Factors influencing the quality of medical documentation when a paper-based medical records system is replaced with an electronic medical records system: An Iranian case study

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Objectives: Information technology is a rapidly expanding branch of science which has affected other sciences. One example of using information technology in medicine is the Electronic Medical Records system. One medical university in Iran decided to introduce such system in its hospital. This study was designed to identify the factors which influence the quality of medical documentation when paper-based records are replaced with electronic records.
Methods: A set of 300 electronic medical records was randomly selected and evaluated against eleven checklists in terms of documentation of medical information, availability, accuracy and ease of use. To get the opinion of the care-providers on the electronic medical records system, ten physicians and ten nurses were interviewed by using of semi-structured guidelines. The results were also compared with a prior study with 300 paper-based medical records.
Results: The quality of documentation of the medical records was improved in areas where nurses were involved, but those parts which needed physicians' involvement were actually worse. High workloads, shortage of bedside hardware and lack of software features were prominent influential factors in the quality of documentation. The results also indicate that the retrieval of information from the electronic medical records is easier and faster, especially in emergency situations.
Conclusions: The electronic medical records system can be a good substitute for the paper-based medical records system. However, according to this study, some factors such as low physician acceptance of the electronic medical record system, lack of administrative mechanisms (for instance supervision, neglecting physicians and/or nurses in the development and implementation phases and also continuous training), availability

of hardware as well as lack of specific software features can negatively affect transition from a paper-based system to an electronic system.

Keywords: Electronic medical records, Paper-based medical records, Documentation

Information technology (IT) has changed our lives in different ways. There is no part of our environment that has not been affected by IT. Cellular phones and portable media players on one hand and computers, Internet, e-learning and e-commerce on the other hand are the result of rapid developments in IT in recent years. The medical sector has also been affected by IT. Advanced diagnostic equipments, for instance computerized tomography scan (CT scan), are signs of implementation of IT in medicine. Information technology has also shown a large potential in the medical records systems. Different systems have been designed to be used in hospitals and medical centers to facilitate the collection, processing and archiving of medical information. The Electronic Medical Records system (EMR) is one of these systems. EMR is a computer application that helps medical staff to create, edit, store and retrieve medical information electronically.

Several countries have implemented EMR in their medical care systems. Different studies have been conducted to evaluate the impact of EMR on the quality of medical documentation, attitude of medical staff and quality of medical care. Some of these studies have shown improvements in the quality of documentation when an EMR system was introduced (5). Traditional Paper-based Medical Records systems (PBMR) have some drawbacks (such as missing records, illegible hand writing, bulkiness and slowness of information retrieval) that overshadow their usefulness (13). Because earlier studies on EMR systems have shown some advantages over PBMR, the medical care system in Iran might benefit from using information technology to overcome problems with PBMR too, so the question is "Can a simple replacement of PBMR with EMR solve issues with PBMR, and even improve the quality of documentation of medical records?"

The Tabriz University of Medical Sciences, one of the leading medical universities in Iran, decided to expand the use of IT in its practice, and together with the Alzahra hospital (one of its subset university hospitals) took the initiative to introduce an EMR system in August 2004. The Alzahra hospital's old PBMR has been shown to be imperfect and have several shortcomings. When the new EMR system was introduced, it was seen as a good opportunity to study how the EMR system might affect the quality of medical records at the hospital by comparing the quality of documentation of the old PBMR with the new EMR. This was the first study of this kind in Iran and the authors believe that the results of this study might be interesting not only for this hospital but for others considering a shift to the EMR system.

