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A Study of Nurses' Interaction with an Alerts and Reminders System of a Nursing Documentation Application

José A. Borges, Néstor J. Rodríguez, Carlos Pérez, Gilberto Crespo,Carlos Martinez, Celia R. Colón-Rivera

Center for Industrial Software Development (InduSoft),
Institute for Computing and Informatics Studies, University of Puerto Rico - Mayagüez

Abstract

Alerts and reminders can keep nurses aware of pending actions or procedures for patients and provide warnings on abnormal conditions or potential health hazards for patients. An alerts and reminders system can provide added value to an electronic medical records system (EMR) facilitating its adoption. This paper describes a study of nurses' interaction with an alerts and reminders system of a nursing documentation application. The system provides alerts on critical patients' conditions and reminders on pending nursing activities such as medication administration, physician orders and patient treatments. The nurses' interaction was analyzed in terms of task completion times, number of items found and subjective user satisfaction. Results revealed a wide variability in nurses' completion times which correlated with nurses' age. Younger nurses exhibit better performance than older nurses. Nurses are able to identify most alerts and pending activities on the system. However, the lack of experience with the system is a factor that affects their ability to identify some alerts and pending services. Nurses were very satisfied with the system and demonstrated a strong preference for it over the traditional paper-based system.

Keywords:

electronic medical record systems, nursing documentation, alerts and reminders, usability engineering

Introduction

The benefits of Electronic Medical Records (EMR) are well established and documented. Successful implementations of such systems have shown to improve patient care in terms of safety, effectiveness, and efficiency. However, in spite of the proven and potential benefits of electronic medical records, paper-based records are still predominant. The reasons for the lack of a widespread adoption of electronic medical record systems are also well documented in the literature. Factors such as cost, user resistance, complexity and poor usability, have contributed to the slow implantation of these systems.

The design, development, and deployment of an electronic medical record is a complex endeavor. An EMR must integrate the unpredictable, complex, and information intensive nature of the health care environment into the clinician workflow in a timely, easy to use, and effective manner [1]. Knowing this, it then becomes important to research mechanisms and alternatives that facilitate the adoption of these support systems.

Alerts and reminders can be an added value to an EMR system that can facilitate its adoption. Alerts and reminders are typically useful to inform clinicians of events, such as the correct time to administer medication, the arrival of test results, or other more urgent events such as an overdue procedure [2]. The key is in providing these alerts in an intuitive manner, one that is tailored to the clinician using the system. The systems display must be straightforward, offering as much useful information as possible without being cluttered or awkward.

A study by Krall [3] determined that physicians are most concerned with efficiency, usefulness, information content, user interface and workflow when asked about an alerts and reminders system. Efficiency was found to be the most important and fundamental criterion for success as perceived by the physicians. A similar study [4] used questionnaires sent out to community family physicians to determine their needs regarding electronic medical records. The topic of interest from the results of this study were the respondent's comments regarding what information is important enough to be included in the electronic records' "front page". Most mentioned among the replies were laboratory results, medication information, consultations, hospital follow-up and health maintenance. More specific atoms of information that were deemed important included allergies, flags for abnormal lab results, patient age, an active problem list, notifications if any screening procedures were recommended, and other data.

Usability [5] is one of the most important considerations in the design of any electronic health care system. It can has a significant impact on the acceptance, learnability, efficiency, and satisfaction of the users. Conducting usability tests with users is the most effective mechanism to evaluate the usability of a system. This is precisely

what this paper is about. It presents a usability study in which nurses interacted with the alerts and reminders system of a nursing documentation application of a prototype of an EMR. This alerts and reminders system evolved from a system called SAAS [6], conceived to track patients in an Emergency Room setting and provide status information about pending services for each patient. The study focuses on the usability attributes of learnability, efficiency and subjective user satisfaction.

The alerts and reminders system

The alerts and reminders system described in this section is part of the nursing documentation module of a prototype of an EMR system called hPad. The system allows efficient navigation between patient records, reduces nurses' memory load, and serves as a workflow management tool. The categories or selection of alerts, reminders, warnings, messages, pending services, and any other item of information to be referenced in this system could be customized for the specific needs of a particular health organization. Potentially, the system could be the basis to manage and assist in other health environment concerns mentioned in the medical literature. It could be used to assist the patient transfer or sign-out process [7,8], to enhance the adherence to guidelines [9] and documentation, and to provide timely information for clinical decision making [10].

