



Electronic Health Record Design Patterns for Patient Safety

Developed by the Electronic Health Record Association (EHRA)

September 2017

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Introduction

In response to the ongoing discussion of health information technology (IT) and its potential impacts on patient safety — both in preventing errors and contributing to miscommunications — the EHRA offers this *Electronic Health Record Design Patterns for Patient Safety*. This document was created through a collaborative effort of EHRA member companies' software designers and engineers, human factors experts, clinicians, and other staff who bring decades of experience in the development and deployment of EHRs in healthcare organizations of varying sizes and specialties.

While there is important intersection between usability and patient safety, not all usability opportunities involve patient safety and not all patient safety risks arise from usability concerns. This guide focuses specifically on that intersection between the two, establishing and cataloguing design patterns that will help increase consistency in the most safety-critical areas of the EHR.

Reflecting our learning health system, the EHRA sees this as an evolving document. We offer it to all stakeholders for their consideration as we continue to work together to ensure that EHRs provide the tools that physicians and other caregivers strive to deliver more effective, efficient healthcare to their patients.

Electronic Health Record Design Patterns for Patient Safety is organized into six sections:

- Medications
- Alert Fatigue
- Lab Results
- Numeric Display
- Text Display and Layout
- Color

Each section presents recommendations for the most effective use of display design techniques and elements, based on our collective experiences. Additional references and resources relevant to each section are presented at the end of the section. The EHRA welcomes feedback from reviewers and suggestions for future editions of this document.

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Medications

The proper display of medication information can improve the safety of the medication ordering, administration, and dispensing process. Unclear, incomplete, or confusing presentation of medication information can increase the opportunity for health practitioners to make errors and cause patient harm.


A medication error is an error (of commission or omission) at any step along the pathway that begins when a clinician prescribes a medication and ends when the patient receives the medication.

Medications should be displayed in accordance to the FDA-approved list of “Generic Drug Names with Tall Man Letters” and the Institute for Safe Medication Practices’ (ISMP’s) list of “Additional Drug Names with Tall Man Letters”.

Since 2008, ISMP has maintained a list of drug name pairs, and trios with recommended, bolded tall man (uppercase) letters to help draw attention to the dissimilarities in look-alike drug names. The ISMP, the Food and Drug Administration (FDA), The Joint Commission, and other safety-focused organizations have promoted the use of Tall Man letters as one means of reducing confusion between similar drug names.


Medication names can be provided by a content vendor separate from the EHR developer, meaning that support of this guideline is not always within the EHR developer’s control. However, EHRs should store medication names in a way that is case-sensitive and can support tall man letters.

Example

 **DON'T**

Similar drug names can be confused with each other, increasing the risk of adverse events.

Drug Name	Confused With...
acetazolamide	acetoHEXamide
acetoHEXamide	acetazOLamide
bupropion	busPIRone
chlopromazine	chlorproPAMide

 **DO**

Use of the approved tall man letters for look-alike drug names highlights the dissimilarities, enhancing differentiation.

Drug Name with Tall Man Letters	Differentiated from...
aceta ZOLAMIDE	aceto HEXAMIDE
aceto HEXAMIDE	aceta ZOLAMIDE
bu PROP ion	bus PIR one
chlopro MAZINE	chlorpro PAMIDE


When drug name, strength, dosage form, and dosage units appear together, avoid confusion by providing a space between them.

Standardized and well-thought-out drug labeling practices need to be a part of an overall strategy to improve medication adherence and reduce inadvertent medication errors from label misinterpretation.

Overly tight word spacing causes words to appear to run into each other, making it more difficult for the reader to distinguish one word from the next. Conversely, word spacing that is too open creates oversized blocks of white space between words, forcing the reader to read individual words rather than phrases or blocks of copy. This dramatically slows down the reading process, reducing reader comprehension and increasing the risk of distraction.


A basic guideline for text is for the word spacing to approximate the character width of the lowercase ‘n’ or ‘o’. The developer should choose a font that meets this criteria and then use it consistently throughout their product displays.

Example

 **DON'T**

The “l” at the end of propranolol may be misread as the number 1. With no space between “10” and “units”, it is difficult to separate the word from the number.

Drug Name	Misread As...
propranolol20 mg	propranolol 120 mg
10Units	100 Units

 **DO**

Clear spacing makes it easy to separate drug and dose.

