A Component-Based Evaluation Protocol for Clinical Decision Support Interfaces

Alessandro Febretti¹, Karen Dunn Lopez², Janet Stifter², Andrew E. Johnson¹, Gail M. Keenan², and Diana J. Wilkie²

¹ Department of Computer Science, College of Engineering, University of Illinois at Chicago (UIC), USA
² Department of Health Systems Science, College of Nursing, UIC, USA
febret@gmail.com

Abstract. In this paper we present our experience in designing and applying an evaluation protocol for assessing usability of a clinical decision support (CDS) system. The protocol is based on component-based usability testing, cognitive interviewing, and a rigorous coding scheme cross-referenced to a component library. We applied this protocol to evaluate alternate designs of a CDS interface for a nursing plan of care tool. The protocol allowed us to aggregate and analyze usability data at various granularity levels, supporting both validation of existing components and providing guidance for targeted redesign.

Keywords: component-based testing, cognitive interviewing, user-centric design, healthcare interfaces.

1 Introduction

Clinical Decision Support systems (CDSs) are software tools designed to support decision making in the clinical setting and facilitate the practice of evidence-based healthcare. CDSs have traditionally consisted of alerts and guidelines based on randomized clinical trials, systematic reviews and other sources of evidence. More recently developed CDSs are based on the characteristics of an individual patient that are matched to an electronic knowledge base and health record, to provide healthcare personnel with just-in-time, patient-specific recommendations.

The use of electronic health records in general and clinical decision support systems in particular has the potential of greatly improving care quality, but the adoption rate of these tools in the United States has been lower than expected. One of the main reasons for this delay is the lack of efficiency and usability of available systems [1].

Most CDS research and systems focus on identifying what information to show to users, but little has been done to find how to present complex patient data to support efficient decision making. Performing usability testing in the context of CDS design is therefore fundamental. CDS systems should drive healthcare
personnel towards effective and targeted actions to improve patient outcomes. Poorly designed CDS features may confuse the user and lead to longer response times. Nursing staff often have strict time constraints and may also choose to ignore CDS features that are not easily accessible, or that do not provide clear information. Worse yet, inconsistent CDS features may drive healthcare personnel into making wrong decision about the patient’s care.

Given the variety of forms in which clinical information can be transformed and presented, the overall organization of user testing is highly complex. For example, a single user may be exposed to multiple prototypes of the overall system, each one showing variants and compositions of CDS features in order to determine what is the best (i.e. fastest and clearest) interface. As the interface evolves and new evidence arises from practice or literature, features may be added, removed or redesigned and then evaluated in a new testing cycle.

In this paper we present a protocol that applies the principles of component-specific usability testing, quantitative content analysis and cognitive interviewing to the evaluation of a prototype CDS interface. The protocol has been applied to support the design of the next generation Hands-on Automated Nursing Data System (HANDS). In particular, we wanted to assess the accessibility, interpretability, satisfaction and value-to-practice of distinct CDS artifacts embedded in the interface. We wanted to compare variants of those artifacts across all those metrics. And we wanted to evaluate different compositions of those artifacts in the prototype.

2 Related Work

Usability testing of electronic health record (EHR) interfaces is not new and has been applied both for personal and clinical interfaces [2], [3]. Beyond usability capturing practice-based and literature-based evidence for CDS interfaces, it is also critically important to evaluate how the integration of this evidence into EHRs affects professional and organization practices [2].

Similar work has also been done in the context of CDS [4], but most of the work evaluates interfaces as a whole, have a priori defined tasks or do not consider compositional variations of multiple interface features. For these reasons, they typically lack a quantitative analysis of user response to specific features within the interface.

In [5], the authors underscore how traditional usability tests that capture usability for the application as a whole are less effective at capturing the inherent interaction between application components: evaluating the overall usability of an application also cannot inform the selection of right components, their composition into a system and the analysis of their value which includes human-factor issues.

A component-based testing methodology can drive the development of modular, usable interface artifacts for future use and helps in determining whether, for instance, the user interface provided by the various components do not rely on conflicting mental models. Our work represents a practical example of iterative, component-based testing applied in the context of CDS systems.