DECISION SUPPORT EVALUATION TOOLS

CLINICAL DECISION SUPPORT DESIGN

Prepared by:

Jan Horsky, PhD
Dylan Sherry, BA
Eric Pan, MD, MSc
Colene Byrne, PhD
Doug Johnston, MTS

Submitted on:
May 12, 2011

Prepared for:
Department of Health and Human Services Contract # HHSP23320095649WC
Task order HHSP23337009T
Office of the National Coordinator ARRA Contract entitled "Advancing Clinical Decision Support"

Principal Investigators:

Douglas Bell, MD, PhD

Blackford Middleton, MD, MPH, MS

Decision Support Evaluation Tools

Introduction

This document contains a collection of practical recommendations and references to tools and publications that can be used to inform the design of CDS with the goal of achieving optimal human-computer interaction characteristics. Designers, production managers and researchers at commercial sites and academic institutions may use these resources to guide them in the iterative process of developing decision support interventions according to high usability standards and workflow fit. Purchasers and implementers can find appropriate evaluation methods for systems that need to be adapted to support clinical work at specific service and practice locations at their institutions and clinics.

This guide is organized into four sections:

I. discussion of CDS development and design approaches;
II. usability inspection methods that can be used by implementers
III. discussion of common CDS problems and potential solutions using the design approaches; and
IV. list of general design and usability resources.

I. CDS Development and Design Approaches for Healthcare Institutions and Commercial Vendors

Relying upon input from clinicians and observing their interactions with CDS interventions in a clinical environment are fundamental principles to CDS development. The observations should take place in specific care environments where decision support will be implemented. The optimal design approaches for CDS developers are described below and include: iterative development, user-centered design, collaborative design teams, usability inspection, clinician interviews, log analysis, and cognitive walkthrough.

1. Iterative development

Usability evaluations are most effective when performed frequently on successive versions of wireframe (e.g., diagrams, general layout of controls, text, and graphics on a user interface object) and on low-fidelity prototypes early in the development cycle. Findings from preceding iterations inform design improvements of successive prototypes. These can be done with relatively few test subjects (clinicians) while high-

fidelity and fully functional mature prototypes should be tested with a larger number of expert and novice clinical personnel. Only one or two redesign cycles are generally sufficient at that point. Iterative testing should start as early as possible when redesign time and resources are still relatively low compared to making substantial changes to the finalized product.

2. User-centered design

User-centered design is a framework for the development of health IT applications that places a systematic understanding of clinical work and the healthcare environment at its core. Medical care is complex and dynamic, and demands attention and cognitive resources in a high-pressure environment. Providers are faced with the challenge of making quick decisions, often with unreliable or missing data. This requires designers to study and thoroughly understand how CDS interventions will function under these conditions and how effectively they will provide advice to clinicians. From the beginning, expert and novice clinician-users in various professional roles need to be engaged as often as possible in the testing of prototypes. Testing will complement known human behavior principles and interface models and help estimate how well interventions meet the expected objectives. Informaticists and usability experts need elicit knowledge of tasks and workflows from clinicians so that it can be formulated into the design approach. Significant attention needs to be paid to the identification of possible unintended effects and their mitigation.

3. Collaborative design teams

Usability professionals, informaticists, clinical experts, visual designers, software developers and production managers need to create cross-functional teams that plan, build and evaluate prototypes of CDS interventions. Organizations periodically engage clinical experts and consultants, who may or may not become design team members, to help solve specific design problems. Although practicing clinicians have first-hand insight into tasks and workflows, they usually lack the expertise to transform that knowledge into a practical design. Informaticists and usability experts can help bridge this gap and create a productive dialog between the design team experts.

Resources

Iterative development and test planning

Schumacher, R. M. and S. Z. Lowry (2010). NIST Guide to the Processes Approach for Improving the Usability of Electronic Health Records. Washington, D.C., National Institute of Standards and Technology.

Use case testing scenarios

Armijo, D., C. McDonnell, et al. (2009). Electronic Health Record Usability: Evaluation and Use Case Framework Rockville, MD, Agency for Healthcare Research and Quality

Usability evaluation and rating
Belden, J., R. Grayson, et al. (2009). Defining and Testing EMR Usability: Principles and Proposed Methods of EMR Usability Evaluation and Rating, Healthcare Information and Management Systems Society: EHR Usability Task Force.

