

# SHARPC Coordinated Safety Enhanced Guidelines

Project Leader: Todd R Johnson

Project Co-Leaders: Yang Gong, Jeff Belden

# Primary Guidelines Products

## 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.

- 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



- To group items into different categories
  - Use no more than 7 colors (4 recommended)
- To show sequential ranges of quantitative values
  - Use 1 color (for diverging) values
  - 2-color heatmap of varying intensity visualizes sequential ranges
  - Vary color intensity from pale (low values) to darker (extreme values)
- 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)
- To ease understanding and learnability of colors
  - Use text, tooltips or legends
- 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
- 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.utah.edu/ncod/SED/Briefs/seed-G01.htm>

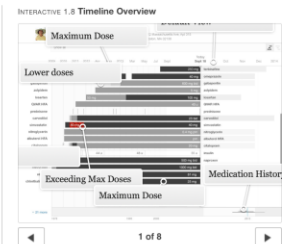


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There are just a few simple rules necessary to understand how it works. Each bar represents the history of a single medication (e.g. citalopram started at 10 mg, and progressively increased to 40 mg daily). The timescale can be adjusted. The color black represents the maximum dose of that particular medication. Shades of gray represent progressively lower doses (lighter means lower). At a glance, there is a wealth of information. It's straightforward.

- Here are the cognitive science and interface usability features incorporated into the timeline view.
- The high-level overview shows the time course for the complete list of medications in a single view. It's very efficient. The user won't need to keep different pieces of information in working memory or make written notes just to keep track of details scattered across several EHR views. Patterns emerge visually (from preattentive attributes like color, length, and proximity) that would be far more difficult to deduce from text or numerical data.
  - Zooming in on an area of interest allows exploration of more detail (text explanations, dose details, and even adherence information if pharmacy refill data is available to the EHR) to confirm hunches or to develop new questions to pursue.
  - Filtering may show only active medications, discontinued medications, or both to help answer other questions that arise during the inquiry. ("Why was this medication stopped here, and a switch made to that alternative medication?")

The timeline view serves every conceivable user well: physician, nurse, patient and caregiver, pharmacist, mental health professional, health coach, and any medical specialist. It can accommodate long lists of medications. A dozen medications can be quite common. Twenty medi-



cations would not be surprising. Thirty medications, sadly, may not be rare. The timeline view handles the visual burden with ease. Let's look at a gallery to demonstrate how.

The timeline efficiently shows an entire medication history in a single view. The user can tell at a glance important details about the medication dose at any particular point in time, and allows comparison to other medication dose patterns simultaneously.

It is a tool for data visualization, whose mantra is "overview first, then zoom and filter, then details-on-demand."

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NCCO

SAFETY ENHANCED DESIGN

EHR USABILITY

Usability

Designing for Usability

Evaluating Usability

Decision Support

TURF USABILITY SOFTWARE

RESEARCH

### EHR Usability

The purpose of the SHARPC project began as an exploration of how to provide cognitive support to physicians using Electronic Health Records (EHRs).

EHRs will provide "Patient-Centered Cognitive Support" when they are specifically designed and optimized to support problem solving and decision making that maximizes the chance of providing the highest quality of care for patients, as measured by IOM's six dimensions of quality (safe, effective, timely, efficient, equitable, and patient-centered).

- At the **work domain level**, the ideal EHR will have an explicit, unified, accurate, and comprehensive model that reflects the true ontology of the work domain and provides a clear understanding of the care problem, independent of how it is implemented within the system. Some systems suffer from models of the work domain that are implicit, multiple, unconnected, disparate, incomplete, and often inaccurate.
- At the **representation and implementation level**, ideal EHRs should have clear, comprehensive, easy to navigate information and knowledge models optimized for human users. Some systems have representations that are based on hardware and software features, making them confusing, siloed, task-specific, difficult to use & learn, and hard to navigate because they do not match human expectations.
- At the level of task performance, an ideal EHR will "build-in" safe, timely, effective, efficient, equitable, patient-centered task performance. Some systems seem disconnected, redundant, tedious, and use unclear user models based on billing and legal requirements that actually interfere with task performance.

The projects under the NCCO umbrella have responded to the changing aims at the ONC.

