Guidelines for Safety Enhanced Design

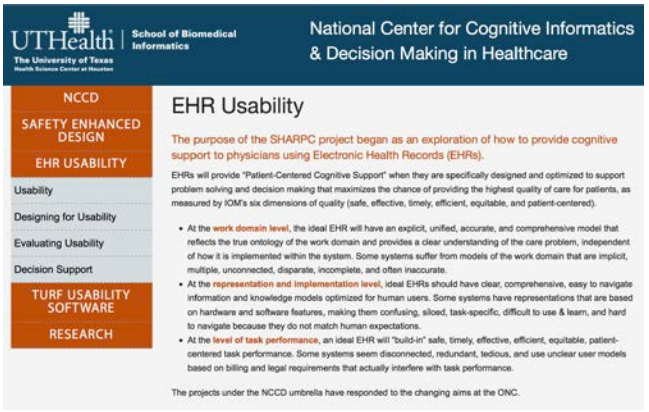
Project Leader: Todd R Johnson

Project Co-Leaders: Yang Gong, Jeff Belden

Motivation

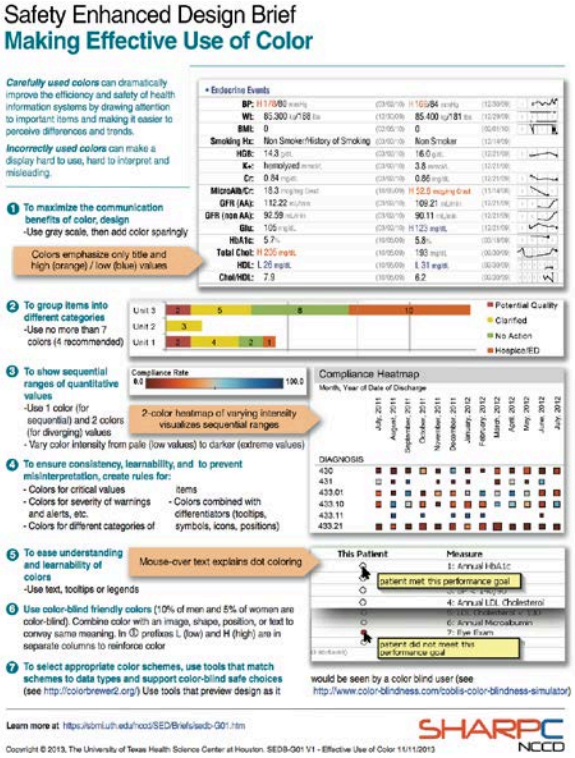
- Early 2013
  - Several SHARPC subprojects begin work on guidelines to help vendors improve EHR usability
- June 2013
  - Recognized need to coordinate, integrate and cross-link guidelines efforts
  - Todd Johnson named Guidelines Lead
  - Weekly guideline-specific teleconference calls begin
- Over 25 participants

Primary Guidelines Products



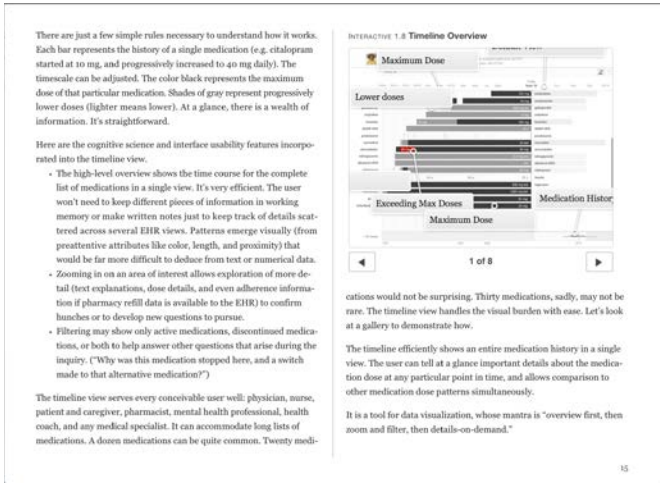
Detailed Usability Guidelines

Yang Gong



Safety Enhanced Design Briefs

Todd Johnson



EHR Style Guide interactive iBook

Jeff Belden

sbmi.uth.edu/nccd/

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- NCCD
- SAFETY ENHANCED DESIGN
- EHR USABILITY
- TURF USABILITY SOFTWARE
- RESEARCH