II. Usability inspection by CDS implementers

CDS implementers often inspect the user interface to detect usability problems. In the implementation process, almost all systems need to be modified to conform to local guidelines, established practices and terminology, workflow preferences, and existing legacy systems. Out-of-the-box systems may allow customization by the implementers, although the extent may differ significantly depending on the vendor. Hospitals and practices may need to perform basic usability inspections to assure that modifications do not violate principles of human-computer interaction and are suitable for the selected tasks and environment. Findings should be communicated to the vendor, who may offer assistance with changes that go beyond customizations purchasers can ordinarily make by themselves.

Another reason for inspection may be the need to adjust the interventions based on problems identified in the first few months of live use. For example, the estimated frequencies of order set use may have been inaccurate. Menu structures or the names of the sets may need to be changed to ensure that the most frequently used order sets are easily accessed. Observations of CDS use in actual clinical work conditions coupled with clinician interviews may also identify a number of workarounds that may be addressed by modifications of the interface.

Finally, the CDS product selection process should involve short usability tests to both inform the product choice and to negotiate for needed usability adjustments as part of the purchase contract.

1. Clinician interviews

Interviews with clinicians about their experiences with CDS (including any workarounds they may have developed) will help to be informed when designing CDS. The interviews can be informal or more structured to survey a particular topic across the different end-users. Open-ended questions may be followed-up on to gain more insight about how a

task is performed and the satisfaction with available support from the CDS. Interviews may add clarity to observations (e.g., discovered workarounds) although by themselves the data may reveal a bias towards descriptions of how things *should be* done rather than what is *actually* done in practice.

2. Log analysis

Logs of interactive activities and automatic interventions can help to better understand actual use of the CDS. The logs typically contain hundreds of thousands of individual entries. Large datasets may need to be processed with professional statistical software such as SAS or SPSS. Some CDS systems may also provide their own periodic reports of activity. Descriptive statistics may be run to show frequency of both the most common actions and the outliers. The pattern should be compared to expected values, such as the number of specific procedures performed at a location over a period of time compared to the number of order sets used for that purpose. Over-alerting, for example, may be detected from the logs, and it might be shown that overrides occur most often for a particular clinician or for a particular type of alert within a specialty (e.g., diabetes-related alerts for endocrinologists) Findings should be followed up by discussions and analyses with responsible clinical committees.

3. Cognitive walkthrough

This method is intended to determine how well an interface supports fast and error-free completion of typical tasks by clinicians in specific professional roles. For example, a physician evaluating an order entry decision support system may "walk" through a pre-determined clinical scenario for patient admission, step-by-step. At each step in screen navigation, data entry and decision support intervention responses the evaluator documents the expected behavior.

1. Is the clinician likely to achieve the expected goal?
   Example: An admission order set is available, however, physicians may need to know from training about its existence and from which screen to initiate it.

2. Will the clinician notice the availability of the correct action?
   Example: A reminder to give a due immunization includes a link to the order form.

3. Can the correct action be easily associated with the intended goal?
   Example: Clicking the "OK" button overrides an alert and lets the clinician to continue with the original order; "Cancel" will discontinue that order.

4. Is the completion of an action and progress towards the intended goal indicated?
   Example: After changing the dose of a medication after an order alert, the order with the corrected dose has been completed and validated by decision support.

The evaluators review the potential problems identified and formulate suggestions for improvements to the interface.

Resources

Nielsen, J. and R. L. Mack (1994). Usability inspection methods. New York, John Wiley & Sons.

Charlton, S. G. and T. G. O'Brien (2002). Handbook of human factors testing and evaluation. Mahwah, N.J., Lawrence Erlbaum Associates, Publishers.

Guides to simple inspections of systems before purchase can be found in these documents. They include heuristic evaluation, usability questions, sample tasks and sample questionnaires.

HIMSS (2010). Selecting an EMR for Your Practice: Evaluating Usability, Healthcare Information and Management Systems Society: EHR Usability Task Force. http://www.himss.org

Schumacher, R. M., J. M. Webb, et al. (2009). How to Select an Electronic Health Record System that Healthcare Professionals can Use. Oakbrook Terrace, IL, User Centric, Inc.
http://www.usercentric.com/publications/2009/02/05/how-select-electronic-health-record-system-healthcare-professionals-can-use

III. Common problems related to CDS

This section describes common usability problems related to CDS, the methods to identify them and recommendations for correction. Many problems are manifested by workarounds that clinicians devise to complete a task when the system design or poor workflow fit prevents them from doing so efficiently or at all.

1. Inconsistent terminology, missing coded entries

Indication or workarounds:

Search for drug names, procedures, orders and order sets may be laborious as clinicians may be searching for a common local term represented differently or missing from pick lists and menus, make frequent errors from which they may

recover, or leave uncorrected and unfilled data fields. Workarounds may include the use of free text in place of coded entries (if allowed) or the use of another free-text field not intended for that information.

