is high. Despite this fact, a majority of the physicians at most departments reported that several clinical tasks were performed more easily, and their user satisfaction scores were, on average, relatively high.

When considering the physician's frequency of use of the EMR for information retrieval, the difference between Aust-Agder Hospital and that of the reference group is distinct (Fig. 5). It may simply be accounted for in terms of lack of suitable alternatives to the EMR, although several informal sources of patient data are available to the physician (e.g., gathering printed excerpts from the EMR, asking the patient, or calling the patient's family practitioner). However, as pointed out previously,6 EMRs are much more useful when they are complete, leading to a higher frequency of use. This is in agreement with Bleich et al.,14 who found that a critical mass of patient data is necessary to make the physicians use the system. Also, a higher proportion of the physicians in Aust-Agder Hospital than in the reference group reported that they enter daily notes into the system (task 5, lower part of Fig. 5). This suggests that the critical mass effect might also apply to documentation, a task described as difficult to computerize in other studies.15 Apart from entering daily notes, the physicians infrequently used the system for generating and storing information (Fig. 5, lower part). This could be due to the limited structuring and reuse of patient data in the system, forcing the user to repeatedly enter the same information. Furthermore, selecting, filling, and printing out short forms may involve more work when using the computer compared with filling it out by hand (e.g., short prescriptions, see task 12 in Fig. 6).

Regarding the performance of the clinical tasks, all tasks for which the EMR really was used were generally performed more easily (Fig. 6). This could be due to an increased accessibility of clinical information, a finding supported by results from the interviews. On the other hand, some physicians—particularly the internists—found information retrieval more difficult to perform, indicating the opposite. A possible explanation is that although the medical record is accessible to the physicians, locating specific information in a large collection of patient data can be difficult. Furthermore, any network problems and problems regarding practical access to a computer terminal will have a negative impact on this matter.

Regarding user satisfaction, the physicians were equally satisfied with the EMR containing regular electronic data as that of the physicians in the reference group (Fig. 9C). However, they were less satisfied regarding the EMR system as a whole (Fig. 7). This indicates that the changes come at a cost, and the role of the scanned document images should be considered.

The scanned document images play an essential role in making the EMR complete. However, the physicians were not satisfied with using this part of the system (Fig. 9A) and tended to avoid using it (Fig. 8). This could be due to poor practical availability of the information, as the images of multiple documents in continuous sections can be more than 50 pages long, and they are searchable only through manual scrolling. The internists were particularly dissatisfied (Fig. 9B) with the use of the scanned document images, presumably because their work depends more on the information contained in them. This contrasts the generally positive attitudes of the physicians, suggesting that the scanned document images are less prominent than the regular electronic data in clinical work. The negative aspects of the scanned document images may decrease with time, as the data in the old medical records become outdated and slowly lose their relevance. Possibly, a more comprehensive indexation and more efficient search functionality for the scanned multiple documents could improve the situation.

Four limitations of this study should be considered. First, the findings from evaluations of an EMR system in one hospital may not be valid for another hospital due to confounding factors such as financial and organizational differences as well as the variation in implemented functionality in each hospital.6 The numerous organizational changes induced by the introduction of a complete EMR system may, however, make a conventional pre–post study equally difficult to interpret. We have in this study tried to reduce the effects...
of confounding factors specific to each hospital by using
a reference group consisting of physicians from several
hospitals. Second, the one-year difference in time between
this study in Aust-Agder Hospital and the study from which
the reference group of hospitals is extracted might widen
the differences found between the groups. However, the EMR
systems in the reference hospitals have been unchanged
during this time, except from minor maintenance updates.
Third, we have compared the results from one whole hospital
with those of selected units from several others, which means
comparing samples drawn differently. However, the
proportions of physicians from units in medical, surgical,
and other wards were not statistically different in the two
samples \( \chi^2 p = 0.5 \). Fourth, this study has focused on
clinical processes and has not been designed to cover patient
outcomes. Although desirable, we have not considered it
realistic to look for quantifiable changes in patient outcome
until the effects of EMR on clinical practice in this hospital is
documented.16

Conclusion
Scanning and elimination of the paper-based medical record
are feasible, as use of an EMR that includes access to the old
medical record as document images is considered acceptable
by a majority of the physicians at most clinical departments.
However, a significant proportion of the internists reported
a negative impact on clinical work, due to the rigid structure,
slow processing, and limited functionality of the scanned
document images. The images should, therefore, be consid-
ered an intermediate stage toward fully electronic medical
records. All considered, we believe that such a scanning
project can be justified by the increased availability of patient
data to the physicians and the faster transition to full
utilization of an EMR. The reported disadvantages of the
scanned documents may diminish over time as their contents
become outdated. To our knowledge, this is the first
assessment from a hospital in the process of completing such
a scanning project.

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