METHOD

Test Setting

The Alzahra University Hospital, supported by funding from Tabriz University of Medical Sciences, began implementation of the EMR system in November 2004. This software was developed and tailored for the hospital, which was also the first among the university hospitals of Iran to implement the EMR system, under the supervision of hospital authorities. Because the initial goal was to replace paper sheets with an electronic system, all informational elements on paper records were transferred to the EMR system. All staffs at the hospital were trained to use the EMR system in daily practice. The main language of the EMR system was Persian, but all medical terminology and disease classification were in English. Data were entered at different levels and by different persons. At admission, all identification information of the patient and the physician were entered by an admission officer. This information was entered once and then distributed throughout the entire system. Similar to the PBMR, physicians and nurses had to enter information into the medical record. Physicians were responsible for entering information on physical exams, progress notes, orders/prescriptions and in the case of surgery, they had to fill in an operation report. Nurses, on the other hand, had to fill in nursing reports, vital signs, laboratory requests and radiology exams, following-up of the orders, coordinating transfer of patients from one ward to another, and finally patient discharge. All these tasks were performed through the EMR system. One year after EMR's introduction at this hospital, it was considered to be sufficiently stable and to hold data for evaluating its impact on the quality of medical records in terms of quality of documentation, availability, and accuracy.

MATERIALS AND METHODS

From November 2004 to the end of September 2005, a total of 19,900 patients had been admitted to the hospital. As a first step, eleven checklists were designed based on national standards for the medical records in Iran (9). These checklists covered all required information items in the medical records, including patient and care-provider's identification information, medical and laboratory exam results, medical and surgical interventions. Then a set of 300 EMR was randomly selected for analysis. Each of the selected EMR was evaluated against the checklists in terms of completeness of medical information, identification

Table 1. Results of the Evaluation of 300 Electronic Medical Records (section A) and Paper-Based Medical Records (section B) at the Alzahra hospital, Tabriz, Iran

Sheets	Section A						Section B			
	Expected sheets	Existing sheets	Group A[a](%)	Group B[b](%)	Group C[c](%)	Group D[d](%)	Group A[a](%)	Group B[b](%)	Group C[c](%)	Group D[d](%)
Admission	300	300	100	100	NA[e]	100	71	78	88	81
Medical history and physical examination	300	300	100	48	46	37	67	73	91	100
Physician's order	300	300	100	48	46	37	54	72	98	100
Progress note	300	300	100	48	46	37	54	74	99	100
Laboratory report	188	188	100	98	98	98	56	72	100	100
Radiology report	65	65	100	98	98	98	57	24	53	95
Vital signs	300	300	100	100	100	100	59	57	89	100
Nurse report	300	300	100	100	100	100	NA[f]	NA[f]	NA[f]	NA[f]
Operation report	71	71	100	100	100	100	94	60	69	98
Pathology report	12	12	100	100	100	100	95	56	51	22
Unit summary	300	300	100	100	100	100	99	61	87	98

[a]Percentage of the documentation of patient's identification information: unit number, patient's name and family name, father's name, date of birth, place of birth, address, and phone number.
[b]Percentage of the documentation of administrative information: date of admission, admitting physician, ward, and room and bed number.
[c]Percentage of the documentation of diagnostic and treatment procedures: physical examination, laboratory and radiological exams, orders, and medical and surgical interventions.
[d]Percentage of the documentation of identification information of diagnosis and treatment provider: name and family name of physician and nurse, signature, seal, time, and date.
[e](N/A) It is not required to document identification information of care-providers on these sheets.
[f](N/A) The nurse report sheet was not included in the paper-based medical records system.

information of patient and care-provider and the time and date of documentation.

After collecting and analyzing data, and to get the opinions of care-providers regarding the EMR system, we also arranged interviews with ten physicians and ten nurses who were using the EMR system in daily practice at the hospital. Most of the interviews (carried out with the consent of the interviewee) were recorded and later transcribed for analysis. Interviewees were asked about availability of information and ease of use of the EMR system. They were also asked for their opinion regarding the accuracy of the EMR system in comparison with the PBMR system. The ethical board of medical research of the Ministry of Health and Medical Education of Iran has approved this study.

Because different information is registered in the medical records and, to facilitate interpretation and comparison of the results, we categorized these informational elements into four groups: Group A: Demographic information consisting of unit number, name and family name, date of birth, address and phone number of the patient. Group B: Administrative information consisting of date of admission, admitting physician, ward, room and bed number. Group C: Medical information (diagnostic and treatment) consisting of physical exam, laboratory and radiological report, medical orders and surgical interventions. Group D: Care-provider's information consisting of name of care provider (physicians and nurses), date, and time.

