

Evaluating Physician Satisfaction Regarding User Interactions with an Electronic Medical Record System

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ABSTRACT

A limiting factor in realizing the full potential of electronic medical records (EMR) is physician reluctance to use these applications. There have been very few formal usability studies of experienced physician users of EMRs in routine clinical use. We distributed the Questionnaire for User Interaction Satisfaction (QUIS) to 75 primary care physicians who routinely use the Brigham and Women's Integrated Computing System (BICS). BICS scored highest in the area of screen design and lowest in the area of system capability. Overall user satisfaction was most highly correlated with screen design and layout, and surprisingly not with system response time. Human-computer interaction studies can help focus our design efforts as we strive to increase clinician usage of information technology.

Keywords:

User interaction satisfaction, Electronic medical record keeping systems

INTRODUCTION

Electronic medical records (EMR) applications have the potential to improve the quality and reduce the cost of health care¹. However, the majority of these benefits will not be realized until physicians and other clinicians routinely use these applications. Physician acceptance of EMR applications has been slow and application designers attempting to solve this problem face several hurdles. First, the structured nature of electronic interactions takes longer than paper-based interactions². Second, full-time clinicians are very busy. Physicians often see 3-10 patients per hour thus leaving little time for them to interact with an inefficient EMR³. Clinicians are highly paid so applications that are difficult to use are costly as well as frustrating. Third, many outpatient practice settings have a small number of employees and the complex processes of chart and information management have been tuned to

a high degree of efficiency. An EMR that introduces inefficiencies will not be well received⁴. Also, most outpatient clinicians are independent entrepreneurs and will not embrace any technology that disrupts their workflow or decreases their sense of professionalism.

Much has been said about the importance of the human computer interface in medical applications however, there has been little study of this topic⁵. There are five axes along which the human computer interface can be evaluated: system response time, time required by users to learn the system, ability of users to remember what they learned, error rate, and subjective user satisfaction⁶. Several studies have shown that regardless of the outcome of the other four factors, if users do not "like" the system they will not continue to use it.

This study was undertaken to measure user interaction satisfaction with an EMR in routine clinical use to begin to understand which aspects of the system pleases users and which do not.

BACKGROUND

This study was carried out within the Brigham & Women's Physician Hospital Organization (BWPHO), a physician group affiliated with Brigham and Women's Hospital (BWH), located in Boston, MA. The BWPHO includes 75 ambulatory practice, primary care physicians (PCPs). Approximately one-half of the PCPs are full-time clinicians while the remainder see patients on a part-time basis. The vast majority of the BWPHO PCPs use the Brigham & Women's Integrated Computing system (BICS) as the clinical information system in their offices.

Brigham & Women's Integrated Computing System (BICS)

BICS is a PC-LAN based hospital information system that provides financial, administrative, and clinical functions to BWH. BICS has been in use for over 10 years⁷. The main clinical functions provided by BICS are: clinical results review, an outpatient electronic medical record application, inpatient order entry, patient list management, and an inpatient alerting application.

The interface to BICS is menu-based and requires keyboard navigation. The majority of the user interface was developed using Hyper-M, a character-based, windowing toolkit. System developers had only one font size and style and 16 colors to work with. The majority of the screens have dark blue backgrounds with white or gray text, although a significant number have a white background with dark blue text (see figure 1).

The Questionnaire for User Interaction Satisfaction (QUIS)

In 1988, researchers from the Human Computer Interaction Laboratory at the University of Maryland developed the Questionnaire for User Interaction Satisfaction (QUIS). The QUIS is a standardized, general user evaluation instrument for interactive computer systems. It was developed using psychological test construction methods to ensure proper construct and empirical

validity and reliability of the items⁸. The short form of the QUIS is divided into 5 sections of 4-6 questions each. The sections are designed to assess 1) overall user reactions, 2) screen design and layout, 3) terminology and system messages, 4) learning, and 5) system capabilities. Users rate each question on a scale from 1 (the lowest rating) to 9 (the highest) rating. Figure 2 shows the text of each question along with the user's responses.

