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# HCI Challenges Case Study: Implementing an Electronic Medical Record

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**Abstract**

In this paper, we present a case study for the workshop on human-computer interaction (HCI) challenges in non-traditional environments. The case study presents HCI challenges encountered during implementation of an electronic medical record (EMR) in a pediatric hospital system. Obstacles, including highly variable work practices, heterogeneous user populations, and the safety-critical nature of the EMR system, are discussed along with methods used to overcome them.

**Keywords**

Healthcare, Electronic Medical Record (EMR), Ecological Validity, Evaluation Techniques, Work Modeling, Usability Testing

**ACM Classification Keywords**

H.5.2 [User Interfaces]: Evaluation/Methodology

**Introduction**

The healthcare industry is under increasing pressure to utilize IT to reduce process inefficiencies, control spiraling healthcare costs, and improve the quality of patient care. Because the use of IT in clinical care is increasing, the likelihood of HCI-related errors and their associated ramifications are growing as well. The pressure to implement IT systems in healthcare is driven in part by their potential to reduce the number

and severity of patient care errors. However, the size and complexity of these IT systems also creates the potential for new HCI-related errors as demonstrated in a recent article in the *Journal of the American Medical Association (JAMA)* [2]. The study highlighted several new risks for medication errors associated with an electronic prescribing system implementation. Many of the potential errors resulted from usability problems with the system. Thus, addressing HCI challenges associated with clinical information systems is paramount. The healthcare domain is very complex, however. Its inherent intricacies along with the sheer complexity of the IT systems used make effective user studies and designing usable systems a challenge.

### **Case Overview**

This case study highlights the implementation of an electronic medical record (EMR) at Children's Healthcare of Atlanta (Children's), a pediatric hospital system consisting of two hospitals and several outpatient and immediate care clinics. Once completed, the system will provide functions to support several patient care activities: order entry and tracking for medication and other (e.g., lab) orders; entry and tracking of clinical documentation including patient medical history, allergies, test/lab results, vital statistics over time, and current medications; limited decision support, such as checking medication orders for allergies and potential drug interactions; and entering charges as needed for certain clinical tasks. Consequently, the EMR system will play a central role in delivering quality clinical care to patients.

To provide these functions, Children's selected an EMR vendor package in 2003 that allows for considerable configuration. Since then, Children's has engaged in

extensive workflow analysis and system configuration to optimize system utility, safety and efficiency. Children's is rolling out the system's functionality to staff using a phased approach. Currently, the first two stages are complete: 1) inpatient pharmacy system rollout to pharmacy personnel, and 2) electronic medication administration and clinical orders rollout to nursing and clinical ancillary staff (e.g., respiratory therapists).

### *Challenges*

Several characteristics of the healthcare domain have presented challenges to applying HCI methods and ensuring the usability and utility of the system:

#### HETEROGENEOUS USER GROUPS

Because the EMR system eventually will be used to document all aspects of clinical care, a wide range of staff with varying responsibilities and goals will use the system including: physicians, nurses, pharmacists, therapists, patient care technicians, and administrative staff. Even within each of these groups, users vary widely in their clinical background, computer experience, and other factors that likely affect their interaction with the system.

#### VARIABILITY IN WORK PRACTICES & CONTEXTS

Despite working for the same hospital system, work practices varied significantly in the two hospitals, one teaching and one community hospital. In fact, different processes even were used in different units at the same hospital. These process differences translated to different design requirements. Thus, the team undertook a significant work process redesign initiative to determine which care processes should be standardized and how. In instances where the clinical

need warranted truly different work processes, the system design also had to provide the flexibility and customization necessary to support them. In addition, the EMR is used in a variety of work environments (e.g., general care units, intensive care units) and work contexts (e.g., staffing levels, patient census) that lead to unique needs, also increasing the need for customization and user freedom. As is often the case, this increased flexibility created the potential for numerous usability issues.

#### SAFETY-CRITICAL NATURE OF EMR

Because the EMR is used to support and document all clinical care processes, problems resulting from use of and/or interaction with the system can affect patients' health. To ensure patient safety is not compromised, users of the system must be able to focus on caring for the patient, not on using the system. Design decisions must thoughtfully accommodate both user efficiency and patient safety.

#### RESOURCE CONSTRAINTS

The number of user groups and scope of work supported by EMRs make completing user studies time consuming and both human- and financial-resource intensive. Unfortunately, many healthcare facilities, especially in rural areas, are facing a financial crisis. They often have little money to invest in new technologies, let alone the additional evaluation, testing, and development required to address HCI issues. Many hospitals also are facing staffing shortages of nurses and other clinical staff. Thus, importance should be placed on cost-effective and resource-conscious techniques which identify user needs and integrate user input into the system design.

## Overcoming the Challenges

Based on experiences and feedback gathered during the first two EMR implementation stages at Children's, a number of methods for overcoming these challenges and ensuring the usability and utility of the EMR are recommended:

### *Integrating clinical expertise into the team*

HCI practitioners recognize the need to integrate subject matter experts into the design team. To achieve this at Children's, a team of seasoned clinicians (primarily nurses with 10 or more years of hospital experience) were assigned full time to the EMR implementation team. This 'Clinical Informatics' team completed several weeks of Epic configuration training to complement their clinical expertise with a thorough knowledge of the system's capabilities. Clinical Informatics personnel were integral to designing the system and work processes; they served as the primary liaisons between the implementation team and the clinical users. Having this dedicated group who could effectively communicate with both clinical users and the technology team was crucial to ensuring user requirements were clearly understood and applied to the design and implementation.

### *Using work modeling techniques*

Because of highly variable work practices across the hospitals, it was essential to model current clinical practices and use this information to develop system requirements. Methods, such as interviews, surveys, and focus groups, were adequate for capturing some simple, single-track processes. However, most work practices were of sufficient complexity to require a more rigorous approach to work modeling. Combination field observation/interview techniques like the

Contextual Inquiry method[1] were better suited to capture more complex tasks involving transitions between people/units and tasks that were subject to frequent disruptions or requiring fluid workflows. Having the Clinical Informatics team lead the work modeling effort was effective because their clinical expertise provided a shared background and vocabulary, which enabled them to communicate effectively with users and pick up on subtleties that non-clinical work modelers might otherwise miss. Completing preliminary interviews/focus groups to develop initial work models and validating these models through field observations/contextual inquiries helped ensure the understanding of the work processes was accurate and, consequently, the understanding of the design requirements by the implementation team was improved.

#### *Obtaining iterative design feedback*

As redesigned work practices and system function prototypes became available, several methods were used to obtain iterative design feedback and adjust the design prior to rollout. First, members of the Clinical Informatics team met independently with small workgroups from each clinical area to review the proposed system design and workflows. These discussions occurred throughout the design lifecycle and provided a means for users to identify anticipated problems and for the implementation team to improve the design based on that feedback.

In addition, 'Department Champions' began meeting with the implementation team monthly at the start of the first stage. The Department Champion group included at least one representative from each unit on each campus to ensure complete representation. These

meetings provided a forum for communicating updates about the system implementation and obtaining user feedback on design decisions and system prototypes. They also helped establish a healthy working relationship between the user community and the implementation team.

In addition to these methods of obtaining iterative feedback from target users, members of the Clinical Informatics team and external HCI practitioners completed a predictive usability evaluation of system functions. The results of this evaluation also were used to improve the EMR implementation prior to rollout in the hospitals.

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