RESULTS

Completeness

Documentation of Demographic Information (Group A). Information such as name, family name, date of birth, address, and phone number is only registered once in the EMR system at the admission office. The percentage of documentation was high for the different parts of the records (Table 1, section A) and in comparison with the PBMR system, EMR showed an improvement in the documentation process. In our previous study, none of the medical records had this information 100 percent documented, with a highest value of 97 percent for anesthesia sheets (Table 1, section B). Thus, the documentation of patient identification information has improved dramatically.

Documentation of Administrative Information (Group B). This information is important for administrative purposes and for tracking patients inside the hospital. Documentation of this information varied in different parts of the EMR system. The medical exam, progress note, and physician orders sections had the lowest percentage (48 percent) of documentation (Table 1, section A).

Documentation of Medical Information (Group C). Most of the records had medical information documented, but again the lowest figures belonged to those parts of the medical records that are usually filled in by physicians, i.e., medical exam, progress note, and physician

orders (Table 1, section A), but in PBMR the pattern was reversed, almost all information being fully completed by physicians. We could, however see some improvements in the documentation of information on pathology and radiology reports in the EMR system (Table 1, section B).

Documentation of Care-provider's Information (Group D). This information is important in terms of legal follow-ups and must be documented in every medical record. However, again, those parts which needed physicians' involvement had the lowest documentation rate (Table 1, section A), but in PBMR the pattern was different, almost all information being fully completed by physicians (Table 1, section B).

Ease of Use and General Issues

To get a general picture of the use of EMR and possible issues, two groups of ten physicians and ten nurses were interviewed using separate semistructured interview guide lines.

The average work experience of the physician's group was 8.5 years. Seven of ten physicians had previous experience of working with EMR systems, mainly abroad. The average working experience of the nurses' group was ten years. Only two nurses had previous experience with the EMR system. Both groups rated their computer skills as moderate to good.

They were asked for how much time they spent entering data into the EMR system. In the physicians' group, only four of them had used the EMR system personally to enter data, and the rest depended on nurses or were still using PBMR at the bedside. They were also asked how much time they spent retrieving information from the EMR system. Almost all of them were using the EMR to retrieve information, and time spent varied from fifteen minutes to two hours in each working day, depending on the number of the patients they had on the specific day, but in average 30 minutes for a working shift. The average time that the nurses spent entering data into the EMR was 2.5 hours per working shift, and they spent 1 hour in average retrieving information from the EMR system on each working shift. Documenting the nursing reports, transferring patients to other wards and following-up laboratory, radiology/sonography reports were the most commonly used features of the EMR system by the nurses interviewed.

When asked to compare EMR with PBMR, almost all of the physicians interviewed believed that the EMR system was very easy to use, particularly for retrieving information. For seven of ten physicians, retrieval of information was easy or very easy, particularly laboratory, radiology, and sonography reports. The remainder of the interviewed physicians had found the EMR system difficult to use and preferred PBMR. Ninety percent of the nurses interviewed believed that using the EMR and retrieving information from it was easier than with PBMR.

The physicians were also asked how often the EMR system was accurate and 60 percent of them believed that the system provided 100 percent accurate information, but 40 percent referred to incompleteness of data in the EMR system. For them, the EMR has provided accurate information in only 60 percent of cases. Almost all interviewees mentioned that they were completely satisfied with laboratory, radiology, and sonography reports that the EMR system provides. Ninety percent of the interviewed nurses rated the accuracy of the EMR system as good to very good, but also mentioned that sometimes human error reduce the accuracy.

Changes in the quality of their daily practice were another issue that was questioned. All physicians interviewed believed that EMR had changed their performance positively, especially in emergency situations which needed prompt action: in such cases, the EMR provided information faster than PBMR and it helped them to make faster and better-informed decisions than before. The nurses interviewed emphasized that through using EMR, the quality of their daily practice had improved positively (although there was no change in work flow) and 90 percent believed that EMR had helped them to save time in terms of searching, following-up, reporting, and communicating with other wards.

