Pre-Post Evaluation of Physicians’ Satisfaction with a Redesigned Electronic Medical Record System

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Abstract: Physicians’ acceptance of Electronic Medical Record Systems (EMRs) is closely related to their usability. Knowledge about end-users’ opinions on usability of an EMR system may contribute to planning for the next phase of the usability cycle of the system. A demand for integration of new functionalities, such as computerized order entry and an electronic patient status led to redesign of our EMR system, which had been in use for over 8 years at the Academic Medical Center of Amsterdam. The aim of this study was to understand whether the redesigned EMR system was an improvement of the earlier EMR and which system aspects accounted for user satisfaction and which did not. We conducted a formative pre- and post usability evaluation of our former and redesigned EMR system. For the assessment of both system versions’ usability, we distributed two standardized usability questionnaires among 150 clinicians who routinely had used the older EMR system and had been working with its newer version for 6 weeks. Though overall user satisfaction was relatively high for both EMR systems, screen layout and interaction structure proved less easy to work with in the newer EMR system. The new EMR system however was more appreciated because of its enhanced functionality, capabilities and likeable user-interface. The results point to a number of actions that might be useful in future usability improvement efforts of our EMR system and other EMRs.

Keywords: User Interfaces, EPR-CPR-EM, HER, Assessment-Evaluation, Health professional workstation

Introduction

Electronic Medical Records (EMRs) have the potential to advance the quality of care, patient safety, to facilitate work flow, decrease medical errors and reduce costs [1], and to improve communication among physicians [2,3]. The integration of order-entry systems and decision support further enhance their use [4,5]. At the same time, EMRs have disseminated slowly and many EMRs have failed their expectations, whereas health care organizations and their health care professionals nowadays make high
demands upon EMRs [6]. One of the largest barriers to EMR adoption has been resistance from physicians [7]. Factors influencing physicians’ adoption of and satisfaction with EMRs have been system’s ease of use, learnability and memorability, error frequency, system response time, and additional work load for physicians [8]. End users’ adoption of and satisfaction with interactive computer systems indeed is directly influenced by user interface characteristics such as the extent to which the system functions are obvious and accessible to the user, labels and names are distinct from one another and follow the users’ terminology and language, recognition is promoted instead of recall of information, and the natural workflow of the user is supported [9]. But even nowadays, design and evaluation of EMRs interfaces have not received much attention as a research area, though from the users’ perspective the user interface is the only visible part of an EMR. If our aim is to increase physicians’ acceptance of EMRs, we should know which features make EMRs usable and which should be improved.

This study was undertaken to measure usability and user satisfaction with an EMR in routine clinical use in a large academic medical center. In a pre-and post-evaluation, we compared physicians’ user interaction satisfaction with the EMR before and after its redesign. The aim was to understand whether the redesigned EMR system was an improvement of the earlier EMR and which system aspects accounted for user satisfaction and which did not. This paper provides the results of this usability evaluation study. We conclude with lessons learned about end-users’ satisfaction with EMR design aspects and about the next phase in the usability life cycle of our EMR.

1. Background setting

This study was performed within the Academic Medical Center (AMC), a large hospital organization in Amsterdam, The Netherlands. The AMC is a 1002 beds hospital including 21 outpatient clinics, 34 inpatient clinics, 5 day care units, employing 2200 clinicians in total. The development of an institute-wide integrated results review EMR was started in 1998; the ‘PoliPlus’ system. At that moment, the ‘PoliPlus system’ was an in-house developed web-based system. Its technology was grounded on the three-tier architecture. Easy accessibility and system simplicity were the system’s primary design principles. For over 8 years, this first EMR system version provided financial, administrative, clinical results review and patient list management facilities.

The vast majority of clinicians had used this PoliPlus system in support of their daily-patient care practices. Due to a demand for increase of its functionality, the PoliPlus system was integrated with commercially based facilities for ordering medications and clinical tests and an electronic patient status. On the front-end, this functional enhancement of the EMR required redesign of the navigational structure. The provision of all old and new functionalities in a logical and consistent manner was required in the new interface, and the proven user friendliness of the EMR system was to be preserved. Due to vast use of Microsoft windows, the new system version integrated Microsoft Windows menu-based components to realize this aim. This new version of the EMR system, the ‘AMC Care desktop’ was introduced hospital-wide in 2006. Figure 1 displays an overview of the main screens of the former PoliPlus system (left) and the new EMR system, the AMC Care desktop (right). Clinician users were informed about the introduction and capabilities of the new EMR system by flyers
explaining the new system functions and providing a step through scenario for learning to use the new system. Besides, a digital demonstration video was available and clinicians were invited for demonstrations of the new system at their departments.

