

Assessment of the impact on time to complete medical record using an electronic medical record versus a paper record on emergency department patients: a study

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ABSTRACT

Background Electronic medical records are becoming an integral part of healthcare delivery.

Objective The goal of this study was to compare paper documentation versus electronic medical record for non-traumatic chest pain to determine differences in time for physicians to complete medical records using paper versus electronic mediums. We also assessed physician satisfaction with the electronic format.

Methods We conducted this before-after study in a single large tertiary care academic emergency department. In the 'Before Period', stopwatches determined the time for paper medical recording. In the 'After Period', a template-based electronic medical record was introduced and the time for electronic recording was measured. The time to record in the before and after periods were compared using a two-sided t test. We surveyed physicians to assess satisfaction.

Results We enrolled 100 non-traumatic patients with chest pain in the before period and 73 in the after period. The documentation time was longer using electronic charting, (9.6±5.9 min vs 6.1±2.5 min; $p<0.001$). 18 of 20 physicians participating in the after period completed surveys. Physicians were not satisfied with the electronic patient recording for non-traumatic chest pain.

Conclusions This is the first study that we are aware of which compared paper versus electronic medical records in the emergency department. Electronic recording took longer than paper records. Physicians were not satisfied using this electronic record. Given the time pressures on emergency physicians, a solution to minimise the charting time using electronic medical records must be found before widespread uptake of electronic charting will be possible.

INTRODUCTION

Information technology, including electronic medical records, is becoming an integral part of healthcare delivery. Many systems, including electronic medical records, are implemented without a full analysis of the clinical impact. There is currently a push to increase the use of electronic medical records to profit from the obvious benefits of increased legibility and accessibility. However these systems are expensive and must be acceptable to the users to be successful.¹⁻³

Electronic medical records are not being used in many emergency departments. A survey of

emergency departments in the USA found that only 31% were using some form of electronic medical record.⁴⁻⁵ Paper systems have inherent troubles, including problems with legibility and completeness.⁶⁻⁷ Many electronic medical record systems currently exist including template-based, free text, dictation, voice recognition; however, most are not fully integrated within hospital systems and none have been tested to determine impact on the time taken by the treating physician to complete their medical record or have assessed physician satisfaction with their implementation.⁸⁻¹⁵

The goal of this study was to compare paper documentation versus a template electronic medical record for a single chief complaint, non-traumatic chest pain, to determine: (a) *time for physicians to record medical information* and (b) *physician satisfaction with the electronic medical record*.

MATERIALS AND METHODS

Study design

This before-after controlled study was conducted at the Ottawa Hospital. This urban tertiary care academic emergency department has approximately 60 000 patient visits per year. We have approximately 45 attending physicians, 100 nurses, emergency medicine residency programme, rotating residents and undergraduate medical rotations.

Study population

The before period cohort was a convenience sample using sequential periods from 8:00 to 18:00 Monday to Friday over a 4 week period. During this period, trained medical students identified adult patients with non-traumatic chest pain. We excluded patients: (a) with chest pain as a secondary complaint (eg, shortness of breath or a rapid heart rate as a chief complaint with chest pain), (b) assessed directly by consultant services (eg, internal medicine or cardiology directly without first seeing an emergency physician), (c) who were seen by a second physician concurrently while another patient with chest pain was being enrolled by the research assistant.

During the after period, the same inclusion criteria were applied. The exclusion criteria were the same except only staff physicians enrolled patients and patients could be enrolled simultaneously, as a research assistant was not required. Medical students and residents were excluded from the after phase due to lack of resources to continuously train



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new learners. Our study was approved by the Research Ethics Board without the need for informed consent from patients or physicians.

Study interventions

In the before period, study assistants monitored eligible patients' charts. Once the record was selected by a staff they would unobtrusively observe the treating physician and record the time spent charting for these patients. Physicians wrote in free text their history, exam, diagnosis, disposition and management. Each charting interval was recorded in seconds. The physicians may have realised that they were being timed, but the observers were trained to stand unobtrusively off to the side to minimise their presence. The time was stopped if the physician was interrupted. A new segment was started when the physician returned or resumed their charting either immediately after the interruption or following reassessment of their patient. In addition, the time of physician assessment, the time of disposition (ie, when the physician has decided to discharge home or refer to a consultant), admission status and the final diagnosis was recorded.