Safety Enhanced Design Briefs  
Todd Johnson

EHR Usability Interactive iBook  
Jeff Belden

EHR Usability Website  
Yang Gong

# sbmi.uth.edu/nccd/



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Informatics

## National Center for Cognitive Informatics & Decision Making in Healthcare

NCCD

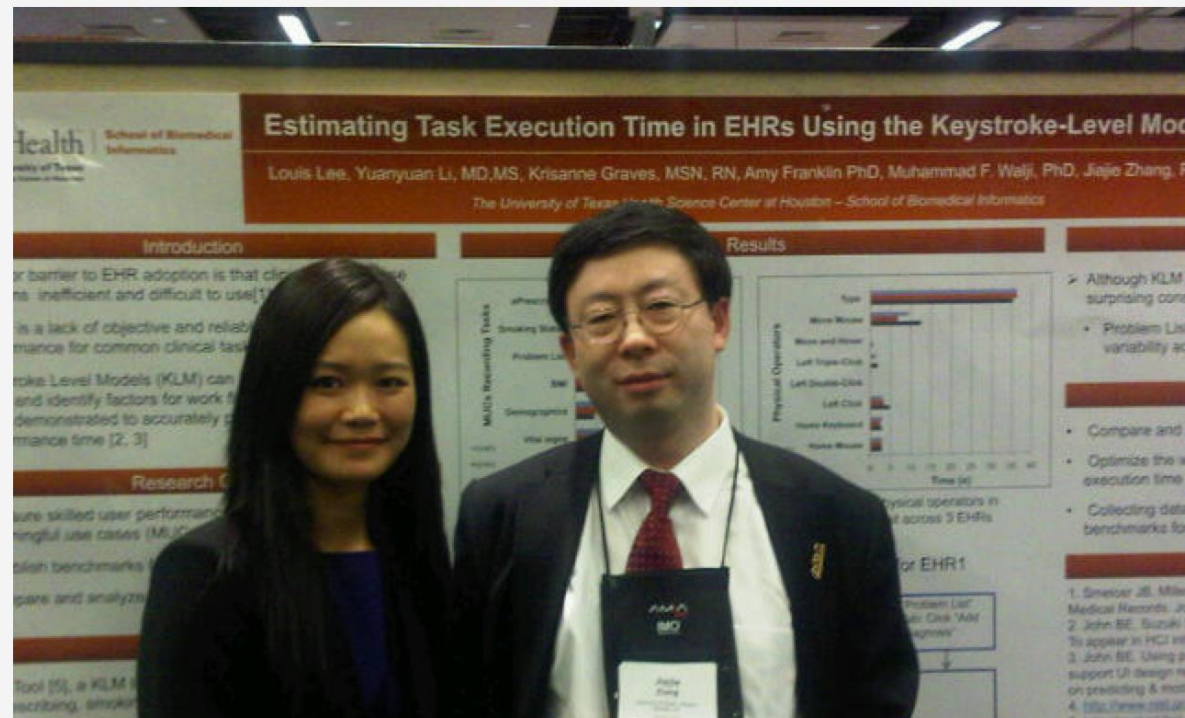
SAFETY ENHANCED  
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## National Center for Cognitive Informatics & Decision Making in Healthcare





NCCD

SAFETY ENHANCED  
DESIGN

EHR USABILITY

Usability

Designing for Usability

General Design Principles &  
Guidelines

Inspirational Prototypes

Workflow

Systematic Yet Flexible Systems

Evaluating Usability

Decision Support

# 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:

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

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.

Patient: Marva Jones (4)  
DOB: 1967-01-23 Age: 46

Encounter History ▾

### Report - Standard Measures

Target Date: 2013-05-10 07:23:56

Rule Set: Passive Alert Rules ▾

Plan Set: -- Ignore -- ▾

Provider: -- All (Cumulative) -- ▾

Provider Relationship: Primary ▾

**Submit**

Please input search criteria above, and click Submit to view results.

---

Patient: Marva Jones (4)  
DOB: 1967-01-23 Age: 46

Encounter History ▾

### Report - Automated Measure Calculations (AMC)

Begin Date:

End Date: 2013-05-10 07:27:07

Provider: -- All (Cumulative) -- ▾

Provider Relationship: Primary ▾

**Submit**

Please input search criteria above, and click Submit to view results.

*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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**SAFETY ENHANCED DESIGN**

Safety Enhanced Design Briefs

EHR Style Guide iBook

**EHR USABILITY**

**TURF USABILITY SOFTWARE**

**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](#)

# Safety Enhanced Design Briefs

## SAFETY ENHANCED 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

## TURF USABILITY SOFTWARE

### [About these briefs](#)

### [Who should use these briefs](#)

### [How to use these briefs](#)

We welcome your feedback on these guidelines. Please email comments to [sharp@uth.tmc.edu](mailto:sharp@uth.tmc.edu).

