Evaluation of medication alerts in EHRs for compliance with human factors principles

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Phansalkar; JAMIA Journal Club Webinar
5th June, 2014
Background

- CDS when implemented in EHRs has the potential to reduce ADEs (Bates, Weingart, et al.)
- Medication-related decision support alerts form a large part of the CDS implemented in EHRs
- Alert Fatigue
  - High (49-98%) override rates persist (van der Sijs, et al.)
Medication Alert Fatigue Is Curable

Medication alerts are supposed to ensure patient safety, but clinicians ignore them when bombarded with too many. This dilemma needs to be solved.

Medication alerts within EHRs can save lives, but as many clinicians are quick to point out, these alerts can also prove to be a major headache. The alerts sometimes note potential adverse effects that even first year medical students would know. While there’s no perfect system, we can do better.

Given that between 33% and 96% of medical alerts are ignored, there’s little doubt that providers need help in this regard. A good place to start is with a core set of critically important drug/drug interactions (DDIs) that everyone in your healthcare system needs to watch.
The Clinical Alerts that Cried Wolf

March 20, 2012 by Gabriel Perna

As clinical alerts pose physician workflow problems, healthcare IT leaders look for answers

EXECUTIVE SUMMARY:
Across the U.S., as healthcare providers implement computerized physician order entry (CPOE) systems, they find themselves dealing with the growing issue of clinical alert fatigue. With patient care alerts proliferating within clinical decision support (CDS) systems, physicians have often come to ignore all alerts. Healthcare IT leaders are working to resolve this important issue to everyone’s benefit, increasingly implementing systems that put out only effective alerts or apply asynchronous alerting strategies.

What happens when something designed for patient safety ends up having the exact
Search is on to cure EHR alert fatigue

Researchers, physicians and others are coming up with strategies to ensure that warning alerts generated by health IT systems are less frequent — and more meaningful.

By PAMELA LEWIS DOLAN — Posted April 16, 2012

Almost every physician who has typed orders into an electronic health record or e-prescribing system probably has experienced so-called alert fatigue — the frustration of seeing warning after warning popping up before that order is accepted. The alerts are designed to inform physicians of possible patient safety issues, but their frequency and often lack of necessity make them the electronic equivalent of the boy who cried wolf.

As researchers and health care organizations work to alleviate alert fatigue, it’s clear that the answer is to create systems that take human behavior and supplemental patient data into account when writing rules that decide when
Previous Work

Understanding alert fatigue from a multi-dimensional perspective:

• Content-
  – ONC high and low priority DDI lists

• Design/ Display of alerts
  – I-MeDeSA - Instrument for evaluating Human-factors Principles in Medication-related Decision Support Alerts

• Workflow
  – Corrective actions from within the alert
  – Where in the medication ordering workflow is an alert most effective?
Aims

1. Compare drug-drug interaction (DDI) alerts in EHRs to assess their compliance with human factors principles using the I-MeDeSA instrument.

2. Provide recommendations for appropriate alert design based on this evaluation.
The I-MeDeSA Instrument

– Developed from a review of the human factors literature in the safety domain


– Previously validated instrument

The I-MeDeSA Instrument

– Nine constructs/ human factors principles:

1. Alarm philosophy
2. Placement
3. Visibility
4. Prioritization
5. Color
6. Learnability and confusability
7. Text-based information
8. Proximity of task components being displayed
9. Corrective actions

– 26 Items

– Binary scoring (0/1), Total score= 26

– For tiered alerts a score was produced for each “level” of an alert and the average score was calculated to represent the score of the EHR on that item
Methods

• Those EHRs that display DDI alerts to their users
• Evaluation of a diverse set of 14 EHRs implemented in outpatient and inpatient settings:
  – 8 developed in-house
  – 6 vendor solutions
• From 9 participating Institutions
  – 7 Academic Medical Centers (AMCs) and
  – 2 EHRs
• No financial incentive offered for participation
## Participating EHRs