Drug Name
Inderal 40 mg (Clear that it is 40)
10 Units (Clear that it is only 10 units)

Support Universal Medication Schedule display for patients

Universal Medication Schedule (UMS) is a methodology that simplifies medication administration instructions for the patient and/or their caregiver. The goal of UMS is to increase patient understanding and adherence of their medication instructions, thus resulting in improved health outcomes. It also takes into consideration the discussion that will inevitably surround implementation of UMS into daily workflows of prescribers and pharmacists, and attempts to practicably address those associated items.

For Further Reading

- Australian Commission on Safety and Quality in Healthcare. (2016, January). National guidelines for on-screen display of clinical medicines information. Retrieved April 20, 2017, from <https://www.safetyandquality.gov.au/wp-content/uploads/2016/03/National-guidelines-for-onscreen-display-of-clinical-medicines-information.pdf>.
- AHRQ. (2015, March). Medication Errors. Retrieved April 20, 2017, from <https://psnet.ahrq.gov/primers/primer/23/medication-errors>.
- Institute for Safe Medication Practices. (2016). FDA and ISMP Lists of Look-Alike Drug Names with Recommended Tall Man Letters. Retrieved April 20, 2017, from <https://www.ismp.org/tools/tallmanletters.pdf>.
- Institute for Safe Medication Practices. (2014, December). Principles of Designing a Medication Label for Community and Mail Order Pharmacy Prescription Packages. Retrieved April 20, 2017, from <https://www.ismp.org/tools/guidelines/labelFormats/comments/default.asp>.
- Strizver, I. (n.d.). Word Spacing. Retrieved April 20, 2017, from <https://www.fonts.com/content/learning/fontology/level-2/text-typography/word-spacing>.
- NCPDP. (2013, April). Universal Medication Schedule White Paper. Retrieved April 20, 2017, from <http://www.ncpdp.org/members/pdf/201304.UMS.WhitePaper.pdf>.

Alert Fatigue

Alert fatigue describes how healthcare workers become desensitized to safety alerts and, as a result, may ignore or fail to respond appropriately to such warnings. Providing simple and clear alerts can improve the ability of a clinician to distinguish important alerts. When many alerts are necessary, an alert hierarchy, in which only the most serious alerts require a response by the healthcare worker and less serious alerts are presented in a non-interruptive manner, can help reduce cognitive load.

Differentiate alerts by severity: low, medium, and high

The EHR should be used to classify alert priority levels for unsafe events, in which the priority level of the alert is based on the severity of potential patient harm. This prioritization should separate critical events from non-critical events through visual, spatial, or other differentiators.

Visual differentiators for alert priorities include color, icons, and signal words. In the United States, green checks typically indicate success, red exclamation marks or the letter “X” indicate errors, yellow triangles indicate warnings, and blue “i”s (for “information”) indicate informational alerts. Most importantly, differentiators should be used consistently throughout the product.

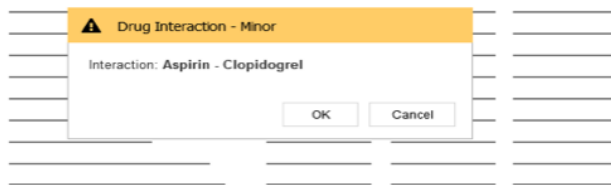
An alert’s criticality should determine its intrusiveness

Alerts should be presented according to their alert priority. Critical alerts should be prioritized as interruptive alerts - i.e., an alert that stops the user’s workflow and require the user to respond before continuing their tasks. Non-critical alerts should generate passive notices. If necessary, a non-critical alert may eventually produce an interruption if action is required but not addressed.

Example

An interruptive alert used for a low-priority notice. The alert covers the user’s current place in the workflow and must be acknowledged to resume the workflow.

✗ DON'T



A low-priority notice presented as a passive notification within the task workflow. The user can continue their workflow and does not need to dismiss the alert.

✓ DO



Use a standard, simple structure for all alerts

Simplification of alerts reduces the effort required for users to visually perceive and interpret critical alerts. A key to simplifying active, interruptive alerts is to provide relevant and structured data within each alert. Four basic components are recommended by the safety literature:

1. A consistent signal word indicating the seriousness of the alert;
2. Information about the hazard (e.g., the drug-drug interaction);
3. Instructions or actions to mitigate the hazard;
4. And, specific clinical consequences that may ensue if the hazard is not averted.

Example

⊗ DON'T

Drug-Drug Interaction Alert containing insufficient data to perceive and interpret a critical alert

Drug Alert

Ordering: Isosorbide Dinitrate

Patient currently taking: Sildenafil (Viagra)

OK Cancel

✓ DO

Drug-Drug Interaction Alert containing the four components in a structured format to improve perception and interpretation of a critical alert

! Drug Alert - Contraindicated

Existing Medication: **Sildenafil (Viagra)**

Ordering Medication: **Isosorbide Dinitrate**

Combination may cause sharp falls in blood pressure. Concurrent use is contraindicated. Eliminate one of these medications.