The initial interface of the nursing documentation module is presented in Figure 1. The user is identified at the top left of the header of the user interface. A dropdown menu at the top right allows the user to select the clinical area in which she/he will be working. However, the system starts by default with the clinical area normally assigned to the nurse. A list of the patients in the clinical area selected is displayed below the header. Each entry of the list provides the name of the patient and his/her room number. Alerts and reminders for a specific patient are indicated with circular or oval icons to the right of the room number in the patient's row. These icons are aligned in columns and each column represents a specific type of reminder or an alert. The type of alert or reminder is specified with the pictorial icons at the heading of the table. The pad with the blue strip refers to physicians' orders reminders, the capsule to medication reminders, the test tubes to laboratory reminders, the chest x-ray to diagnostic studies reminders, the phone to physician consultations reminders, the yellow pad to pending documentation reminders, and the yellow triangle to general alerts.

Figure 1 - Initial Interface of the Nursing Documentation Module

The level of urgency of an alert or reminder is indicated with the icon color as well as its shape. These two ways of distinguishing the urgency of an alert or reminder were adopted to support colorblind users. The green circle indicates the lowest level of urgency. It means that a service or an action needs to be performed soon. The small yellow oval indicates that a service or an action is reaching the time it needs to be performed. The large red oval indicates that a pending service or action has exceeded the time when it should had been performed. In cases when there are more than one instances of a specific alert or reminder for a patient a number is displayed inside the corresponding icon indicating the number of instances. Placing the pointer over an alert or reminder icon for a few seconds activates a small tool tip-type window that provides additional information about the alert or reminder.

A double click on a patient's name opens a nursing documentation window like the one shown in Figure 2. This window facilitates the documentation of typical nursing tasks such as handling physicians' orders, medication administration, drip type medication administration, taking vital signs, writing nursing notes, performing daily assessment, collecting I/O measurements and assessment of pain. Access to a specific documentation category is accomplished by clicking on the corresponding keyword of the tab bar provided on the window. By default the nursing documentation window opens on the physicians orders tab when a patients name is double clicked on the window that lists the patients and the pending alerts and reminders (see Figure 1). However, if the user clicks on one of the alerts or reminders icons on the patients' lists window, the nursing documentation window will open on the documentation tab that corresponds to the particular alert or reminder.

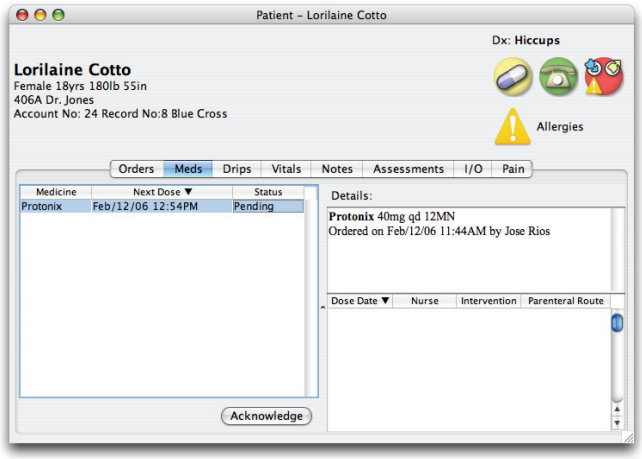

Figure 2 - Nursing Documentation Window

The nursing documentation window indicates the name of the patient and some relevant information at the top left side. Pictorial icons with a circular background are displayed at the top right of the window. These icons correspond to the pending alerts and reminders for the patient. The color of the circular background indicates the urgency of the alert or reminder. Double clicking on a pictorial alert or reminder icon will open the documentation tab on which the alert or reminder can be managed. The pictorial icons will disappear from the nursing documentation window as soon as the pending action or service that it represents is performed and documented. Similarly, the corresponding circular or oval icon will disappear from the patients' list window.

The alerts and reminders system allows efficient navigation between patient records and between specific items requiring attention. At a glance, the system provides a snapshot of the specific ward or floor, which can help nurses coordinate and manage their activities.

Methods

Participants

Twenty staff nurses from a hospital serving only a cardiovascular clientele participated in the study. They were selected on a first-come first-serve basis from those that responded a call for participation and were compensated for their participation. Their experience as staff nurses ranged from 0.2 to 27.4 years (M=8.5 years). Experience with computers ranged from 0 to 28 years (M=3.5 years). None had prior experience with the hPad system, nor with any other electronic patient record system.