<table>
<thead>
<tr>
<th>Institution</th>
<th>EHR</th>
<th>Version number</th>
<th>Inpatient/outpatient</th>
</tr>
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<tr>
<td>Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA</td>
<td>WebOMR</td>
<td>WebOMR 2009</td>
<td>Outpatient</td>
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<tr>
<td>GE Healthcare (vendor), Waukesha, Wisconsin, USA</td>
<td>Centricity</td>
<td>2005 6.0</td>
<td>Outpatient</td>
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<td>Harvard Vanguard Medical Associates, Newton, Massachusetts, USA</td>
<td>EpicCare (Epic)</td>
<td>2007 IU3</td>
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<tr>
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<td>NextGen Ambulatory</td>
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</tr>
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<td>Northwestern Memorial Faculty Foundation, Chicago, Illinois, USA</td>
<td>EpicCare (Epic)</td>
<td>Spring 2008 IU7</td>
<td>Outpatient</td>
</tr>
<tr>
<td>Northwestern Memorial Hospital, Chicago, Illinois, USA</td>
<td>PowerChart (Cerner)</td>
<td>2007.19</td>
<td>Inpatient</td>
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<tr>
<td>Northwestern Memorial Hospital, Chicago, Illinois, USA</td>
<td>PowerChart Office (Cerner)</td>
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<td>Outpatient</td>
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<tr>
<td>Partners Healthcare, Boston, Massachusetts, USA</td>
<td>Longitudinal Medical Record</td>
<td>8.2</td>
<td>Outpatient</td>
</tr>
<tr>
<td>Partners Healthcare, Boston, Massachusetts, USA</td>
<td>BICS (tiered)</td>
<td>November 2010</td>
<td>Inpatient</td>
</tr>
<tr>
<td>Partners Healthcare, Boston, Massachusetts, USA</td>
<td>BICS (un-tiered)</td>
<td>November 2010</td>
<td>Inpatient</td>
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<tr>
<td>Regenstrief Institute, Indianapolis, Indiana, USA</td>
<td>Gopher</td>
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<tr>
<td>US Department of Veterans Affairs (VA), Washington, DC, USA</td>
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<td>Vanderbilt University, Nashville, Tennessee, USA</td>
<td>RxStar</td>
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<td>Outpatient</td>
</tr>
<tr>
<td>Vanderbilt University, Nashville, Tennessee, USA</td>
<td>WizOrder</td>
<td>Not available</td>
<td>Inpatient</td>
</tr>
</tbody>
</table>
Evaluation of screenshots

• Two reviewers independently assessed alerts using the I-MeDeSA
  – Third reviewer helped arrive at consensus
• Sometimes a picture was not worth a thousand words!
  – Virtual demos to understand workflow
• Cohen’s κ for inter-rater reliability between reviewers
Results

• Scores ranged from 8 (31%) to 18.4 (71%) out of a total score of 26 points
  – Top scoring system barely made a ‘C’ grade!

• Inter-rater reliability was high (Cohen’s κ=0.86)
Results: What constructs were most systems good at?

#1: Visibility (94.3%)

- Is the area where the alert is located distinguishable from the rest of the screen? (...)

- Is the background contrast sufficient to allow the user to easily read the alert message? (ie, dark text on a light background)

- Is the font used to display the textual message appropriate for the user to read the alert easily? (...)

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What constructs were most systems good at?

#2: Proximity of task components (71.4%)

Are the informational components needed for decision making on the alert present either within or in close spatial and temporal proximity to the alert?

For example, is the user able to access relevant information directly from the alert, that is, a drug monograph, an ‘infobutton,’ or a link to a medical reference website providing additional information?
What constructs were most systems good at?

• #3: Placement (70.8%)
  • Are different types of alerts meaningfully grouped? (ie, by the severity of the alert, where all level 1 alerts are placed together, or by medication order, where alerts related to a specific medication order are grouped together)
  • Is the response to the alert provided along with the alert, as opposed to being located in a different window or in a different area on the screen?
  • Is the alert linked with the medication order by appropriate timing? (ie, a DDI alert appears as soon as a drug is chosen and does not wait for the user to complete the order and then alert him/her about a possible interaction)
  • Does the layout of critical information contained within the alert facilitate quick uptake by the user? Critical information should be placed on the first line of the alert or closest to the left side of the alert box. Critical information should be labeled appropriately and must consist of: (1) the interacting drugs, (2) the risk to the patient, and (3) the recommended action. (Note that information contained within resources such as an ‘infobutton’ or link to a drug monograph does NOT equate to information contained within the alert.)
Figure 1  Example of a system that scored highly on the construct of Placement by identifying the type of interaction, allowing the user to easily enter in their response to the alert, linking the alert to the medication order by appropriate timing, and providing the critical information needed to act on the drug-drug interaction alert.
Figure 2  The drug–drug interaction alert presented here shows insufficient information for the user to act on the interaction between warfarin and the interacting drugs on the patient’s medication profile. In addition, reviewers found it difficult to read the statement indicating the interacting drugs in bright yellow font on a dark blue background.
What constructs did most systems perform poorly on?