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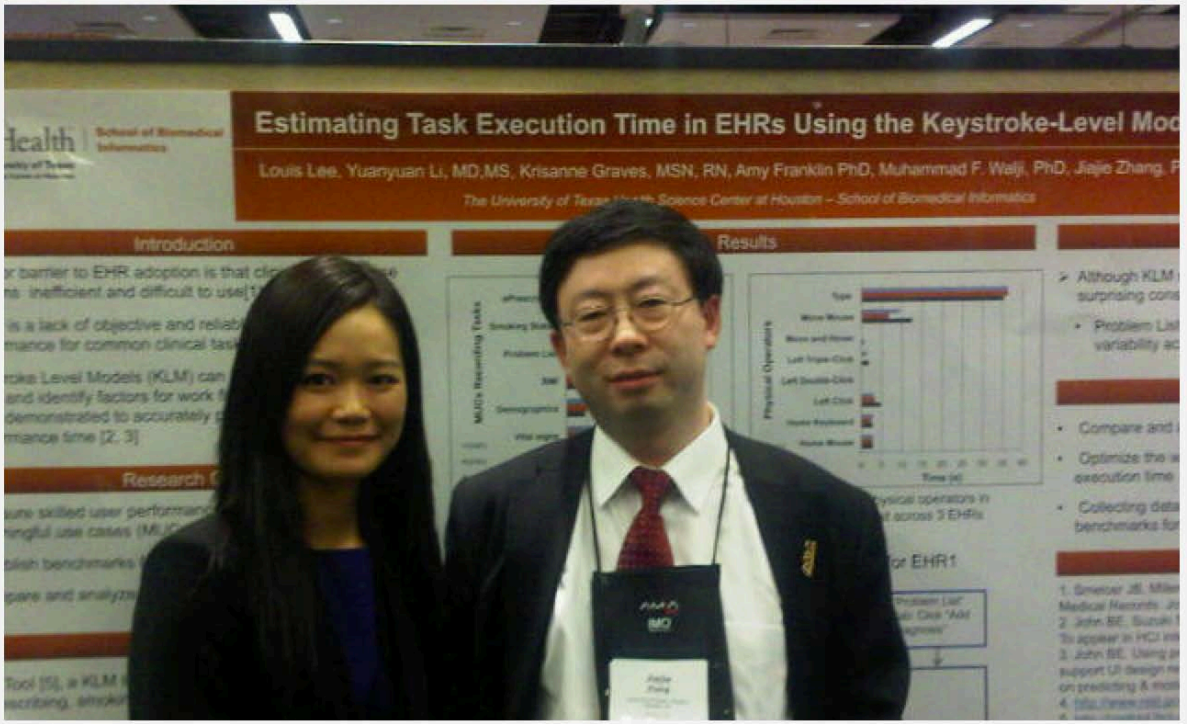

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Designing for Usability

Interface design in modern health IT has come to mean **User-Centered Design (UCD)**. In this iterative approach to design, the user is a major part of the process from first to last. The product life cycle starts with an understanding of users and their working environment, then proceeds through design, development and evaluation. Designers and engineers don't simply make assumptions about how users are likely to use a product, they use scenarios, create **use cases** and test their predictions with actual users, with formative assessment techniques.

Today we've moved beyond what might be called product-centered engineering. Today's designers apply the findings of decades of cognitive science, the accumulated knowledge of human factors, ergonomics, and usability methodology. Now the focus is on the people who will use the product in their work, day in and day out, to get the job done effectively, efficiently and with maximum satisfaction.

In this section, we present a number of resources to guide the development of EHRs. Please use the links to the left to review our guidelines, inspirational prototypes, and other ideas about EHR design.

SHARPC has developed several different types of guidelines designed to assist developers in designing EHRs that ease the cognitive work of healthcare providers.

These include:

- General Design Principles & Guidelines;
- Safety Enhanced Design Briefs; and
- A more detailed EHR Style Guide eBook.

What is a guideline?