Figure 1. Screenshots of the old PoliPlus system (left) and the new EMR system (right) to offer a visual overview of the changed screen and navigation layout, from button structure (left) to window based (right).

2. Methods

We applied two standardized questionnaires to measure user satisfaction with the EMR system before and after its redesign: the Questionnaire for User Interaction Satisfaction (QUIS, see [10]), and the IBM Computer Usability Satisfaction Questionnaire [11]. The short-form QUIS was used to assess the EMR interface as regards overall user reaction to the system, user satisfaction as regards screen layout, terminology used, system learnability and system capabilities. More specifically, we were interested to know to what extent screen layout and navigation structure of the new EMR system supported the clinicians in searching for patient information. The IBM Computer Usability Satisfaction Questionnaire was used in addition to the QUIS to assess to what extent the system as compared to its earlier version was efficient, effective, responsive, learnable, and informative in its help functions. Both in the pre-and post evaluation phase of the EMR system, a group of 150 clinicians were asked to participate in the study via an interdepartmental e-mail explaining the purpose of the study, providing a web link for filling in the QUIS and IBM Computer Usability Satisfaction questionnaires. Additional validation and confidence of findings were pursued through a comparison of the quantitative questionnaires’ results by a pre- and post-survey among the respondents allowing them to provide additional comments and remarks with regard to the older and newer version of the EMR system.
3. Results

In the pretest condition, 54 clinicians and in the posttest condition 62 clinicians filled out the questionnaires (36% and 41% respectively). Overlap in system respondents in the pre- and posttest was estimated on 80%. The pretest was organized three weeks before introduction of the new system. The posttest evaluation was organized six weeks after the introduction of the newer EMR system to give system users familiarity with the new system in daily clinical practice. The respondents covered all clinical departments within the AMC. The respondents of the pretest and posttest did not significantly differ in the distributions of age, general computer experience, and experience with the former PoliPlus system. The average age of the respondents was 44 years, computer experience ranged from intermediate (45%) to experienced (55%). Eleven percent of the respondents had 3-6 months experience, 18% had 6-11 months of experience, 32% had 1-3 years of experience, and 39% had over 3 years experience with the former PoliPlus system. Forty-four percent of the respondents had used the EMR system 2-10 hours per week, 28% used the EMR system 10-20 hours per week and 15% used it over 20 hours per week. Eleven percent of the respondents had seen a demonstration of the new EMR system after which they immediately had started to use the new EMR system. Eighty-nine percent of the respondents had read the flyer introducing the EMR system, of which 44% of the respondents had learned to use the new system by stepping through the scenario described in the flyer and 45% had started using the system without stepping through the scenario. Ninety-five percent of all respondents were of the opinion that no further training or instruction was required for learning to work with the new EMR system.

Table 1 shows the mean user response for the QUIS questionnaire in the pretest and posttest evaluation of the EMR system. The mean user responses for each QUIS section in the pre- and posttest condition were relatively high, ranging from 7.0 to 7.8. The mean user ratings of the categories easy, stimulating and flexible of the QUIS section ‘overall user reaction’ were significantly higher for the redesigned EMR compared to its earlier version. The newer EMR however scored lower on the question related to the organization of information on the screen QUIS section ‘screen design and layout’ than the older version. Remembering names and use of commands was somewhat more difficult, but error messages were more helpful and correcting mistakes was less complicated with the new EMR system. The IBM Computer Usability questionnaire shed some light on the satisfaction of the users with the newer EMR with regard to its efficiency, efficacy, responsiveness, learnability as compared to its previous version. Overall, users were as much satisfied with the new EMR system as with the older EMR system with regard to these aspects, but significantly more satisfied with the interface and with the functions and capabilities provided by the newer EMR system. These findings were confirmed by the survey results. Clinicians reported that the older EMR system was easy to work with because all patient information could be accessed and all system functionalities could be activated from the main screen. In the post-test survey, clinicians remarked that the new EMR system was an improvement because of its enhanced functionality, capabilities and likeable user interface, but was somewhat more difficult to work with because of the reorganization of information and functions on these screens.
Table 1. Results of the QUIS questionnaire for assessing user interface satisfaction with the older EMR compared to the new version EMR on a LIKERT scale of 1-9, with 1 as lowest and 9 as highest rating.