The electronic record was designed as an added application to the existing OASIS (Dinmar, Ottawa, Ontario, Canada) computer information system, used by the entire hospital already for several years, with the same user identification and passwords. This non-traumatic chest pain documentation was a template-driven interface using mainly YES/NO answers to click with a mouse with the option of providing free text as appropriate (figures 1 and 2). The system did not mandate that all boxes be

completed. The tool was designed and pretested by five emergency physicians. The tool was then retested by the hospital information technology personnel to ensure that it operated correctly. The chest pain template could be accessed at any of the 10 fixed user stations distributed throughout the emergency department at the time of the study. Physicians also had the option of using a computer on wheels or portable tablet (IBM ThinkPad) computers with wireless internet connectivity. In the after period, emergency physicians were trained individually by an information technology trainer on how to use the electronic health record. A convenience sample of patients, with non-traumatic chest pain, was enrolled by physicians who completed an electronic record in lieu of a paper record. This data collection continued for a 12 month period. Because the hospital was still officially using a paper record system, once the physician completed their notation, a summary of the electronic record including laboratory and radiography results was printed, signed and placed in the patient's official medical record.

The computer system automatically recorded the time the physician spent on the documentation section of the record (including history, examination findings, ECG interpretation, disposition and follow-up plans) while logged in as well as the number of times the physician modified the record. Physicians were surveyed with a one-page questionnaire at the end of the after period to determine their satisfaction with the electronic record. This survey contained eight questions, with five directly related to their experience completing the electronic record, two regarding demographics and one asking if they had completed

Figure 1 Screen shot of template used for recording patient history in electronic medical record.

Figure 2 Screen shot of template used for recording patient examination in electronic medical record.

any electronic records during the study period. For the five questions regarding their experience and opinions regarding electronic medical records, physicians were asked to answer using a 5-point Likert scale (strongly disagree, disagree, neutral, agree, strongly agree). Physician surveys were placed in their hospital mailbox and email reminders were sent weekly for 4 weeks to complete the survey. No incentives were provided. Completed surveys were returned to the principal investigator's mailbox.

Data entry for the before period and the postimplementation survey was carefully performed by an experienced data entry clerk into an Excel database. Data for the after period were collected electronically by the hospital information technology staff who had dedicated time to this project. These data were exported into an Excel database and then combined with the before dataset for analysis. Data analysis was conducted using SPSS.

Outcome measures

The primary outcome in the before period was the sum of all the time spent charting on paper as measured by a research assistant observer, while in the after period this was measured electronically by the amount of time logged into the OASIS system application. Secondary outcomes included emergency department length of stay prior to referral or discharge and emergency physician user satisfaction. User satisfaction was assessed in the final question of the postelectronic medical record survey. Physicians were asked to respond to the statement "I am completely satisfied with the current electronic patient

record for non-traumatic chest pain". Physicians were classified as being dissatisfied if they either strongly disagreed or disagreed with this statement.

Data analysis

The primary outcome analysis used a two-tailed t test to compare means. Categorical variables were analysed with Pearson's χ^2 or Fisher's exact test as appropriate. Descriptive analyses were performed for survey results of physician satisfaction.

Sample size

We enrolled as many patients as possible within the specified study period. We had hoped to enrol 100 patients in the before period and 100 patients in the after period of this study.

RESULTS

Our study collected data from July 2008 until July 2009. We enrolled 100 patient encounters involving 40 physicians in the before paper charting period and 73 patient encounters in the postelectronic charting period involving 20 physicians. There were six physicians involved in both periods of the study.

Table 1 displays the results comparing the time to record on paper in the before period versus the time to record electronically in the after period. The patients enrolled in both study periods were comparable with no statistically significant differences in age, sex, admission status or final diagnosis. We found that the time to record was statistically significantly longer using electronic charting, taking 9.6 ± 5.9 min versus 6.1 ± 2.5 min

Table 1 Comparison of paper charting period to electronic charting period for emergency department patients with non-traumatic chest pain

	Before period with paper chart (N=100)	After period with electronic chart (N=73)	p Value
Patient demographics			
Mean age (SD)	57.5 (18.0)	54.9 (15.3)	0.33
Male (%)	52.0	53.4	0.99
Admitted to hospital (%)	15.1	15.0	0.99
Final diagnosis (%)			0.22
Acute coronary syndrome	14.0	11.0	
STEMI (%)	1.0	1.4	
Gastrointestinal	6.0	12.3	
Musculoskeletal	11.0	9.6	
Pulmonary embolus	0	0	
Pneumonia	4.0	0	
Anxiety	3.0	1.4	
Chest pain not yet diagnosed	44.0	56.2	
Other	17.0	8.2	
Charting characteristics			
Mean number of times to chart (SD)	2.4 (1.1)	5.6 (3.0)	<0.001
Mean time to chart in minutes (SD)	6.1 (2.5)	9.6 (5.9)	<0.001

STEMI, ST elevation myocardial infarction.

using the electronic record with 2.4 ± 1.1 and 5.6 ± 3.0 separate encounters (ie, discrete charting episodes separated by either interruptions or patient reassessments) to complete the patients' record of treatment, respectively.