## General Briefs

SEDB-G01	<a href="#">Making Effective Use of Color</a>	<a href="#">PDF</a>	<a href="#">More Info</a>
SEDB-G02	<a href="#">Effective Table Design</a>	<a href="#">PDF</a>	<a href="#">More Info</a>
SEDB-G03	<a href="#">Reducing Wrong Patient Selection Errors</a>	<a href="#">PDF</a>	<a href="#">More Info</a>
SEDB-G04	Result Management	PDF	More Info

## Specific Meaningful Use Cases

SEDB-MU01	<a href="#">Drug-drug, drug-allergy interaction checks</a>	<a href="#">PDF</a>	<a href="#">More Info</a>
SEDB-MU02	Medication list	PDF	More Info
SEDB-MU03	Medication allergy list	PDF	More Info
SEDB-MU04	<a href="#">Clinical decision support</a>	<a href="#">PDF</a>	<a href="#">More Info</a>
SEDB-MU05	<a href="#">Electronic prescribing</a>	<a href="#">PDF</a>	<a href="#">More Info</a>
SEDB-MU06	Clinical information reconciliation	PDF	More Info
SEDB-MU07	Electronic medication administration record	PDF	More Info
SEDB-MU08	Computerized Practitioner Order Entry	PDF	More Info

## DESIGN

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EHR Style Guide iBook

## EHR USABILITY

### [About these briefs](#)

### [Who should use these briefs](#)

### [How to use these briefs](#)

[Back to SED Brief Menu](#)

## Version 1: [Making Effective Use of Color](#)

### Tools for Selecting Effective Color Schemes

<a href="#">Color Brewer 2.0</a>	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.
<a href="#">Coblis</a>	A color blindness simulator

### Websites

<a href="#">Colblindor</a>	Site for learning more about color-blindness. Includes tests and tools for checking designs ( <a href="#">Coblis</a> )
<a href="#">Perceptual Edge</a>	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



# Safety Enhanced Design Brief

## Making Effective Use of Color

## Background



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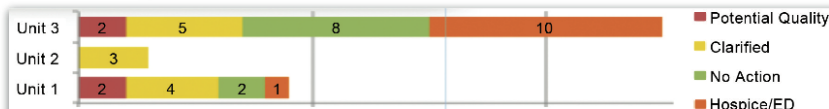
- To maximize the communication benefits of color, design**  
- Use gray scale, then add color sparingly

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

• Endocrine Events					
BP:	H 178/80 mmHg	(03/02/10)	H 169/84 mmHg	(12/30/09)	
Wt:	85.300 kg/188 lbs	(12/30/09)	85.400 kg/181 lbs	(12/29/09)	
BMI:	0	(02/08/10)	0	(02/01/10)	
Smoking Hx:	Non Smoker/History of Smoking	(03/02/10)	Non Smoker	(12/14/09)	
HGB:	14.3 g/dL	(03/02/10)	16.0 g/dL	(12/21/09)	
K+:	hemolyzed mmol/L	(03/02/10)	3.8 mmol/L	(12/21/09)	
Cr:	0.84 mg/dL	(03/02/10)	0.86 mg/dL	(12/21/09)	
MicroAlb/Cr:	18.3 mcg/mg Creat	(10/05/09)	H 52.8 mcg/mg Creat	(11/14/08)	
GFR (AA):	112.22 mL/min	(03/02/10)	109.21 mL/min	(12/21/09)	
GFR (non AA):	92.59 mL/min	(03/02/10)	90.11 mL/min	(12/21/09)	
Glu:	105 mg/dL	(03/02/10)	H 123 mg/dL	(12/21/09)	
HbA1c:	5.7%	(10/05/09)	5.8%	(03/18/09)	
Total Chol:	H 205 mg/dL	(10/05/09)	193 mg/dL	(09/30/09)	
HDL:	L 26 mg/dL	(10/05/09)	L 31 mg/dL	(09/30/09)	
Chol/HDL:	7.9	(10/05/09)	6.2	(09/30/09)	

## Guidelines

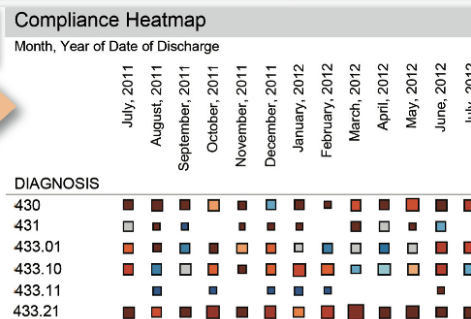
- To group items into different categories**  
- Use no more than 7 colors (4 recommended)



- 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)