METHODS

Data collection

A paper version of the QUIS (version 5.5 short form) was sent via interdepartmental mail along with a cover letter explaining the purpose of the study to all 75 PCPs in the BWPPO. An addressed return envelope was also included.

The physicians were asked to consider three BICS clinical applications in their evaluation:

- clinical results review which allows physicians to view patient-specific results from the clinical chemistry, hematology, and microbiology laboratories, as well as freetext documents such as discharge summaries, operative notes, and radiology examination reports;

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TEST,TEST      13029004      98M (P) 617-222-2222
Most recent VS: 07/21/98 BP 150/90 P 88 R 18 WT 180 T -- FS --
PCP: KRONENBERG,FRANNIE RENEE,M.D. PCP phone: 732-5773
PROBLEMS:
P1. HTN
P2. CHEST PAIN
P3. HEART
ALLERGIES/SENSITIVITIES:
A1. PENICILLINS->GI UPSET
MEDICATIONS: PHARM: -----
M1. ATENOLOL          50 MG PO QD
M2. PENICILLIN        300 MG IM Q4H
M3. .AMITRIPTILIN     100 MG QD
M4. ZINC SULFATE      220 MG PO BID
M5. EES400            250 MG 1 TID PO
M6. EES                250 MG PO TID 1
M7. ALBUTEROL (INHALER) 2 PUFF INH QID
M8. ALBUTEROL (TABS)  10 MG PO BID
(more)
VISITS:
V1. 11/17/98 RADIATION
V2. 09/15/98
V3. 08/27/98 RADIATION
V4. 08/05/98 RADIATION
V5. 07/17/98
V6. 05/26/98
V7. 03/11/98
V8. 05/19/97
(more)
A ALLERGIES          C CLINICAL ALGORITHM D ADV DIR          F FUTURE APPTS
+H HEALTH MAINT.    I MAILBOX              L LAB LOOKUP          M MEDS
+N NOTES             P PROBLEMS             S VITAL SIGNS        -T TO-DO LIST
V VISIT DISPLAY     +X EXTRA FUNCTIONS
CHOICE:
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Figure 1. Patient summary screen from BICS EMR.

- ambulatory medical record which allows clinicians to record and review a patient's current medications, medical problems, allergies, visit notes, health maintenance data, visit history, and a to-do list;
- list management which allows clinicians to add and delete patients from their personal patient lists.

Data Entry and Analysis

Data from the returned surveys were double entered and the means for all individual answers, answers within each section of the QUIS, and all answers as a group were calculated. In addition, we performed a Spearman Correlation analysis to identify which specific questions were most highly correlated with overall user satisfaction.

RESULTS

Of the 75 PCPs, 50 (65%) returned the survey. The average age of the respondents was 40 years with males (24) and females (26) nearly equally represented. Respondents had 2-3 years experience with the BICS system and they were heavy users (4-10 hours/week) of results review and the ambulatory medical record. The list management application was used less than 1 hour/week.

Figure 2 shows the mean user response for each of the QUIS questions. The mean response for all questions by all users was 5.6 (S.D. = 1.1). Table 1 shows the mean user response for each section of the QUIS.

Table 1. Mean user response for each QUIS section.

QUIS Category	Mean	St. Dev.
Overall user reactions	5.1	0.7
Screen design & layout	6.5	0.7
Terms & system information	5.9	1.2
Learning	5.7	0.6
System capabilities	4.9	1.8

The correlation results among questions within a QUIS category were always higher (mean = 0.36) than they were across categories (mean = 0.19). The six questions with the highest correlation outside of the "overall user reactions to the system" category*, were:

- Were screen layouts helpful (never - always)?
- Is correcting mistakes difficult or easy?
- Can tasks be performed in a straightforward manner (never - always)?
- Is use of terms throughout the system (inconsistent - consistent)?
- Are error messages helpful or unhelpful?
- Does the terminology relate well to the work you are doing (unrelated - well related)?