<table>
<thead>
<tr>
<th>QUIS Section</th>
<th>Older EMR</th>
<th>S.D</th>
<th>New EMR</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall reaction to the system</td>
<td>7.1</td>
<td>0.4</td>
<td>7.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Screen design and layout</td>
<td>7.8</td>
<td>0.2</td>
<td>7.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Terminology and system information</td>
<td>7.5</td>
<td>0.4</td>
<td>7.4</td>
<td>0.3</td>
</tr>
<tr>
<td>System Learnability</td>
<td>8.1</td>
<td>0.2</td>
<td>7.6</td>
<td>0.2</td>
</tr>
<tr>
<td>System capabilities</td>
<td>6.7</td>
<td>0.3</td>
<td>7.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

4. Discussion/ conclusion

The pretest results suggest that prior to installation of the newer EMR system, clinicians overall had positive experiences with the older PoliPlus system, specifically with regard to its screen design and layout and the ease with which system commands could be memorized. Whereas the newer version of the EMR system proved to be more flexible and stimulating to its users, the organization of information on the screens proved to be less usable to its users than the former EMR version. These findings were not too surprising for two reasons. First, clinicians had been using the older PoliPlus system for at least 1 year and were thus rather proficient in operating the older EMR system. The introduction of the new EMR system, extended with order-entry ordering facilities and an electronic patient status brought with it a radically changed interaction structure and screen layout. The lower post test ratings of screen layout and ease of commands use in the new EMR system might be attributed to the short time period of six weeks in which clinicians had to become acquainted with the new EMR system. This fact may also account for clinicians' higher appreciation of error messages of and the way mistakes could be corrected in the new system. In learning to use the redesigned EMR system with its more sophisticated interaction structure, clinicians were probably more dependent upon these messages than in daily use of the older system, with which they had become very much familiar with. Despite the difficulties clinicians seemed to experience in learning to operate the new EMR system, they apparently appreciated it for its extended functionalities and capabilities, and even liked using the new interface more than the older user interface. What remains one of the greatest challenges of designing our EMR system user interface is balancing the clinicians’ requirements with regard to an integrated fully-functional EMR and simple screen design and navigational structure. In many instances, navigation and orientation problems in the CPR make it hard for clinicians to gain a rapid overview of the patient’s clinical problems [2, 12]. Too much information and functions on a single screen may make these hard to find and problematic when trying to perform tasks efficiently. Less information and functions on a single screen will require more screens to provide these all and thus will lead to a more complex user-interaction structure. Minor changes in screen designs and interaction structure can have a major impact on the usability of a system. The context and interaction issues discovered in this study can be linked back to the importance of user-centred system design. For the interaction structure being effective, the tasks and procedures that the user may perform with an
EMR system need to be structured in a logical and consistent manner. This means that the system functions should correspond one to one with the goals that the user sets him self in performing his tasks and the order in which the user wants to attain these goals. Also, the presentation order of information should match the order in which a user processes this information. And as a general rule it can be stated that information that has to be memorized is more easily remembered if data elements that are related are clustered on the computer screen [13].

A further usability improvement of the EMR system will be necessary to determine how the clinicians’ needs can be even more accommodated than with our current version. The results of our questionnaire contribute to extensive discussions for modification of the system on the usability issues revealed. Understanding clinicians’ activities, information needs in the context of performing these activities and communication patterns is crucial in designing a user interface that is truly usable.

The next phase in the usability life cycle of our EMR is to conduct extensive cognitive analysis studies of clinicians’ daily activities, types of information needed and communication patterns. We recently conducted a study focused on a detailed analysis of the physician-nurse communication patterns and information exchanges during the morning report. The results of this study and others will be used to redesign our EMR computerized record system that will support our clinicians in performing their tasks supported by the EMR system in an even more user-friendly way.

References