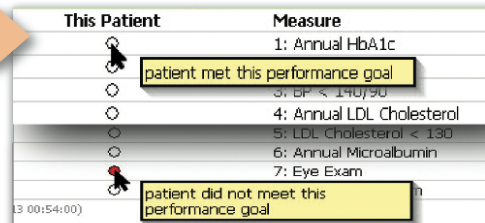
2-color heatmap of varying intensity visualizes sequential ranges



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

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

Mouse-over text explains dot coloring



- 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
- 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>)

## Pointer to web



NCCD

SAFETY ENHANCED  
DESIGN

Safety Enhanced Design  
Briefs

EHR Style Guide iBook

EHR USABILITY

TURF USABILITY  
SOFTWARE

RESEARCH

## 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.

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.

# iBook

- ▶ The EHR Usability Style Guide
- ▶ Interactive eBook emphasizing:
  - clinical scenarios & examples
  - galleries of examples of before & after design makeovers
  - interactive widgets for exploratory learning
- ▶ Released in 2 formats
  - iBook (interactive)
  - PDF with web supplement

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
trazodone	50 mg	3 tablets at bedtime	180	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

Here's an example

### Medication List

aspirin 81 mg 1 tablet daily  
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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	
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Interactive widgets  
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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

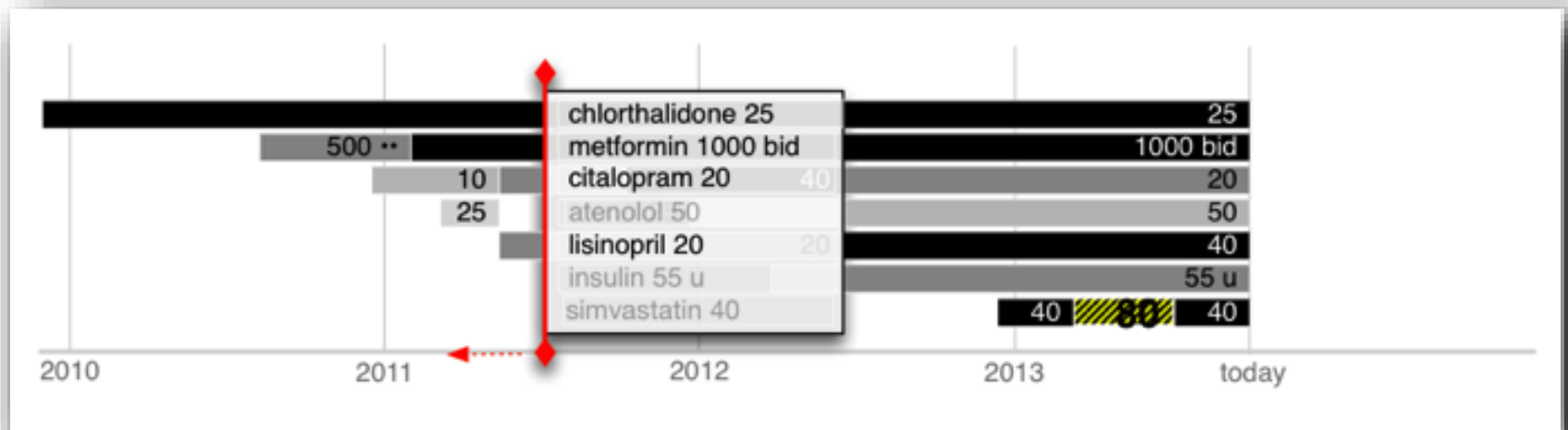
Tap to open the interactive widget of a patient’s medication list you can sort and filter.

# 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





# Clinical focus

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

Name of medication		Instructions
aspirin 81 mg	1 daily	Is this for hypertension?
chlorthalidone 25 mg	1 daily	How about this one? Yes.
citalopram 20 mg	1 daily	Or this one?
Lantus	28 units at bedtime	Or this one?
lisinopril 20 mg	1 daily	Or this one? ...
metformin 1000 mg	1 twice a day	
metoprolol XL 50 mg	1 daily	
naproxen 500 mg	1 twice a day	
omeprazole 20 mg	1 daily	
pravastatin 40 mg	1 daily	
trazodone 50 mg	2 at bedtime	
warfarin 5 mg	1 daily MWF, 1.5 tabs daily TuThSaSu	

# Evaluation component

- ▶ Did you find it?
- ▶ Did you use it?
- ▶ Do you want more books like it?

# Coordination

- ▶ Coordinating examples and guidelines
- ▶ Referencing one-pagers and [ehrusability.org](http://ehrusability.org)

# Questions?