Guidelines refer to a set of rules or principles by which to set standards or determine a course of action. The rule or

General Design Guidelines

- Provides instructional materials relevant to EHR usability
  - Introduction to EHR usability
  - Applicable usability guidelines aggregated and refined from the existing literature
  - EHR usability testing tool
- Cross link and harmonize with
  - Design Briefs
  - iBook

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Safety Enhanced Design Briefs
EHR Style Guide iBook
Inspirational Prototypes
Workflow
Systematic Yet Flexible Systems

General Design Principles & Guidelines

A great user interface follows established human interface design principles that are based on the way users (doctors, nurses, patients etc.) think and work. The following are 14 general design principles that can be applied to the development of EHRs:

Consistency	Visibility	Match	Minimalism	Memory	Feedback	Flexibility
Error Messages	Prevent Errors	Closure	Undo	Language	Control	Help

1. **Consistency and standards**. Users should not have to wonder whether different words, situations, or actions mean the same thing. Standards and conventions in product design should be followed.
2. **Visibility of system state**. Users should be informed about what is going on with the system through appropriate feedback and display of information.
3. **Match between system and world**. The image of the system perceived by users should match the model the users have about the system.
4. **Minimalist Design**. Any extraneous information is a distraction and a slow-down. Less is more.
5. **Minimize memory load**. Users should not be required to memorize a lot of information to carry out tasks. Memory load reduces users capacity to carry out the main tasks.
6. **Informative feedback**. Users should be given prompt and informative feedback about their