The post study user satisfaction survey had 18 responses out of 20 physicians (90% response rate) completing at least one study form during the electronic charting period (table 2). Physicians completing the survey had a wide range of experience with a median number of years in clinical practice of 5.1–10 years (options given were in 5 year intervals from 0 years to 20 years and then over 20 years). Physicians were 'neutral' (on a 5-point Likert scale from strongly disagree to strongly agree) regarding the question asking if an electronic record for non-traumatic chest pain was useful. Physicians were also 'neutral' regarding the question if the electronic record would allow for better communication versus paper. While the median response was also neutral when asking if the electronic record would assist subsequent physicians caring for their patients, the IQR was between neutral and agree. Questions, 'the electronic record will allow me to see more patients per shift' and 'I am completely satisfied with the current electronic patient record for non-traumatic chest pain' had a median response of disagree with IQRs of strongly disagree to disagree.

DISCUSSION

Our study found that electronic charting for emergency department patients with non-traumatic chest pain was significantly slower than the standard paper-based system. Physicians were not satisfied that an electronic record would lead to seeing more patients per shift and they were not completely satisfied with the current template. However, physicians in this study were neutral to positive in believing that an electronic record would assist subsequent physicians managing their patient.

Table 2 Postelectronic charting pilot study user satisfaction survey of physicians completing at least one electronic patient record during the study period (N=18)

An electronic chart for non-traumatic chest pain is helpful (median, IQR)*	3 (2,4)
An electronic chart will allow for better communication versus the current paper record (median, IQR)*	3 (2,4)
The electronic chart will allow me to see more patients per shift (median, IQR)*	2 (1,2)
The electronic chart will assist other physicians who subsequently manage my patient (median, IQR)*	3 (3,4)
I am completely satisfied with the current electronic patient record for non-traumatic chest pain (median, IQR)*	2 (1,2)
Number of years of practice (%)	
0–5 years	14.8
5.1–10 years	40.7
10.1–15 years	25.9
15.1–20 years	7.4
>20 years	11.1

*5-Point Likert Scale from strongly disagree=1, disagree=2, neutral=3, agree=4, strongly agree=5.

Comparison with other studies

Other studies, in settings outside the emergency department, which assessed the time for charting, found similar results as our study. The systematic review by Chaudhry in 2005 identified two studies on physician order entry which demonstrated increased time utilisation using electronic order entry. They also identified one study which found physician documentation using electronic documentation to be slightly faster, taking a mean 0.5 min less time than paper recording; however this was in an outpatient setting for which the notation is often much less detailed than in the emergency department. Finally, this review identified two papers demonstrating a decrease in charting time for nursing notes on inpatient wards using electronic charting.^{16–21}

Another study of 155 paediatric inpatient hospital admission history/physical examinations assessed (1) transcribed records, (2) paper records and (3) a template-based electronic medical records. The paper-based model took a mean 9:00 min to complete; transcription took three times longer for the first eight cases with a mean of 26:42 min, decreasing to twice as long as paper with a mean of 17:46 min with subsequent transcriptions. The electronic record took two and a half times longer with a mean of 24:22 min for the first four records, and only decreased by 10% to a mean of 21:50 min for subsequent electronic recordings, which was still over twice as long as the paper record.²² While our study assessed emergency department documentation which is less detailed than inpatient admission history/physicals, their results were consistent with our results. Their study also demonstrates that, while there is some efficiency gained with experience using the system, this only decreased the time requirement by approximately 10%, and is still considerably longer than a paper-based system.

Strengths

To our knowledge, this is the first study assessing the impact on the time to chart of electronic medical records versus paper charting in the emergency department setting. This study is also one of very few studies which has assessed physicians' satisfaction and impressions of using electronic records versus a paper-based model.^{1–3} Our research assistants carefully recorded the

amount of time physicians spent charting on paper charts. We were then able to electronically monitor the number of times and amount of time spent documenting on our electronic information system.

Impact on clinical practice

While this study did not assess the full impact of implementing a full electronic medical record (eg, patient outcomes, cost effectiveness, completeness of the medical documentation, etc), this study demonstrates the need to ensure that any electronic charting or electronic medical record does not take more time than it currently takes to record patient information. Given the chronically overcrowded state emergency departments find themselves in, it is unlikely that any electronic charting solution which adds a significant amount of time will be accepted by the end users. Alternative systems such as voice recognition software, dictation, paper templates which are scanned or scanning and electronically archiving paper records are alternative approaches which can be considered.