The tasks

Each participant was asked to perform the nine tasks listed below on the hPad system. All the tasks began with the hPad system displaying the patients' list window (figure 1).

1.Indicate the patients with pending lab orders.

2.Indicate the pending alerts and reminders for a specific patient.

3.Indicate the pending services for a specific patient.

4.Determine the time a physician submitted a consult order for a specific patient.

5.Acknowledge the consult orders for a specific patient.

6.Open a pending note for a specific patient, add a specific text to it and save it.

7.Acknowledge the pending reminders for a specific patient.

8.Identify the rooms in which there are patients with pending medication orders.

9.Acknowledge all pending medication for the patients in the clinical area.

During the execution of task 9 one new alert and one new reminder is generated.

Research design

Before proceeding with the test the, participants were asked to sign consent forms and fill out a background questionnaire. All received a short tutorial of about 15 minutes on the hPad system. The participants were asked to perform the nine tasks indicated in the previous section. The patients' records used in the study were realistic in terms of their content but did not belong to real patients.

After performing the tasks the participants were asked to fill out a subjective user satisfaction questionnaire. The questionnaire asked them to rate five aspects of the hPad system using a 1-5 scale (see Table 3). The participants were also asked to indicate their system preference for the hPad or the traditional paper-based system.

Data analysis

Descriptive statistics were used to analyze the results. Average, standard deviations, maximum and minimum values were used for analyzing the completion times of all the tasks. Percentages were used to analyze the number of items asked to identify or act on by nurses while performing tasks 1, 2, 3, 8, and 9. Average ratings were used to analyze the users' responses to the subjective satisfaction questionnaire.

Results

A summary of the completion time results for all the tasks is presented in Table 1. The table indicates the average completion time, standard deviation, and maximum and

minimum times recorded for each task. The results exhibit a very wide variability in completion times. In most of the cases the maximum time recorded was more than ten times the minimum recorded.

Table 1. Completion Time Results

	Average (seconds)	Std. Dev. (seconds)	Min (seconds)	Max (seconds)
Task 1	30.4	22.0	6	77
Task 2	39.5	21.5	11	90
Task 3	31.8	19.2	7	91
Task 4	26.2	29.5	6	120
Task 5	39.2	28.0	11	92
Task 6	83.7	61.5	13	253
Task 7	52.1	34.1	12	125
Task 8	34.7	19.5	9	70
Task 9	103.5	95.1	17	480

A summary of the percentages of items found in response to questions posed for tasks 1, 2, 3, 8, and 9 is presented in Table 2. The results show that the participants found the large majority of the items they were asked to look for.

Table 2 - Percentage of items found

	% Found
Task 1: *Patients that have pending lab orders*	73.3
Task 2: *Pending alerts and reminders for patient Lorilaine Cotto*	82.5
Task 3: *Services pending for patient Rafael Cajigas*	98.3
Task 8: *Rooms where patients await for pending medication*	86.7
Task 9: *Pending medication for the patients in the clinical area*	78.8

Table 3 provides a summary of the average ratings given by the participants to various aspects of the hPad system and their system preference (item 6). The ratings given to the different aspects were very favorable to the hPad system. The participants overwhelmingly preferred the hPad system over the traditional paper-based system.

Table 3 - User satisfaction results

Aspect	Meaning of scale	Rating
1. Did you understand the functionality of the system?	1= not understood 5= understood	4.85
2. How did you find the meaning of the icons?	1= very confuse 5= very clear	4.55
3. How easy was to find the patients requiring the most urgent attention?	1=very difficult 5= very easy	4.75
4. How easy was to find the pending actions of a patient?	1=very difficult 5= very easy	4.90
5. How easy was to handle the different windows of the program?	1=very difficult 5= very easy	4.55
6. Which system would you prefer, the hPad or the traditional paper-based system?	1= paper-based 5= hPad	4.80

Discussion

The results for task completion times exhibit a wide variability (see Table 1). These results suggest that there exists a notable difference in the participants' ability to perform the tasks. In order to understand what may account for the variability in the participants' performance a correlation analysis was performed between the overall completion time for each participant and the participants' age, work experience and computer experience. A correlation was found between the overall completion time and the participants' age but not with the participants' work experience or computer experience. A correlation analysis was also performed between individual task completion times and the participants' age, work experience and computer experience. Correlations were found only between the participants' age and the completion times for tasks 1,3,4,6 and 8. These results suggest that age is a key characteristic in the participants' ability to perform the tasks on the hPad system. In general younger nurses exhibit better performance than older nurses. Thus, special attention should be given to older nurses when training them to use the system.