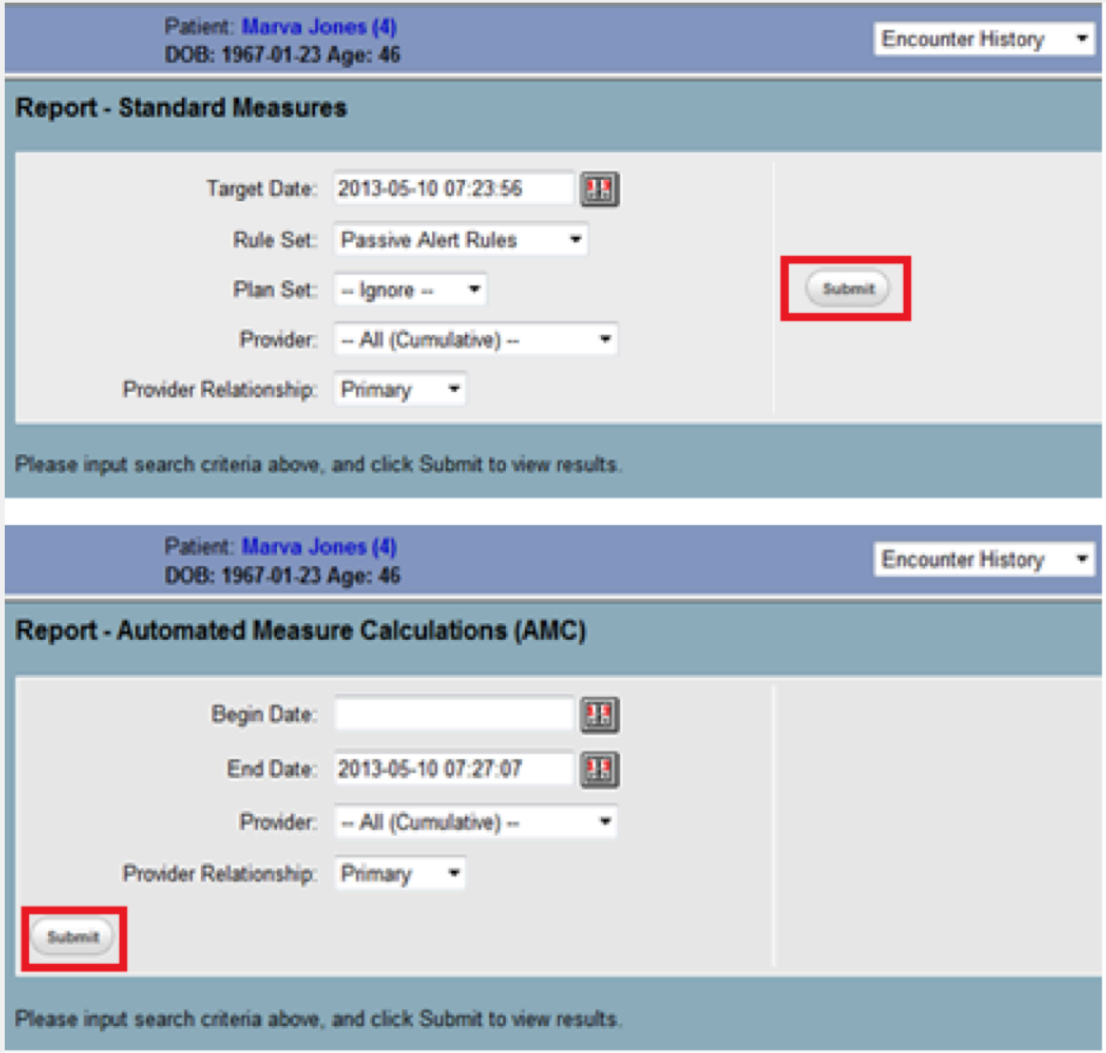

Figure 1. Inconsistent placement of controls.

This is a bad example because the "Submit" button appears in different places when filling the report.

The system should also to use consistent language. Some terminology and languages are widely used in the clinical settings or pre-existing clinical applications. Make sure they do not have different meanings in the EHR. Otherwise, users may have incorrect understanding of displayed information and act erroneously.

In addition to consistent display of information, another important point is to offer consistent user-system interactions. For example, the data input method and process, as well as corresponding assistant functionalities (e.g., filtering, sorting, and alerting etc.) should be standardized and remain consistent. That uniformity will potentially accelerate operation processes as the user repeatedly interacts with the system. Figure 2 shows an example that goes against this rule.

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RESEARCH

What is Safety Enhanced Design?

Safety in healthcare is a hot-button topic today, and with good reason. One of the major advantages of electronic health records is their potential to increase patient safety by preventing, detecting and aiding in the recovery from human errors. In order to turn that potential into reality, the ONC has set certification standards for safety-enhanced design (SED), making patient safety a primary focus in the design of an EHR.

Certification requires that designers follow two major steps:

1. Use a formal **User Centered Design (UCD)** process during development
2. Perform **Summative Usability Testing** on specific areas of the product.

UCD procedures have been specified in detail in several ISO standards, listed below. These are not the only acceptable standards, but the point is that a formal UCD procedure must be followed during design and development, and the procedure must be identified or described as part of the certification process.

The essential document to read and follow is NISTIR 7742 Customized Common Industry Format Template for EHR Usability Testing. It outlines how the ONC requires documentation of the results of summative usability testing.

The Central Requirement: Summative Testing

The second step, **summative usability testing**, is described in detail in "Test Procedure for §170.314(g)(3) Safety-enhanced design" . In addition, ONC provides a handy, elaborate template, NISTIR 7742 Customized Common Industry Format Template for EHR Usability Testing for summative testing. We consider NISTIR-7742 extremely useful, if not essential, in seeking certification.

Safety Enhanced Design Briefs

- One page only
- Print and PDF versions
- Target developers at small to medium EHR companies
- Select most critical, actionable, and relevant guidelines
  - Focuses on what is important ***and*** possible now
- Distills current theory into practical advice

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Safety Enhanced Design Briefs
About these Briefs
SEDB-G01 Making Effective Use of Color
SEDB-G02 Effective Table Design
SEDB-G03 Reducing Wrong Patient Selection Errors
SEDB-MU01 Drug-drug, drug-allergy interaction checks
SEDB-MU04 Clinical Decision Support
SEDB-MU05 Electronic Prescribing
EHR Style Guide iBook
User Testing Scenarios and Methods
Usability Tutorials
EHR USABILITY
TURF USABILITY SOFTWARE

Safety Enhanced Design Briefs

About these briefs | Who should use these briefs | How to use these briefs

We welcome your feedback on these guidelines. Please email comments to sharpc@uth.tmc.edu.