Inspection methods:

Analysis of logs and entered terms, observation, interviews, email feedback

Recommendation:

Review the completeness and accuracy of terms with a committee of clinicians; introduce synonyms for commonly used variations mapped to the same concept code.

2. Underuse or incorrect use of order sets or forms

Indication or workarounds:

The use of existing order sets (e.g., for admission) is markedly lower than expected (e.g., the number of daily admissions). Sets when used are modified much more often than expected.

Inspection methods:

Analysis of logs, cognitive walkthrough

Recommendation:

Review the content of the sets with a committee of clinicians whether they are appropriate for given clinical goals and patient population (need for frequent modifications). Set may not be used because clinicians are not sufficiently informed about their existence in the system or they are not found in the menu structure or in searches. Finding from a cognitive walkthrough should point out appropriate changes to menus or screen layout.

3. Insufficient clinical context for orders or lab interpretation

Indication or workarounds:

Ordering is interrupted or delayed by the need to navigate to screens with needed supporting data (e.g., medication and allergy lists, laboratory values).

Workarounds may include the use of paper notes to gather and write down the required information before invoking the ordering process or relying on memory recall.

Inspection methods:

Cognitive walkthrough, observations

Recommendation:

Review the results of the cognitive walkthrough and outline the optimal information context for identified ordering scenarios. Layout redesigns may sometimes be necessary along with changes to the inference rules and should be communicated to and discussed with the vendor or a consultant.

4. Intrusive alerting

Indication or workarounds:

Alerts and reminders seem to interrupt workflows unnecessarily and are perceived as distractions. A majority of alerts (over 70%) were overridden.

Inspection methods:

Log analysis

Recommendation:

Review alert logs to increase their specificity. Rules may need to be refined or turned off or filtered so that low-utility alerts are prevented from being triggered in situations when they may be irrelevant. For example, overrides may occur at medication renewals and the trigger rules may be suppressed for that clinical task. Insight may also come from recorded reasons for override. If the reason "patient tolerated in the past", for example, is frequently used, it may point to inconsistencies and unreconciled allergy records in the EHR. Extensive and complicated changes to the trigger rules need to be reviewed by a committee of clinical specialists to avoid unintended effects.

5. Poor workflow fit

Indication or workarounds:

The most common cause of workarounds is the misalignment of interactions with the EHR and clinical event flow. For example, a medication needs to be given to a patient immediately, but the electronic record has not yet been properly updated (e.g., the discontinuation of a previously given drug, unavailable laboratory results) and a decision support intervention may be preventing a seemingly inappropriate order or give incorrect advice. Clinicians may instead record the order on paper and update the system at a later point. However, such non-standard behavior may lead to a cascading effect of further forced workarounds.

Inspection methods:

Observations, interviews, periodic staff meetings, focus groups

Recommendation:

Workarounds are a rich source of knowledge about the misalignment of clinical tasks, practices and electronic information and decision support. Discovering the ways in which clinicians are forced to adapt their actions to an inconveniently designed or momentarily irrelevant electronic interventions and discussing possible remedies is essential for planning to transform them into system design customizations when warranted. Informal observations and on-on-one discussions may lay groundwork for more formal discussions in meetings and focus groups.

IV. General design and usability resources

- **HIMSS EHR Usability Task Force** provides vendors and external organizations with education, tools, best practices related to HIT usability.
  http://www.himss.org/ASP/topics_ehr.asp

- **AHRQ** and its community of contractors and grantees have developed tools to help health care organizations plan for, implement and evaluate health information technology (IT). These tools describe and recommend strategies for addressing some of the common challenges organizations encounter when working with health IT systems. The tools are freely available.
  http://healthit.ahrq.gov/

- **Usability.gov** site addresses a broad range of factors that go into web design and development, including data collecting data on user needs, prototype development and usability inspection methods.
  http://www.usability.gov/

- **The Microsoft Health Common User Interface** provides User Interface Design Guidance and Toolkit controls that address a wide range of patient safety issues faced by healthcare organizations worldwide. Presented design guides and controls help in the design of a new generation of safer, more usable and compelling health applications.
  http://www.mscui.net/

- **Partners HealthCare Design Style Guide** is an example of visual layout guidelines for web-based EHR applications.
  http://styleguide.partners.org

- **The Center for Quality and Productivity Improvement** (CQPI) is an interdisciplinary research center at the University of Wisconsin-Madison's College of Engineering. Their work applies principles of human factors engineering to software development with emphasis on health information technology.
  http://cqpi.engr.wisc.edu/