☐ Cancel **Isosorbide Dinitrate**

☐ Discontinue **Sildenafil (Viagra)**

OK Cancel

Signal words indicate alert severity

Information about the hazard

Specific clinical consequences

Clear actions to mitigate the hazard

Helpful Resources

- Leapfrog Survey Tool: <http://www.leapfroggroup.org/survey-materials>. Leapfrog Hospital Survey; used to perform a self-evaluation of the effectiveness of CPOE alerting systems. Free to hospitals.

For Further Reading

- Paterno, M. D., Maviglia, S. M., Gorman, P. N., Seger, D. L., Yoshida, E., Seger, A. C., ... Gandhi, T. K. (2009). Tiering drug-drug interaction alerts by severity increases compliance rates. *Journal of the American Medical Informatics Association: JAMIA*, 16(1), 40–6.
- Marcilly, R., Ammenwerth, E., Vasseur, F., Roehrer, E., & Beuscart-Zéphir, M.-C. (2015). Usability flaws of medication-related alerting functions: A systematic qualitative review. *Journal of Biomedical Informatics*, 55, 260–271.

- Phansalkar, S., Zachariah, M., Seidling, H. M., Mendes, C., Volk, L., & Bates, D. W. (2014). Evaluation of medication alerts in electronic health records for compliance with human factors principles. *J Am Med Inform Assoc*, 21(e2), e332–e340.
- Zachariah, M., Phansalkar, S., Seidling, H. M., Neri, P. M., Cresswell, K. M., Duke, J., ... Bates, D. W. (2011). Development and preliminary evidence for the validity of an instrument assessing implementation of human-factors principles in medication-related decision-support systems--I-MeDeSA. *Journal of the American Medical Informatics Association: JAMIA*, 18 Suppl 1, i62-72.
- 18F. (2017, April 26). Alerts. Retrieved May 12, 2017, from <https://standards.usa.gov/components/alerts/>.

Laboratory Results

Clinical laboratory results are the output of some sort of clinical test, frequently (but not always) performed by a laboratory. They may include numeric values, such as blood glucose level, or text-based results such as the “positive” or “negative” results of a throat swab culture. Numeric results may be presented in tabular form, particularly when a panel of multiple types of test is displayed; a longitudinal series of measurements of a single test is often graphed to show trends over time. Results are typically presented along with a reference range of normal results for the test and type of patient, with abnormal results flagged.

Display numeric and text results clearly

Clinicians must be able to respond correctly to lab results that indicate the presence of a problem. Results that are outside of the range that would be expected for this patient are particularly important, whether they are outside of a reference range individually or represent an abnormal change from previous results.

- Keep multi-component test results together when displaying them along with other test results.
- Display result information in columns wide enough for users to see the full value and abnormality level without having to adjust the display.
- Keep the information needed to make a clinical judgment on the same page, and do not require horizontal scrolling to see critical information. If the screen is not displaying a full message such as a long comment, be sure there is a clear way to see the rest of the message (dragging a scroll bar, clicking an arrow to expand a panel).
- When test results have been changed after the initial report, indicate the change clearly on the display.

Distinguish new results from previous results

Use icons, layout sections, or even notifications to bring a clinician’s attention to new lab results. If multiple instances of a test over time are displayed in rows, display them in reverse chronological order with the most recent at the top.

Use consistent format for abnormal results, regardless of source

Clinicians must be able to respond quickly and correctly to lab results that require attention. Results outside normal reference ranges or abnormal in some other way must be visually distinguished from normal results.

If the mapping between display characteristics and level of abnormality is different in the same system, it becomes more difficult for clinicians to quickly scan and interpret results over time. Display should be kept consistent regardless of where the result originated.

Example

Here is a set of lab results presented to a clinician. The first three results are abnormal, and the second comes from a different system than the first and third. The first and second results are both abnormally high, but the first designates this variance with red text and an exclamation point, while the second uses an asterisk and bold text.

✗ DON'T

Glucose Level (mg/dL)	!183	H	01/17/2017 14:53
BUN (mg/dL)	*40	H	01/17/2017 14:53
Creatinine-Blood (mg/dL)	!42.9	L	01/17/2017 14:53
Sodium (mmol/L)	138		01/17/2017 14:53
Potassium (mmol/L)	4.2		01/17/2017 14:53

In this example, the clinician can more easily tell that the three values are comparably abnormal - all abnormal values use red bold text with an exclamation point.