All these questions had correlation coefficients greater than 0.5. The correlation of overall user satisfaction with speed was low (0.22) as it was with reliability (0.35).

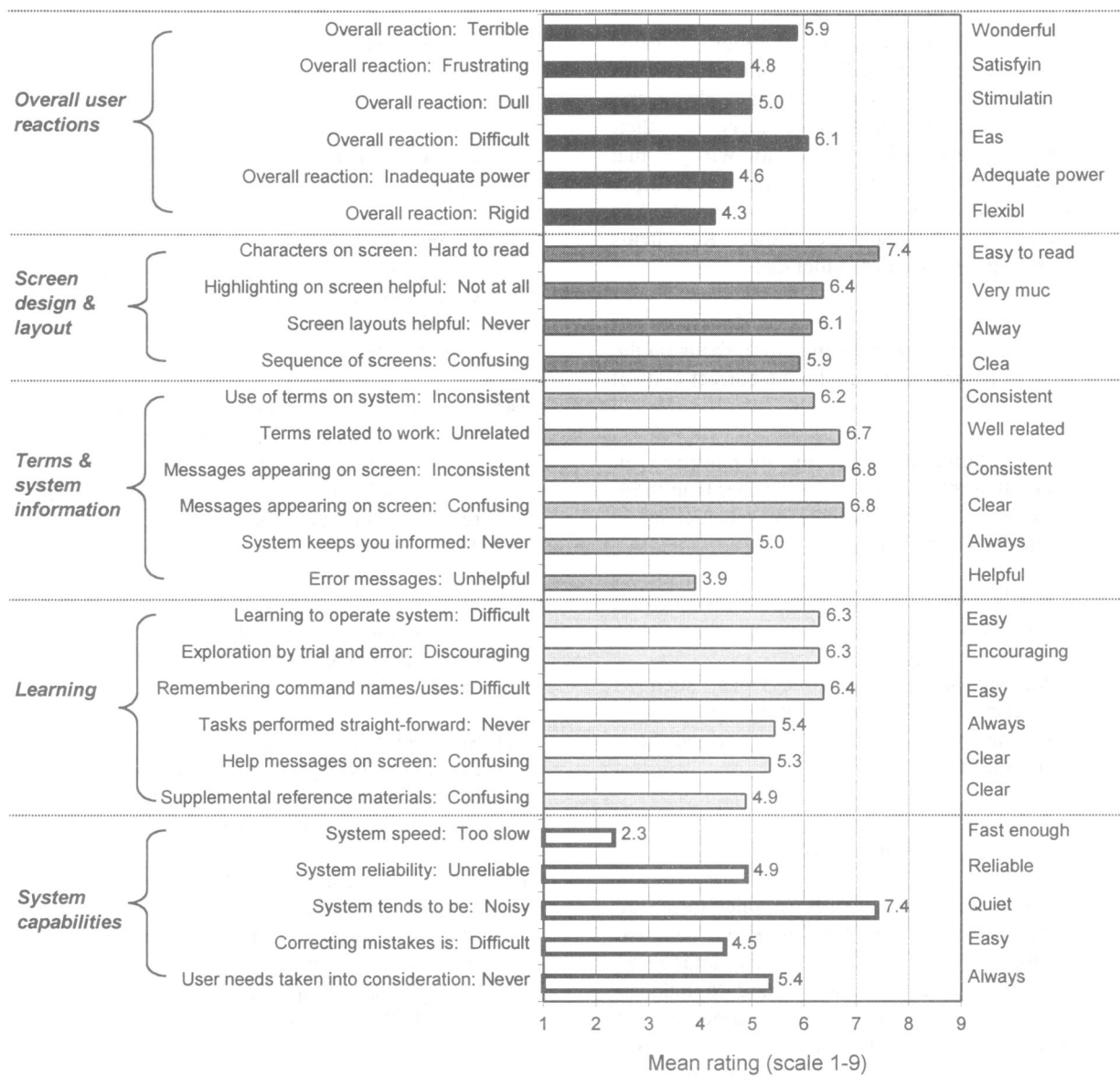
DISCUSSION

BICS scored highest in the area of "screen design and layout" and lowest in the area of "system capabilities". These findings were not too surprising for several reasons. First, experienced clinical system developers working closely with a few highly skilled and committed clinicians developed the original screen designs and layouts. In addition, the BICS screens have been continually revised and improved, based on extensive user feedback over the past 5 years.