General Briefs

SEDB-G01	Making Effective Use of Color	PDF	More Info
SEDB-G02	Effective Table Design	PDF	More Info
SED			More Info
SED			More Info

Six More in Final Production

Sp

SEDB-MU01	Drug-drug, drug-allergy interaction checks	PDF	More Info
SEDB-MU02	Medication list	PDF	More Info
SEDB-MU03	Medication allergy list	PDF	More Info
SEDB-MU04	Clinical decision support	PDF	More Info
SEDB-MU05	Electronic prescribing	PDF	More Info
SEDB-MU06	Clinical information reconciliation		More Info
• SEBB-MU06.1	Medication reconciliation	PDF	
• SEBB-MU06.2	Problem reconciliation	PDF	
• SEBB-MU06.3	Allergy reconciliation	PDF	
SEDB-MU08	Computerized Practitioner Order Entry	PDF	More Info

DESIGN

Safety Enhanced Design Briefs

About these Briefs

SEDB-G01 Making Effective Use of Color

SEDB-G02 Effective Table Design

SEDB-G03 Reducing Wrong Patient Selection Errors

SEDB-MU01 Drug-drug, drug-allergy interaction checks

SEDB-MU04 Clinical Decision Support

SEDB-MU05 Electronic Prescribing

EHR Style Guide iBook

EHR USABILITY

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Version 1: Making Effective Use of Color

Tools for Selecting Effective Color Schemes

Color Brewer 2.0	Web-based tool for selecting appropriate color schemes based on your data type: qualitative (also called categorical), sequential, and diverging. Includes options for color-blind safe schemes.
Coblis	A color blindness simulator

Websites

Colblindor	Site for learning more about color-blindness. Includes tests and tools for checking designs (Coblis)
Perceptual Edge	Stephen Few's website on tools and techniques for visual business intelligence.

Detailed Information for Selecting Effective Color Schemes

Stephen Few's Practical Rules for Using Color in Charts is an excellent summary of how to use color effectively and how to avoid common mistakes with color display.

Title and Subtitle

Background

Guidelines

Pointer to web

Safety Enhanced Design Brief

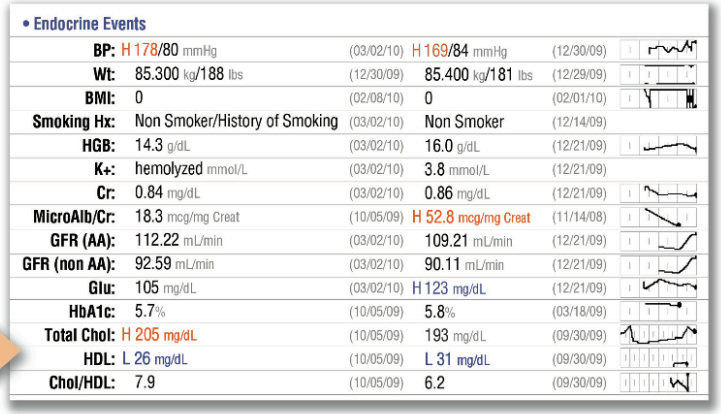
Making Effective Use of Color

Carefully used colors can dramatically improve the efficiency and safety of health information systems by drawing attention to important items and making it easier to perceive differences and trends.

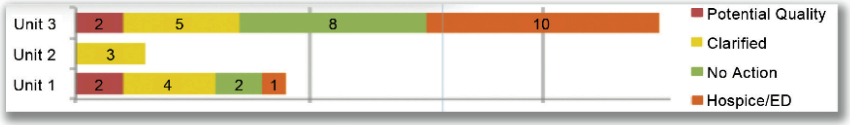
Incorrectly used colors can make a display hard to use, hard to interpret and misleading.