Fifty percent of the physicians mentioned that the quality of care of the whole hospital improved after implementation of the EMR system, admission is faster and the hospital provides better services for emergency situations. However, 30 percent of the physicians were unsatisfied about the quality of care as a whole at the hospital. They believed that because entering data into EMR is a time-consuming process, most of the nurses' time is spent for data entering, so the quality of care worsened. The rest of the physicians (20 percent) believed that there was no change in the quality of care at the hospital.

The interviewees were also asked about missing functionality in EMR. They had different opinions on this matter, 50 percent of physicians interviewed believed that EMR itself was very useful; but because the information inside the EMR system can be incomplete, this limits the usefulness of EMR. The rest of the interviewed physicians did not find any missed functionality in the EMR.

The interviewed nurses said that because entering data into EMR is a time-consuming job, some functions have to be added to the system, such as predefined charts and reports to facilitate the data-entering process and to allow the positive effect of EMR on quality of care to become permanent.

Both physicians and nurses were also asked if they had ever faced any problem in using EMR or computer itself. Almost all of them had faced computer crashes, software failure, and similar problems. Because all problems had been resolved quickly, the interviewees considered it as problems that they might happen in any given situation and had not changed their views on EMR.

Almost all physicians complained about one particular problem. There was no computer workstation at the

physicians' room or at the bedside of the patients. Depending on the wards, there were two to five PC workstations, mainly occupied by nurses. So physicians were usually dependent on nurses, and if physicians could find spare time, they used nursing workstations.

We asked the interviewees which kind of documentation system (PBMR or EMR) they were more satisfied with, and 90 percent of the interviewed physicians were satisfied with EMR, despite shortcomings in hardware and difficulties with data entering. One of the interviewed physicians preferred the PBMR system. Nine of ten nurses interviewed considered EMR more satisfactory PBMR in terms of easiness to search, read (in contrast with poor handwritings in the PBMR system), and printing record information.

DISCUSSION

Completeness

This study revealed that the introduction of the electronic medical records system had positive effects on the quality of medical records at this hospital. It is clear that the documentation process has improved compared with the previous situation, when all records were paper-based. These findings are in parallel with other studies (4).

In group A (documentation of demographic information), almost all electronic records had patient identification information. We can also see almost 46 percent improvement on some pages which contained information about medical procedures, such as physical exam, progress note, and physician's order. Because entry of identification information happens as soon as the patient is admitted to hospital and the EMR system then distributes this information automatically throughout the system, the EMR system has dramatically improved the documentation of these data.

Group B (administrative information) shows some improvements in comparison with the PBMR system. Documentation of informational elements on some pages has dramatically increased, mainly on laboratory (26 percent improvement), radiology (74 percent improvement), pathology (44 percent improvement), vital sign pages (43 percent improvement), and unit summary (39 percent improvement). Here, we can see more nurses' involvement in the documentation process: because they are responsible for requesting, following-up, and allocating resources for patients, the EMR system has helped them to document this information better than PBMR (2). However, there were signs of deterioration of documentation on some pages related to physicians. This downgrading is the effect of both shortcomings on admission (both admission to the hospital and to the wards) and to some extent the EMR system itself. Some parts of this information are entered by the admission officer (e.g., the name of the admitting physician) or registered automatically by the application (e.g., date and time of admission). Omission of

this information resulted in the incompleteness of some fields of the medical records.

In group C (medical information) the pattern of improvement in documentation has changed. Some pages show improvements, for instance, radiology report (45 percent improvement), vital sign (11 percent improvement), operation report (31 percent improvement), pathology report (49 percent), and unit summary (13 percent), but those pages which were supposed to be filled in by physicians have gotten worse, showing a decrement of 55 percent and more in the documentation on these pages. Physicians claim that data entry is a time-consuming process, their workload is high, and there is no portable hardware available to help them to enter data at the bedside: When they want to use nursing workstations, they face long queue, so they prefer to continue with paper sheets at the bedside and use the EMR system just for searching and retrieving information.