Second, BICS system performance has degraded considerably over the past year. The current BICS hardware and software infrastructure is nearing the end of a long and very successful run. It was originally designed to handle 2000 simultaneous users and a total of 5000 workstations and it is currently running at close to 4000 simultaneous users and over 10,000 workstations! Finally, the survey was conducted at a time when BICS's system response time was particularly slow due to network problems.

* A single question was added to the QUIS that summarized the users' overall satisfaction with BICS. One would expect this question to be most highly correlated with the other questions in the overall user reaction category. Therefore, we only looked at the correlation with questions in the other QUIS categories.

User Interaction Satisfaction of BICS Physicians



Perhaps the most surprising finding from the survey resulted from the correlation analysis of the data. Various clinical system designers have stated over the years that "response time" is the single most important determinant of user satisfaction. In contrast, our findings indicated that overall user satisfaction correlated best with the questions that related to the physician's ability to use the system to carry out their assigned tasks. While we acknowledge that response time is vitally important, we firmly believe that the system must also be tailored to optimize the clinician's workflow. Key items that need to be considered include:

1. Arranging the information on the screens in a way that helps the clinician to focus on the key data and hence make the correct clinical decisions.
2. Using terms that clinicians are familiar with and that relate to their work rather than those favored by programmers or technicians in ancillary departments.
3. Facilitating the process of correcting mistakes.
4. Making sure that routine tasks, such as entering an order or looking up a single laboratory result, can be performed in a straightforward manner.

CONCLUSION

Electronic medical records applications are extremely complex and the clinical environment is unforgiving. Human-computer interaction studies provide a valuable method to help us understand how clinicians use computers and how they can be improved. Several kinds of user interaction studies are possible, many of which can be performed inexpensively.

This study provides a snapshot of one EMR at one point in time. The true power of tools such as the QUIS will be realized when different applications are compared, or the evolution of a single application is tracked over time. Optimal use of EMRs by clinicians is mandatory if their benefits are to be realized.

References

- [1] Sittig DF, Stead WW. Computer-based physician order entry: the state of the art. *J Am Med Inform Assoc* 1994 Mar-Apr;1(2):108-23.
- [2] Krall MA. Acceptance and performance by clinicians using an ambulatory electronic medical record in an HMO. *Proc Annu Symp Comput Appl Med Care* 1995;708-11.
- [3] Campbell JR, Givner N, Seelig CB, Greer AL, Patil K, Wigton RS, Tape T. Computerized medical records and clinic function. *MD Comput* 1989 Sep-Oct;6(5):282-7
- [4] Gamm LD, Barsukiewicz CK, Dansky KH, Vasey JJ, Bisordi JE, Thompson PC. Pre- and post-control model research on end-users' satisfaction with an electronic medical record: preliminary results. *Proc Amia Symp* 1998;:225-9
- [5] Graeber S. Application of clinical workstations: functionality and usability. *Clin Perform Qual Health Care* 1997 Apr-Jun;5(2):71-5
- [6] Shneiderman B. *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (3rd edition 1997), Addison-Wesley Publishers, Reading, MA
- [7] Teich JM, Glaser JP, Beckley RF, et al. Toward cost-effective, quality care: The Brigham integrated computing system. 2cd Annual Nicholas E. Davies CPR Recognition Symposium Proceedings (ed. Steen EB); 5-16; 1996.
- [8] Chin JP, Diehl VA, Norman KL. (1988) Development of an instrument measuring user satisfaction of the human-computer interface. In *Proceedings of CHI '88*, ACM Press, 213-21