1 To maximize the communication benefits of color, design
-Use gray scale, then add color sparingly

Colors emphasize only title and high (orange) / low (blue) values

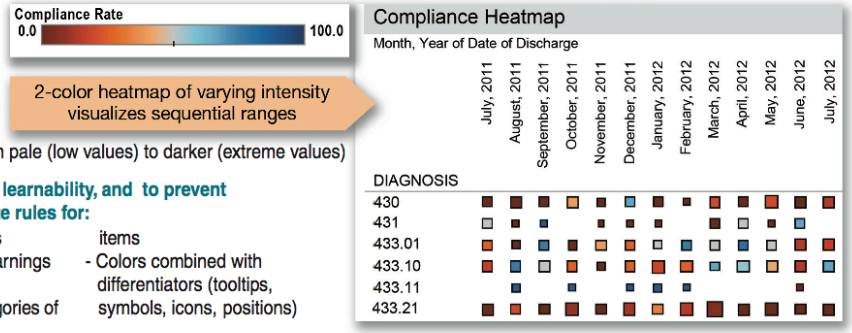


2 To group items into different categories
-Use no more than 7 colors (4 recommended)



3 To show sequential ranges of quantitative values
-Use 1 color (for sequential) and 2 colors (for diverging) values
- Vary color intensity from pale (low values) to darker (extreme values)

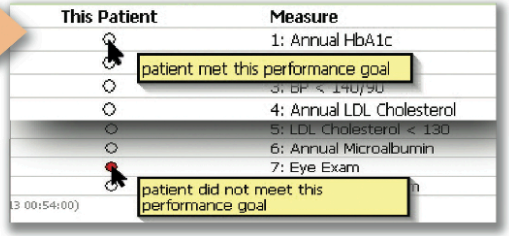
2-color heatmap of varying intensity visualizes sequential ranges



4 To ensure consistency, learnability, and to prevent misinterpretation, create rules for:
- Colors for critical values
- Colors for severity of warnings and alerts, etc.
- Colors for different categories of items
- Colors combined with differentiators (tooltips, symbols, icons, positions)

5 To ease understanding and learnability of colors
-Use text, tooltips or legends

Mouse-over text explains dot coloring



6 Use color-blind friendly colors (10% of men and 5% of women are color-blind). Combine color with an image, shape, position, or text to convey same meaning. In ① prefixes L (low) and H (high) are in separate columns to reinforce color

7 To select appropriate color schemes, use tools that match schemes to data types and support color-blind safe choices (see http://colorbrewer2.org/) Use tools that preview design as it would be seen by a color blind user (see http://www.color-blindness.com/coblis-color-blindness-simulator)

Learn more at https://sbmi.uth.edu/nccd/SED/Briefs/sedb-G01.htm

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EHR Style Guide iBook

In partnership with the California HealthCare Foundation, SHARPC is co-funding a project to develop an interactive, illustrated style guide designed to enhance EHR usability by recommending common user interface elements for key features such as:

- The medication list
- Allergy list
- Medication reconciliation
- E-prescribing
- Computerized provider order entry (CPOE)
- Drug interaction and allergy alerts, and
- Clinical decision support

The vendor community will participate in iterative feedback opportunities.

Click here to see a working prototype of the e-book in HTML5.

Follow this link to find a recorded Webinar, sponsored by the HIMSS HIT Usability Community on November 18, 2013.

Please see an introductory slide deck about the project to the EHRA Clinician Experience Workgroup on October 18, 2013.

The e-book will be publicly available and will be distributed to EHR vendors through the cooperation of their trade organization, the HIMSS EHR Association.

For additional details, contact Jeff Belden, MD.

Please note:The content provided here are intended as guidelines (recommended, but not mandatory) for design and implementation, not as standards (mandatory, minimum requirements).