We can see the same pattern for group D (care provider identification information) with nearly complete documentation of information on admission, laboratory, radiology, pathology, vital sign, and unit summary pages. However, again, documentation of those pages that are related to physicians has decreased dramatically (63 percent decrement of documentation on medical history, physical exam, and progress note pages) in comparison with the PBMR system.

Physicians never felt any obligation to enter data into the EMR system, and there was no control mechanism to report incomplete medical records. The hospital administration has never managed to persuade physicians to fill in the electronic records. Instead, they have hired staff for some critical places, such as the operation room, to transcribe paper sheets (which had been filled in by the physicians) to the EMR system. However, in the wards, where there was direct interaction between physician and patient, none of the data has been entered into the EMR system. It could be in part because of shortage of hardware at the bedside (7), high workload of physicians, or the EMR system itself. In high workload environments, the data-entry interface of the EMR system has to be simple and easy to use, especially by those who are not skilled typists. Some studies have shown that graphical user interfaces and structured data entry have improved documentation of medical information by physicians (14).

Accuracy

Regarding accuracy, physicians and nurses had different opinions. Nurses were using computers and EMR more than physicians for daily tasks and the computer has nearly replaced paper for the nurses. Because the nurses document everything, they found EMR more reliable and accurate than paper, but physicians have ignored documentation and did not rely on the data entered by other persons (for instance, ward secretaries). Meanwhile, the same physicians seem to rely on radiology, sonography, and laboratory reports. This means that they could also rely on the physician's order

section if they had already been involved and documented the details.

There was a strict regulation for the nurses which obliged them to enter all requested data into the EMR. This rigid supervision is one of the key factors in the successful implementation of the EMR in the hospital. Because there was no such supervision for the physicians, they ignored the requirement.

Availability

Availability and ease of use of the medical records were the concern of this study. Both physicians and nurses acknowledge that EMR is easy to use and searching and finding information is much easier than with the PBMR (8). They have also found the EMR more accessible than PBMR as they could obtain information from different places and in emergency decision making they trusted EMR completely (6). The nurses believed that the EMR system gave them more time for patients (by decreasing time needed for documenting, searching, and retrieving information) (11;15). These benefits have led to a belief that there are some improvements in the quality of medical care at the hospital, for instance, provision of better services for patients in a critical condition (1), although another study would be needed to prove changes in quality of medical care in terms of mortality and morbidity.

Administration

Few physicians have been engaged in the implementation and use of the EMR system, and most of the remaining physicians preferred to continue with written sheets, or dictate their notes. This has necessitated extra secretarial help which has increased the financial cost of using the EMR system.

One disadvantage of this approach would be the elimination of any opportunity for integrating real-time clinical decision support into the EMR system, because none of the physicians would be in front of the computer to notice reminders or alerts that might be generated by the EMR system (3).

Authorities at the hospital could help physicians by involving them in the EMR development and implementation phases, and also by providing bedside or portable computers. There have to be some regulations and monitoring mechanisms to encourage physicians to enter data into the EMR system personally, and continuous training of physicians and nurses in use of the EMR system could boost its use in daily practice (12).

Software Development

Technical aspects of the EMR software at this hospital were not the concern of this study, but there were some signs that necessitate changes in the software. For example, the EMR system was without any control mechanism for flagging up incompleteness of the medical records. Users

can easily omit some important fields (date, time, ward, bed number, physician name, etc). There has to be a software mechanism to report errors and incompleteness. If some interfaces of the EMR software could be changed to facilitate data entry by physicians and nurses, we believe it would be helpful (10;16).

We are considering another study to evaluate the possible impact of automatically generated reminders on the completeness of EMR in the future.

CONCLUSION

Our findings indicate some advantages of the Electronic Medical Records system over the Paper-based Medical Records system. Some indications of reduced quality, however, could also be seen, mainly on sections that related to the physicians' own work with the EMR system. Different factors are involved, such as low physician acceptance of the EMR system, lack of administrative mechanisms, shortage of hardware, high workloads, and software characteristics of the EMR system. Steps should be taken, for instance, using a computerized physician order entry system to facilitate use of EMR in hospitals with high workloads. Continuous training and supervision of staff are other key factors for successful introduction of the EMR system.

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