✓ DO

Glucose Level (mg/dL)	!183	H	01/17/2017 14:53
BUN (mg/dL)	!40	H	01/17/2017 14:53
Creatinine-Blood (mg/dL)	!42.9	L	01/17/2017 14:53
Sodium (mmol/L)	138		01/17/2017 14:53
Potassium (mmol/L)	4.2		01/17/2017 14:53

Result reports that are predominantly text-based, such as pathology or microbiology reports, should similarly feature a clear and consistent use of terminology for interpretation - at least, abnormal vs. normal.

Graphical display of results over time

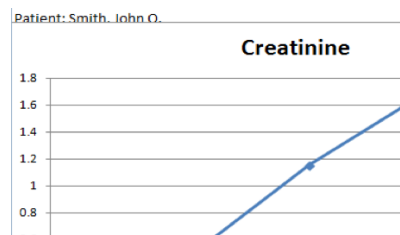
Graphs can be easy to misinterpret, particularly if they do not conform to the expectations of the viewer. If the clinician does not interpret a graph of result data correctly, they may either fail to detect an emerging condition or incorrectly treat a condition that is not actually present. Graphs of result data should meet the criteria described in [Sittig et al \(2015\)](#). These include: *General Characteristics*

- Patient identifying information is clearly associated with the graph, such that it is not possible to view the graph itself while the patient identifying information is hidden.
- The reference range (provided by the laboratory) for each variable should be included.
- The precise value of each data point should be available, either always in view or on hover, single click, or key-press.

Example

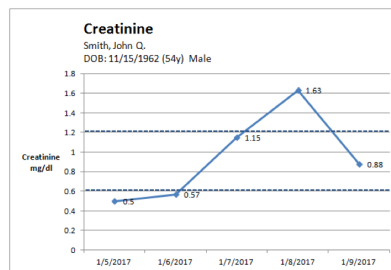
A graph of laboratory results is presented to a clinician - the patient identifying information is outside the graph and so can be obscured. There are no precise values for the individual data points and no reference range.

❌ DON'T



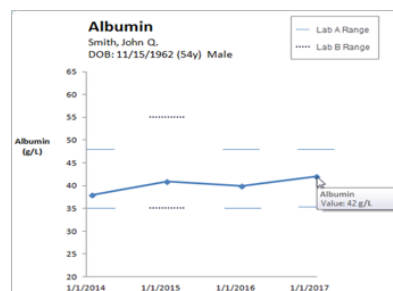
These graphs of laboratory results for clinician use include patient identifying information in the same display as the graph. The normal range of results for an adult male is marked with dotted lines. Precise values are either always shown or available on hover.

✅ DO



This example shows historical results from multiple labs with different reference ranges.

✅ DO



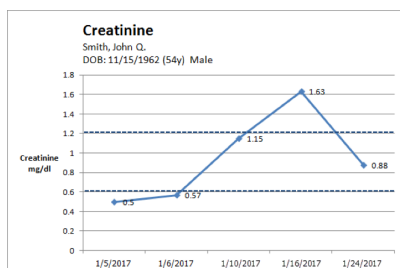
X-Axis

- The x-axis has multiple, intermediate, evenly-spaced tick marks. If results are collected over unequally-spaced times, the horizontal space between them must reflect those differences. The time scale of the x-axis should be consistent across the extent of the graph.

Example

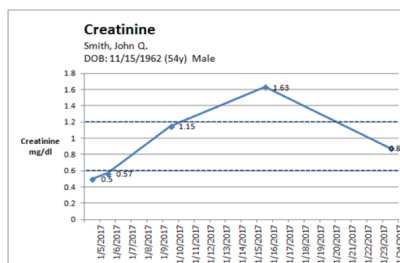
Results are presented to a clinician from an unevenly-spaced set of samples - the samples are evenly spaced on the timeline, which could cause the clinician to misinterpret the rate of changes.

❌ DON'T



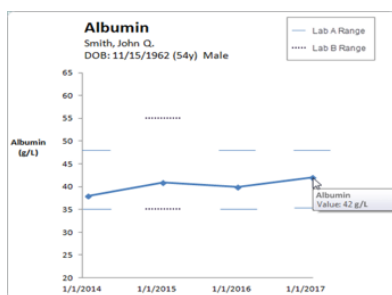
The clinician can better visualize the rate of changes when the horizontal spacing of markers reflects the temporal spacing of the samples.