For tasks 1, 2, 3, 8 and 9 participants were asked to find, identify or perform actions on several items present on the initial window of the hPad system. The results show that the participants were able to identify the majority of these items (see Table 2). However, under normal circumstances nurses should be able to find all these items. The fact that the participants did not have any experience with the system other than a 15 minutes tutorial certainly played an important roll on the participants' ability to identify the requested items. Nevertheless, given the lack of training and exposure to the systems the results are very encouraging.

Although the participants did not know the system very well they were very satisfied with it. The results for the user satisfaction questionnaire were very favorable for the hPad system. The participants gave relatively high ratings to all the aspect considered (items 1 to 5 of Table 3). They understood the functionality of the system and the meaning of the icons very well, and found the windows of the program very easy to handle. The participants' perception of the system is consistent with their observed interaction with the system. It was evident that the participants understood the functionality of the system because 95% of them were able to assess pending services without having to open the patient's record window. In addition all the participants clicked on the alerts or reminders icons instead of the patient's name in the initial window (see Figure 1) in order to open the documentation tab that corresponds to

the particular or alert or reminder. The participants also indicated that it was very easy for them to find the patients requiring urgent attention and to find the pending actions on a patient. In addition the participants indicated a strong preference for the hPad system over the traditional paper-based system used in the hospital (item 6 of Table 3).

Conclusion

Nurses exhibit a wide variability in performing tasks with the alerts and reminders system. This variability correlates with the age of the participants. In general, younger nurses exhibit better performance than older nurses. Thus, in order to learn to use a system like the hPad older nurses may required more training time than younger nurses.

Nurses are able to identify most alerts on pending activities and reminders on the system. However, the lack of experience with the system is a factor that affects their ability to find, identify or perform actions on several items present on the initial window of the system, but the fact that they were able to identify most of them is an encouraging result. With minimum training nurses should be able to identify all pending activities and alerts indicated by the system.

Even though nurses exhibit a wide variability in performing tasks on the alerts and reminder system they were very satisfied with it. They felt they understood the functionality of the system and the meaning of the icons, and found the windows of the systems very easy to handle. In addition, they felt it was very easy to find the patients requiring urgent attention and to find the pending actions on a patient. Nurses also evidenced a strong preference for the alerts and reminders system over the existing paper-based system.

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References

[1] Taylor DP, Coakley A, Reardon G, Kuperman GJ. An analysis of inpatient nursing communications needs. MEDINFO 2004:1393-7.

[2] Payne TH, Savarino J, Marshall R, Hoey CT. Use of a clinical event monitor to prevent and detect medication errors. Proc AMIA Symp 2000:640-4.

[3] Krall MA, Sittig DF. Clinicians' assessments of outpatient electronic medical record alert and reminder: usability and usefulness requirements. Proc AMIA Symp 200:400-4.

[4] Strasberg HR, Tudiver F, Holbrook AM, Geiger G, Keshavjee K, Troyan S. Moving towards an electronic patient record: a survey to assess the needs of community family physicians. Proc AMIA Symp 1998:230-4.

[5] Nielsen, J., Usability Engineering, Academic Press, 1993.

[6] Borges JA, González M, Navarro J, Rodríguez NJ, "SAAS: Automatic System for Auto-Supervision in an Emergency Room", Proceedings of the 10th IEEE Symposium on Computer-Based Medical Systems (CBMS'97), Maribor, Slovenia, June, 1997.

[7] Lasslo R, Balsbaugh T, Malyj W. Web-based patient signout system – evolution of a quality improvement tool. MEDINFO 2004:1707.

[8] Van Eaton EG, Lober WB, Pellegrini CA, Horvath KD. User-driven design of a computerized rounding and sign-out application. AMIA Symp 2005:1145.

[9] Anand V, Biondich PG, Liu G, Rosenman M, Downs SM. Child health improvement through computer automation: the CHICA system. MEDINFO 2004:187-90.

[10] Allen M, Currie LM, Graham M, Bakken S, Patel VL, Cimino JJ. The classification of clinician's information needs while using a clinical information system. AMIA Symp 2003:26-30.

Address for correspondence

José A. Borges (borges@ece.uprm.edu), Nestor J. Rodriguez (nestor@ece.uprm.edu)