Future research

Further study is needed to assess the impact of other technologies which may be used to create electronic medical records. While the potential advantages of electronic access to healthcare providers is fairly well established, it is not known what the optimal record will look like. Assessing the impact on time, accessibility, legibility and user satisfaction needs to be assessed for voice recognition software, dictation, paper templates which are scanned or scanning and electronically archiving paper records in the emergency department setting.

Limitations

While we put much effort into ensuring that the time taken to document on patient charts was accurate, there is likely still a small margin of error present. There is a chance that the research assistants missed some of the times physicians were charting. Likewise, physicians may have remained logged on to the electronic charting system without actually charting, as they were called away to address something more urgent. Minimising the impact of this however, is that we did not include the time spent opening the OASIS programme or logging on and off the OASIS system in our time calculations. This would add approximately 20 s to the charting time per charting episode, however, this was too difficult to assess as there would not be any additional time if the physician was already logged on the system assessing results for this or another patient. This would have the effect of overestimating the increased amount of time it took to chart in the after period.

Another limitation is that only 30% of the physicians participated in the before and after phases of the study. Hence, it is possible that the physicians in the before period were naturally faster charting than those in the after period. We also allowed residents and medical students to be included in the before period, but not in the after period. This decision was due to the information technology department not allowing access to learners at the time of this study. We do not think that this is likely a large source of bias, given that 30% of the physicians participating in the after period also participated in the before period. In addition, learners would be expected to take more time to chart and therefore if there were any bias, it would actually increase the difference between paper and electronic recording found in this study. If physicians used the electronic medical record for 100% of eligible patients, this would have minimised any potential biases; however this was not feasible as we could

not mandate that physicians used the electronic medical record due to hospital administration and ethics requirements.

Physicians self selected if they were going to use the electronic record in the after period. This may have resulted in more technologically inclined physicians, who would likely be faster charters, to overpopulate the after period. This would have biased the results towards a smaller increase in time to complete the electronic record than we found. It is also possible that physicians would have become faster with more experience. This was not assessed in this study, and has the potential to bias the results towards a longer charting time in the after period. However, physicians were individually trained to try to minimise this potential bias.

Our study design was a before-after study rather than a randomised controlled study which may have decreased the likelihood of allocation bias between the study groups. We examined options for using randomised controls and felt that none were feasible. The study intervention, electronic patient record represents a system-wide programme which requires extensive training of over 40 physicians. Randomly allocating patients to use or not use a system-wide programme such as electronic medical records would be very cumbersome. Hospital administration has made it clear that, because of logistical concerns for patient care, they would not participate in a study that required them to randomly use or withhold electronic medical records. For the same reason, randomisation by a crossover design would not be acceptable. The eligibility criteria were virtually identical between the before and after study periods, with the exception of allowing multiple patients to be enrolled simultaneously in the after period, in order to assure comparability of the study populations. The constraint of not having a fully electronic record may also have negatively affected the satisfaction of physicians given that they had to print and sign the electronic record which was added to the existing paper record. This extra burden was minimised given that printers were widely available and that they did not record the information twice, just indicated on the usual record of treatment to see the printed electronic medical record.

It is likely that a better designed electronic medical record may have resulted in better satisfaction with the electronic medical record. While we had a consensus committee of emergency physicians who provided substantial input and pretested the tool it is possible that with further changes the tool may have eventually become more acceptable at some point in time, however physicians were clearly dissatisfied with this version of the electronic medical record.

Finally, our main limitation is that medical records are recorded uniquely in each individual emergency department and electronic systems also differ greatly across the world. Hence this heterogeneity makes our results difficult to generalise to other settings. It is possible other sites may have performed better or that using more optimally designed templates would produce different results. We sought to obtain extensive input from the end users, emergency physicians and technology experts, from Dinmar and the inhouse information technology specialists at the Ottawa Hospital to ensure the optimal product was created. Despite this limitation, all centres do require the same basic elements to be recorded either on paper or electronically. Hence, even though the systems will vary somewhat, some generalised traits can be generated from this study. Given the clear increased time commitment observed in this study, physicians will not likely be satisfied with electronic charting unless this issue is solved.

CONCLUSIONS

The template-based electronic medical record in this study was significantly more time-consuming to complete than the current

paper record. Physicians participating in the study were not satisfied with the electronic medical record and they did not see more patients by using it. Given the enormous time pressures on emergency physicians in overcrowded emergency departments, the issue of creating increased time to record medical information must be addressed before widespread uptake of electronic medical charting will be possible.

Contributors JJP: study concept and design, analysis and interpretation of the data, drafting of the manuscript; JJP, JS: acquisition of the data; JJP, JS, CS, KD, MM, IGS: critical revision of the manuscript for important intellectual content; JS, CS, KD, MM: administrative, technical, or material support; JJP, IGS: study supervision.

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