✅ DO



This example shows historical results from multiple labs with different reference ranges.

✅ DO



Y-Axis

- Label the y-axis with the name of the variable and its units, for example, "Blood Glucose (mg/dl)".
- Labels should be shown on the individual tick marks. Y-axis values should increase from bottom to top.

Support display personalization

Especially in displays devoted to results review, offering personalization options for sorting and filtering the view will allow a user to create a display that best matches their mental model. Potential options for such personalization options include result time, severity, and facility. If a user configures their display, their decisions should be remembered by the system.

Helpful Resources

- SAFER: Safety Assurance Factors for EHR Resilience. Test Results Reporting and Follow-Up. https://www.healthit.gov/sites/safer/files/guides/safer_testresultsreporting_sg008_form.pdf. The SAFER Guides are designed to help healthcare organizations conduct self-assessments to optimize the safe use of EHRs. Free.

For Further Reading

- Sittig, D.F., Murphy, D.R., Smith, M.W., Russo, E., Wright, A. & Singh, H. (2015). Graphical Display of Diagnostic Test Results in Electronic Health Records: A Comparison of 8 Systems. *Journal of the American Medical Informatics Association*, 22, 900–904.



Numeric Display

Numbers are commonly used in healthcare — to represent doses, measurements, prices, and more. EHRs introduce the ability to compute numbers automatically, making it even more important to make sure they are easily read and understood by busy clinicians.



Use a comma to separate groups of three digits

A long, continuous string of numbers, particularly if there are many zeros, is hard to interpret correctly. For numbers greater than 1,000, use the location-appropriate thousands separator. This aids visual interpretation of large numbers by breaking them up into groups of thousands and avoiding misreading errors.

Example

 DON'T	<p><i>The EHR is displaying the dose of a medication that is measured in units. Without a thousands separator, the number is difficult to parse.</i></p> <p>Dose: 5000 units</p>
 DO	<p><i>The EHR displays the dose of the medication with the locale-appropriate thousands separator for a US locale.</i></p> <p>Dose: 5,000 units</p> <p><i>The EHR displays the dose of the medication with the locale-appropriate thousands separator for a Dutch locale.</i></p> <p>Dose: 5.000 units</p>



Example

 DON'T	<p><i>A population health dashboard communicates the size of a registry.</i></p> <p>Population: 162204</p>
 DO	<p><i>A population health dashboard in the US communicates the size of a registry.</i></p> <p>Population: 162,204</p> <p><i>A population health dashboard in France communicates the size of a registry.</i></p> <p>Population: 162 204</p>

Fractional numbers should be displayed with a 0 (zero) before the decimal point

Leading zeros make it less likely that a reader will overlook the decimal point in a fractional number and misinterpret the value.

Example



 DON'T	<p><i>A dose is shown without a leading 0. A distracted user might misread the dose as 5 or 25 mg.</i></p> <p>Dose: .5 mg Dose: .25 mg</p>
 DO	<p><i>The leading 0 makes it clear that these are decimal numbers.</i></p> <p>Dose: 0.5 mg Dose: 0.25 mg</p>

Do not display a trailing zero after the decimal point unless precision is relevant

Including a decimal and trailing zero when displaying a whole number may cause the reader to misinterpret and inflate the value. For example, 1 may be interpreted as 10 if it is expressed with a decimal and trailing zero (1.0).

An exception is when a trailing zero is required to demonstrate a level of precision of the value being reported (labs, imaging studies in regards to size of lesions, catheter/tube sizes, etc.).

Example



 DON'T	<p><i>A dose is shown with an unnecessary 0 after the decimal point. A distracted user might misread the dose as 10 or 200 mg.</i></p> <p>Dose: 1.0 mg Dose: 20.0 mg</p>
 DO	<p><i>Removing the trailing 0 makes the dose clear.</i></p> <p>Dose: 1 mg Dose: 20 mg</p>

Right-justify and decimal-align numbers when displaying them in a column for comparison

When displaying numbers in a column, they should be formatted so the digits with the same significance are stacked vertically. Justify columns with respect to a fixed decimal point. If there is no decimal point, then numbers should be right aligned. By right-aligning or decimal-aligning numerical fields, the values are easier to compare.

This guideline applies specifically to numbers displayed for comparison. When displaying numbers in a table for other purposes — for example, a table displaying the patient's last recorded readings for blood pressure, SpO2, respirations, and pulse -- the numbers will not be compared and can be aligned with their labels.