Alarm philosophy (14%)

• Does the system provide a general catalog of unsafe events, correlating the priority level of the alert with the severity of the consequences?
What constructs did most systems perform poorly on?

Prioritization (25.7%)

• Is the prioritization of alerts indicated appropriately by color? (ie, colors such as red and orange imply a high priority compared to colors such as green, blue, and white)

• Does the alert use prioritization with colors other than green and red, to take into consideration users who may be color blind?

• Are signal words appropriately assigned to each existing level of alert? For example, ‘Warning’ would appropriately be assigned to a level 1 alert and not a level ‘Note’ would appropriately be assigned to a level 3 alert and not a level 1 alert

• Does the alert utilize shapes or icons in order to indicate the priority of the alert? (ie, angular and unstable shapes such as inverted triangles indicate higher levels of priority than regular shapes such as circles)

• In the case of multiple alerts, are the alerts placed on the screen in the order of their importance? The highest priority alerts should be visible to the user without having to scroll through the window.
What priority does this shape indicate?

Order of importance?
What constructs did most systems perform poorly on?

Learnability and confusability (28.6%)

- Are the different severities of alerts easily distinguishable from one another?

  For example, do major alerts possess visual characteristics that are distinctly different from minor alerts? The use of a signal word to identify the severity of an alert is not considered to be a visual characteristic.
Difficult to distinguish between different alert severities!
More than 10 colors on this screen!

How would the user respond to this alert?

Figure 6  Poor corrective actions do not allow the user to provide a response to an alert. In addition, this system utilized more than 10 colors on the screen.
Conclusions

• Lots of room for improvement!
• Even high scoring systems varied widely in their design strengths
  Some of the highest scoring systems (Systems 6 and 7) scored no points on the constructs of “Prioritization” (a 5 item construct) and “Learnability and Confusability.”

• Home grown vs. Vendor systems?
  Lowest scoring system was system was a homegrown system at an AMC that performed worst among all systems on 7/9 constructs.
Work done since then...

- I-MeDeSA goes International!
  - Contraindicated alerts for pregnancy and allergy
    - Dutch context
  - Korean language version of I-MeDeSA
    - **Evaluation of a Korean version of a tool for assessing the incorporation of human factors into a medication-related decision support system: the I-MeDeSA.** *Cho I, Lee J, Han H, Phansalkar S, Bates DW.*
    - Used to evaluate DDI alerts

- Extended use of I-MeDeSA for the evaluation of drug-allergy interaction alerts in EHRs.
- Studying the impact of alert design in alert override rates
Comparative User Experiences of Health IT Products: How User Experiences Would Be Reported and Used

Christine A. Sinsky, Medical Associates Clinic and Health Plans; Jason Hess, KLAS; Ben-Tzion Karsh, University of Wisconsin; James P. Keller, ECRI Institute; and Ross Koppel, University of Pennsylvania*

September 2012
“At present, some vendors prohibit users from sharing screenshots and otherwise effectively communicating with others about a problem with an EHR. There is currently no place for health IT users to share publicly the experiences they have had with their health IT products. However, even if a place were designated and developed a following, its use would be limited because of contractual prohibitions on sharing screenshots.”

Thoughts?

To fully leverage the experiences of individual users, we propose that public reporting include direct paths between the user and the public sphere, without filtering through parties with a potential conflict of interest (see Figure 2).

**FIGURE 2** Direct path for user experience to enter the public sphere.
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• **Acknowledgments:**
  This project was supported by the Centers for Education and Research on Therapeutics (CERT Grant # U19HS021094), Agency for Healthcare Research and Quality, Rockville, MD. USA.