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iBook

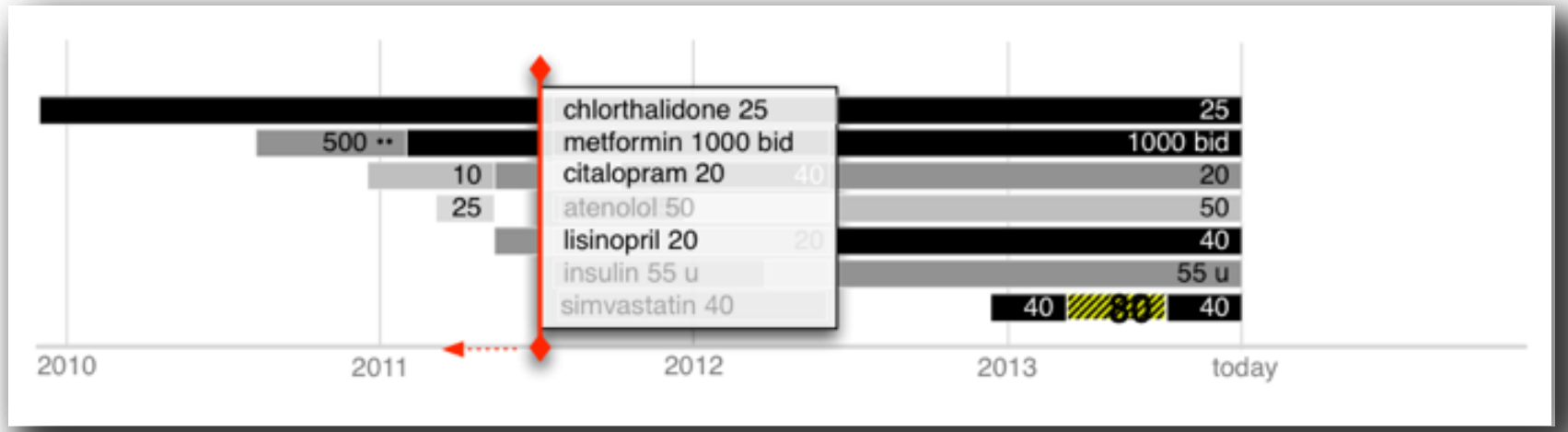
- The EHR Usability Style Guide
- Emphasizes
  - clinical scenarios & examples
  - galleries of examples of before & after design makeovers
  - interactive widgets for exploratory learning
- Released in 2 formats
  - iBook (interactive)
  - Web (HTML plus interactive prototypes)

Stakeholders

- EHRA Clinician Experience Workgroup
  - Reviewer volunteers
  - Dissemination partner
  - Vendor reps at design workshops
- Core team
  - U of Missouri – Belden, Koopman, Moore
  - U of Maryland – Plaisant
  - Involution Studios (Boston) – Sonin
- Sponsors:
  - SHARP-C
  - California HealthCare Foundation

Overall aims

- Illustrative
- Inspirational
- Interactive



medications. The physician needs to have an overall awareness of the patients problems and medications (are they taking insulin? Are they on any high-risk drugs like warfarin?). We can call that "situational awareness" of the patient's overall medical picture.

Here's an example:

Medication List

aspirin 81 mg 1 tablet daily

chlorthalidone 25 mg 1 tablet daily

citalopram 20 mg 1 tablet daily

Lantus 40 units at bedtime

lisinopril 20 mg 1 tablet daily

metformin 1000 mg 1 tablet 2 times a day

metoprolol XL 50 mg 1 tablet daily

naproxen 500 mg 1 tablet 2 times a day

omeprazole 20 mg 1 tablet daily

pravastatin 40 mg 1 tablet daily

trazodone 50 mg 3 tablets at bedtime

warfarin 5 mg 1 tablet daily on MWF, 1.5 tablets daily SuTuThSa

Avoid the temptation to add unneeded and unwanted detail here. Concise lists are easier to read. In this context, the physician doesn't need to see the quantity or the number of refills or the start dates.

We can make that easier to read by **emphasizing** the name of the drug, and de-emphasizing everything else. One method is to use gray text that is perceptibly different while still readable.

Use just enough difference to "make it pop".

Alphabetize the list. Why? The human brain would expect a list of text items to be alphabetical, to facilitate finding a particular name quickly in a long list. "Are they taking warfarin?" Just jump to the "w" section. Other views might have different sorting needs. We'll come to that later in this chapter.