Example

 DON'T	<p><i>Data is left-aligned, making it difficult to determine which numbers are larger. Numbers with values after the decimal point look larger at first glance.</i></p> <table><thead><tr><th>Date</th><th>Value</th></tr></thead><tbody><tr><td>3/17/2017</td><td>6.5</td></tr><tr><td>3/18/2017</td><td>60.5</td></tr><tr><td>3/19/2017</td><td>17</td></tr><tr><td>3/20/2017</td><td>17.48</td></tr><tr><td>3/21/2017</td><td>19</td></tr></tbody></table>	Date	Value	3/17/2017	6.5	3/18/2017	60.5	3/19/2017	17	3/20/2017	17.48	3/21/2017	19
Date	Value												
3/17/2017	6.5												
3/18/2017	60.5												
3/19/2017	17												
3/20/2017	17.48												
3/21/2017	19												
 DO	<p><i>Numeric data is right-justified and decimal-aligned. Note that this display implies and should only be used when values were measured to thousandths-precision.</i></p> <table><thead><tr><th>Date</th><th>Value</th></tr></thead><tbody><tr><td>3/17/2017</td><td>6.500</td></tr><tr><td>3/18/2017</td><td>60.500</td></tr><tr><td>3/19/2017</td><td>17.000</td></tr><tr><td>3/20/2017</td><td>17.480</td></tr><tr><td>3/21/2017</td><td>19.000</td></tr></tbody></table>	Date	Value	3/17/2017	6.500	3/18/2017	60.500	3/19/2017	17.000	3/20/2017	17.480	3/21/2017	19.000
Date	Value												
3/17/2017	6.500												
3/18/2017	60.500												
3/19/2017	17.000												
3/20/2017	17.480												
3/21/2017	19.000												

For Further Reading

- Institute for Safe Medication Practices. (2015). ISMP's List of Error-Prone Abbreviations, Symbols, and Dose Designations. Retrieved April 20, 2017, from <https://www.ismp.org/Tools/errorproneabbreviations.pdf>.
- Lowry, S. Z., Quinn, M. T., et al. Technical Evaluation, Testing, and Validation of the Usability of Electronic Health Records. Retrieved April 20, 2017, from https://www.nist.gov/sites/default/files/documents/healthcare/usability/EUP_WERB_Version_2_23_12-Final-2.pdf.


Text Display and Layout

The ability to understand, process, and act upon text in the EHR is a key factor in efficiency and safety. Clinical users must be able to scan information quickly with high comprehension.

Reduce or eliminate truncated data


Truncating medication names and patient names can be confusing. Instead, table cells should be sufficiently large enough to display complete entries. If truncation is necessary, use a truncation symbol that remains constant throughout the application. The ellipsis symbol is commonly used to shorten words when text is too long.

Example

 **DON'T**

A list of medications unnecessarily truncates the medication name, making it difficult to determine which medications are being taken.


MEDICATION	FREQUENCY
Aceta...	1 daily
Aceta...	1 daily
Aceta...	2 tab q6 PRN
Aceta...	1 daily

 **DO**

Since the name of the medication is the most important piece of data, it is given the most space. If absolutely necessary, other fields are made shorter.


MEDICATION	FREQUENCY
Acetahexamide 250 mg tablet	1 daily
Acetahexamide 500 mg tablet	1 daily
Acetaminophen 500 mg tablet	2 tab q6 PRN
Acetazolamide 250 mg tablet	1 daily

Example

 **DON'T**

A user is viewing or searching a list of patients. If the patient's name is truncated, there is the potential for the wrong patient to be selected and acted upon.

LAST NAME	FIRST NAME	REASON
Christe...	Jos...	Cold
Christe...	Jos...	Cough
Daniels	Mar...	Sinuses
Daniels...	Mar...	Headache

 **DO**



Avoiding patient name truncation when possible reduces the possibility of a patient identification error.

LAST NAME	FIRST NAME	REASON
Christensen	Joshua	Cold
Christenson	Josephine	Cough
Daniels	Margaret	Sinuses
Danielson	Mary	Headache

Use abbreviations sparingly and carefully

Whenever possible, do not use abbreviations, symbols or dose designations. Abbreviations often come from Latin and, with fewer letters, can be more easily mistaken for each other. Using the full text reduces the possibility of misinterpreting medication orders, which may result in harmful medication errors.






Example

 DON'T	<p><i>"AD" stands for "auris dextra." The chosen font makes it easy to read the "A" as an "O," which could stand for "oculus dexter."</i></p> <p>Cortisporin otic suspension 4 drops ad three times a day</p>
 DO	<p><i>Avoiding the use of abbreviations makes the route obvious.</i></p> <p>Cortisporin otic suspension 4 drops in right ear three times a day</p>

Make the difference between "no value recorded" and "actually no value" clear to users

Provide an indicator to inform the user when a result value has not been entered, versus when the result is actually a null value. A zero should not be used to represent a nil value, since a zero is a value. It is better to use non-numerical identifiers, like dashes (--) or N/A to show that there is no value.

Example

 DON'T	<p><i>A clinician cannot determine if the total cholesterol has not yet been calculated or if it cannot be calculated.</i></p> <table><thead><tr><th colspan="2">CHEMISTRY</th></tr></thead><tbody><tr><td>Sodium</td><td>140</td></tr><tr><td>Serum Potassium</td><td>5.0</td></tr><tr><td>Chloride</td><td>120</td></tr><tr><td>Anion Gap</td><td>-5.0</td></tr><tr><td>Random Glucose</td><td>100</td></tr><tr><td>Total Cholesterol</td><td></td></tr></tbody></table> 	CHEMISTRY		Sodium	140	Serum Potassium	5.0	Chloride	120	Anion Gap	-5.0	Random Glucose	100	Total Cholesterol															
CHEMISTRY																													
Sodium	140																												
Serum Potassium	5.0																												
Chloride	120																												
Anion Gap	-5.0																												
Random Glucose	100																												
Total Cholesterol																													
 DO	<p><i>Whenever possible, provide a clear indicator to the user clarifying the value and status.</i></p> <table><thead><tr><th colspan="2">CHEMISTRY</th></tr></thead><tbody><tr><td>Sodium</td><td>140</td></tr><tr><td>Serum Potassium</td><td>5.0</td></tr><tr><td>Chloride</td><td>120</td></tr><tr><td>Anion Gap</td><td>-5.0</td></tr><tr><td>Random Glucose</td><td>100</td></tr><tr><td>Total Cholesterol</td><td>n/a</td></tr></tbody></table>  <table><thead><tr><th colspan="2">CHEMISTRY</th></tr></thead><tbody><tr><td>Sodium</td><td>140</td></tr><tr><td>Serum Potassium</td><td>5.0</td></tr><tr><td>Chloride</td><td>120</td></tr><tr><td>Anion Gap</td><td>-5.0</td></tr><tr><td>Random Glucose</td><td>100</td></tr><tr><td>Total Cholesterol</td><td>pending</td></tr></tbody></table> 	CHEMISTRY		Sodium	140	Serum Potassium	5.0	Chloride	120	Anion Gap	-5.0	Random Glucose	100	Total Cholesterol	n/a	CHEMISTRY		Sodium	140	Serum Potassium	5.0	Chloride	120	Anion Gap	-5.0	Random Glucose	100	Total Cholesterol	pending
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Place labels adjacent to values and maintain consistency

Place labels adjacent to values and data entry fields and maintain consistency throughout the system. Use right alignment for screen labels and left alignment for values.

Example

When values are not consistently placed by labels, cognitive load is increased.

✗ DON'T

Last Name	Barker
First Name	Jennifer
Birthdate	02/08/1970
Age	47
Sex	F

Whenever possible, maintain a clear and logical display to make viewing and locating data clear and consistent for the clinician.

✓ DO

Last Name	Barker
First Name	Jennifer
Birthdate	02/08/1970
Age	47
Sex	F

Last Name	Barker
First Name	Jennifer
Birthdate	02/08/1970
Age	47
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For Further Reading

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- Penzo, M. (2006, July 12). Label Placement in Forms. Retrieved May 09, 2017, from <http://www.uxmatters.com/mt/archives/2006/07/label-placement-in-forms.php>.
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Color

Color vision deficiency, also known as color blindness, refers to the decreased ability to differentiate colors. The condition affects one in 12 men and one in 200 women. EHRs must be able to accommodate individuals – users and patients – with color vision deficiency.






Use redundant coding to represent important, meaningful information

Redundant coding refers to the technique of representing information in more than one way. Users with color vision deficiency should still be able to recognize important or pertinent information, such as highlighted actions, trends, system or patient status, etc. Do not use color as the only means of distinguishing this information.