INTERACTIVE 3.1 Interactive Table Medication List

Name	Dose	Sig (Frequency)	Quantity	Refills	Prescribed	Provider	Condition
aspirin	81 mg	1 tablet daily	75	3	16 Oct 2012	Dr. Walter R Lucas MD	Cardiovascular disease
chlorthalidone	25 mg	1 tablet daily	90	2	16 Oct 2012	Dr. Sudha Nahar MD	Hypertension
citalopram	20 mg	1 tablet daily	30	0	30 Sept 2012	Dr. Walter R Lucas MD	Depression
Lantus	40 units	1 injection at bedtime	1200 units	0	20 Sept 2012	Dr. Walter R Lucas MD	Diabetes
lisinopril	20 mg	1 tablet daily	30	0	10 Aug 2012	Dr. Walter R Lucas MD	Hypertension
metformin	1000 mg	1 tablet daily	30	0	30 July 2012	Dr. Walter R Lucas MD	Diabetes
Metoprolol	XL 50 mg	1 tablet daily	30	0	18 July 2012	Dr. Walter R Lucas MD	Hypertension
naproxen	500 mg	1 tablet 2 times a day	30	0	30 June 2012	Dr. Walter R Lucas MD	Rheumatoid arthritis
omeprazole	20 mg	1 tablet daily	75	3	11 July 2013	Dr. Sudha Nahar MD	Gastroesophageal reflux disease
pravastatin	40 mg	1 tablet daily	48	2	7 Aug 2013	Dr. Sudha Nahar MD	High Cholesterol
tazodone	50 mg	3 tablets at bedtime	160	2	21 June 2013	Dr. Sudha Nahar MD	
Ventolin	5 mg	1 puff as needed	140	3	16 July 2013	Dr. Sudha Nahar MD	Asthma
warfarin	5 mg	1 tablet daily MWF 1.5 tablets daily SuTuThSa	45	3	16 July 2013	Dr. Sudha Nahar MD	Thrombosis

Tap to open the interactive widget of a patient's medication list you can sort and filter.

Clinical examples

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Here's an ex…

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Interactive widgets (tap to launch)

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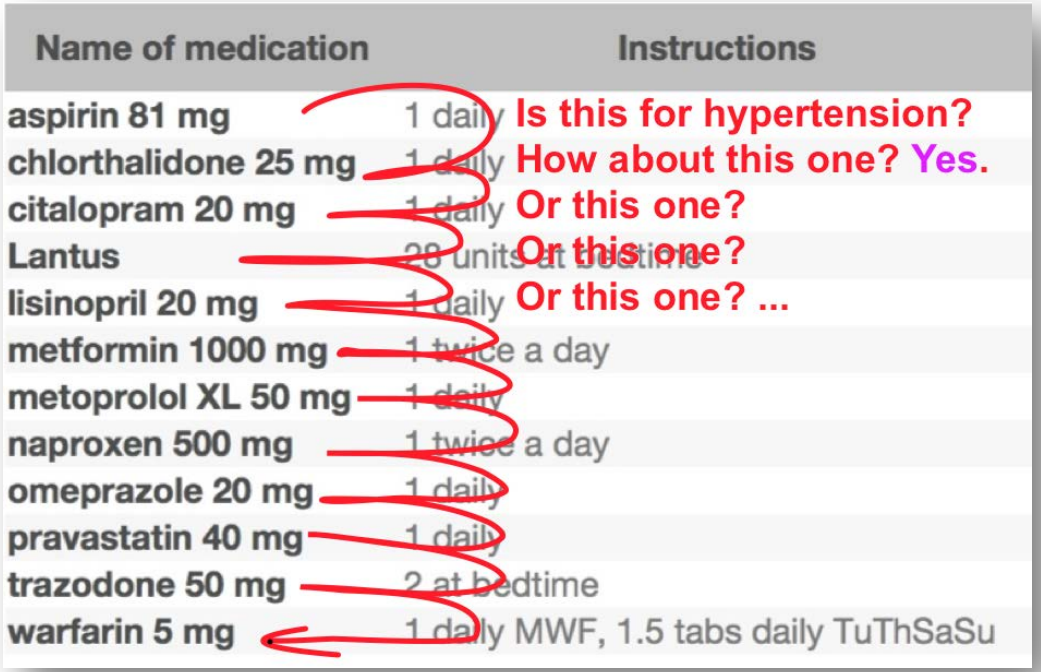
Clinical focus

- Clinical scenarios
- Annotated makeovers
- Interactive widgets for deeper learning



Feedback From EHRA Clinician Experience Workgroup 2/25/14

- Concern about guidelines becoming a requirement
- Strong interest in seeing more, commenting, sharing with others
- What and how strong is the evidence?

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Questions?