Example

<p> DON'T</p>	<p><i>In a physician's view of recommended actions from automated clinical decision support, guidance of higher importance are called out in red. Informational guidance is called out in orange.</i></p> <div data-bbox="337 663 1265 789"><p>Per CDC guidelines, it is recommended this patient be screened for Chlamydial infection annually</p><p>Patient is due for tetanus immunization</p></div>
<p> DO</p>	<p><i>In a physician's view of recommended activities and clinical decision support, guidance uses redundant coding. Font-weight, color, and icons indicate more important information.</i></p> <div data-bbox="337 930 1274 1056"><p>!! Per CDC guidelines, it is recommended this patient be screened for Chlamydial infection annually</p><p> Patient is due for tetanus immunization</p></div>

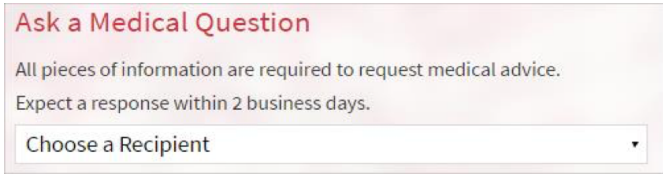
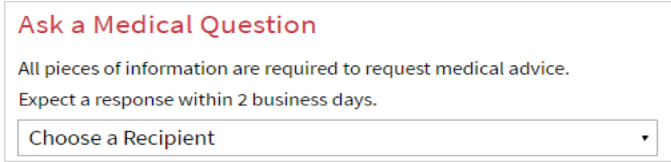
Example

<p> DON'T</p>	<p><i>In an inpatient nurse's view of their patient list, patients in isolation status or who require droplet protection are called out in red.</i></p> <table border="1" data-bbox="337 1323 894 1507"><tr><td>Paranodes, Bailly</td><td></td></tr><tr><td>36 years / M</td><td></td></tr><tr><td>Scribbs, Cheryl</td><td></td></tr><tr><td>55 years / F</td><td></td></tr><tr><td>Emerson, Jacob</td><td></td></tr><tr><td>56 years / M</td><td></td></tr></table>	Paranodes, Bailly		36 years / M		Scribbs, Cheryl		55 years / F		Emerson, Jacob		56 years / M	
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<p> DO</p>	<p><i>In an inpatient nurse's view of their patient list, patients in isolation status or who require droplet protection are called out using an icon, font-weight, font decoration, and color.</i></p> <table border="1" data-bbox="337 1644 899 1818"><tr><td>Paranodes, Bailly</td><td>—</td></tr><tr><td>36 years / M</td><td></td></tr><tr><td>Scribbs, Cheryl</td><td>—</td></tr><tr><td>55 years / F</td><td></td></tr><tr><td>Emerson, Jacob (Isolation)</td><td></td></tr><tr><td>56 years / M</td><td></td></tr></table>	Paranodes, Bailly	—	36 years / M		Scribbs, Cheryl	—	55 years / F		Emerson, Jacob (Isolation)		56 years / M	
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Text of importance must be distinguishable from its background

Following WCAG 2.0 standard level AA (standards used for website accessibility), text smaller than 14pt font should have a contrast ratio of at least 4.5:1. Text used as decoration or text that does not convey additional essential meaning does not need to meet this standard.

Example

✗ DON'T	<i>In the patient-facing portal for secure messaging, the background is colored to match the organization's theme, but as a result, text is not distinguishable by patients with color vision deficiency.</i>
	
✓ DO	<i>In the patient-facing portal, switching to a high-contrast theme removes the background, providing enough contrast.</i>
	

Helpful Resources

- Color Oracle: <http://colororacle.org>. Color Oracle, for Linux, Mac, or Windows, allows you to apply a color filter to your screen to simulate different kinds of color blindness. Free and open source.
- I Want To See Like the Colour Blind: <https://chrome.google.com/webstore/detail/i-want-to-see-like-the-co/jebeedfnielkcjlcokhiobodkjjpbjia>. I Want to See Like the Colour Blind is a Chrome plug-in to simulate different kinds of color blindness, for testing web pages. Free.
- Fiji: <http://imagej.net/Fiji/Downloads>. Fiji, an image editor, for Linux, Mac, and Windows, is a distribution of ImageJ with plugins for simulating color-blindness. Free and open source.
- Sim Daltonism: <https://michelf.ca/projects/sim-daltonism/>. Sim Daltonism is an iOS app that uses your mobile device's camera to present a view of the world as a person with color vision deficiency. Also available as a Mac app, to apply a color filter to the screen. Ads, open source.
- Adobe Photoshop: <http://www.adobe.com/accessibility/products/photoshop.html>. Photoshop comes with color blindness filters, form the Proof Setup menu. Paid (free with Photoshop).

For Further Reading

- Liu, J. (2010, February 1). Color Blindness & Web Design. Retrieved November 18, 2016, from <https://www.usability.gov/get-involved/blog/2010/02/color-blindness.html>.
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