Today’s webinar is sponsored by

Wolters Kluwer Health Drug Information Solutions

Medi-Span® and Lexicomp®

Who we are:

- **Medi-Span** - Embedded drug databases used in 60 EMRs, 1,000+ hospitals, and 37,000 retail pharmacies
- **Lexicomp** - Referential drug information used in nearly 2,000 hospitals and by 80,000 mobile users

Dedicated to building innovative and trusted resources in multiple formats for use in any setting, WKH Drug Information Solutions aims to lessen system-wide costs while helping reduce errors, assist in improving patient safety and creating practical drug information solutions to increase workflow efficiency throughout the continuum of care.
Howard Strasberg
Vice President, Medical Informatics
Wolters Kluwer Health – Clinical Solutions

• Actively involved in standards development as a co-chair of the Health Level Seven (HL7) Clinical Decision Support (CDS) Working Group, which develops CDS standards in areas such as InfoButtons, order sets, and decision support services.

• Prior to joining Wolters Kluwer Health in 2003, Howard was CEO of Skolar, Inc., an online provider of clinical information and "in context" continuing medical education (CME) for medical professionals.

• Howard received his MD degree from the University of Western Ontario and his MS degree in Medical Information Sciences from Stanford University. He is board certified in Family Medicine.
Medication Safety Screening

Important tool to help reduce adverse drug events caused by medication errors

Types of alerts (examples):
• Drug-Drug Interactions
• Drug-Allergy Conflicts
• Dosing
• Pregnancy/Lactation/Age/Gender Precautions
• Drug-Gene Interactions
2014 EHR Certification Criteria § 170.314 (a)(2)

• (i) Before a medication order is completed and acted upon during computerized provider order entry (CPOE), interventions must automatically and electronically indicate to a user drug-drug and drug-allergy contraindications based on a patient’s medication list and medication allergy list.

• (ii) Adjustments.
  • (A) Enable the severity level of interventions provided for drug-drug interaction checks to be adjusted.
  • (B) Limit the ability to adjust severity levels to an identified set of users or available as a system administrative function.
Medication Alerts

Alerts occur frequently.


Major EMR using Medi-Span data:
• 0.12 drug-drug interaction alerts per order
• 0.095 dose alert per order
• 0.05 allergy alerts per order
• ...
• Overall - 0.53 alerts per order

Alert Fatigue

- Alerts can be conceptually divided:
  - Clinically significant (signal)
  - Not clinically significant (noise)
- Alert fatigue occurs when too many alerts are noise and providers start to ignore the alerts
- A systematic review found that drug safety alerts are ignored in 49%-96% of cases (Van Der Sijs. JAMIA 2006 [2])
- Partners study found that 53% of medication-related CDS alerts were overridden (Nanji et al. JAMIA 2013 [3])

Alert Fatigue

Question 1:
Where do you draw the line?

\[
\text{Precision} = \frac{\# \text{ gold coins above the line}}{\text{total } \# \text{ coins above the line}}
\]

\[
\text{Recall} = \frac{\# \text{ gold coins above the line}}{\text{total } \# \text{ gold coins}}
\]
Alert Fatigue

Precision = 18/28 = 0.64
Recall = 18/32 = 0.56
Alert Fatigue

Precision = 6/7 = 0.86
Recall = 6/32 = 0.19

Signal

Noise

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Alert Fatigue

Precision = 30/63 = 0.48
Recall = 30/32 = 0.94
Alert Fatigue

Question 2:
How should we evaluate provider responses to alerts?
McCoy et al provided a framework for evaluating CDS alerts and responses (JAMIA 2012; 19:346-352 [4])

<table>
<thead>
<tr>
<th>Alert Display</th>
<th>Provider Response</th>
<th>Provider Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate (Signal)</td>
<td>Successful alerts</td>
<td>Provider non-adherence (inappropriate overrides)</td>
</tr>
<tr>
<td>Inappropriate (Noise)</td>
<td>Justifiable overrides</td>
<td>Unintended adverse consequences</td>
</tr>
</tbody>
</table>

Overriding an alert may or may not be an appropriate provider response; cannot just look at the override rate

Evaluation Framework

- Nanji study in McCoy framework (assuming all alerts that were not overridden were successful)

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<tr>
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<th>Provider Response</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Appropriate (Signal)</td>
<td>47% Successful (not overridden)</td>
<td>25% Inappropriate overrides</td>
</tr>
<tr>
<td>Inappropriate (Noise)</td>
<td>28% Justifiable overrides</td>
<td></td>
</tr>
</tbody>
</table>

- Nanji: 53% of alerts were overridden AND 53% of alert overrides were appropriate (depicted above as $28%/\(28%+25\%\))
Evaluation Framework

• Evaluation of provider response shouldn’t be limited to the ordering session; need to establish a time window
  • Junior clinicians may initially override an alert, but after discussion with senior clinicians, they may return to implement the alert’s recommendation
  • Similarly, clinicians may discuss the options with other members of the team, with specialists and/or consult reference material before making a management decision
• Clinicians may also override an alert but still implement its recommendation (e.g. tell the patient not to take Drug A within 4 hours of Drug B, but proceed with the order)
Question 3:
Do people agree on which coins (alerts) should be gold-colored?

Are some of my gold alerts your grey alerts, and vice versa?
• Is it possible to achieve consensus on which alerts are clinically significant?
• ONC/RAND list identified 15 critical DDIs (Phansalkar et al; JAMIA 2012;19:735-743 [5])
• Separately, Pharmacy Quality Alliance (PQA) developed a list of 14 critical DDIs for use in evaluating health plans
• These two lists overlapped only for MAO-I interactions
• Warfarin interactions were on PQA list but not ONC/RAND list
• In our own research, we have found poor agreement among generalist physicians on which DDIs are clinically significant
• Universal consensus on what constitutes a clinically significant alert remains elusive

Reducing Alert Fatigue

- In the absence of a universal consensus, systems must be tailored to the needs of individual hospitals, departments and users

  - User level
    - Don’t show me this alert again
    - Don’t show me this alert again for this patient
    - Snooze for a period of time
  
  - Hospital level
    - Always suppress this alert
    - Suppress this alert for physicians, but display it to pharmacists
Question 4:
Does the color assignment depend on the patient and other context factors?

Is an alert gold if the patient has kidney disease but grey otherwise?
Causes of inappropriate alerts

• Lack of granularity in CDS knowledge
• Failing to account for other EMR data (patient demographics, other medications, lab results)
• Relevant information buried in free text without any NLP capability to extract it (but clinician can read the free text and conclude that the alert is inappropriate)
Contextual Factors

• **Consider additional contextual factors**
  
  • Top contextual factors identified by subjects in Riedmann et al in an international Delphi study (JAMIA 2011; 18:760-766 [6])
  
  • Severity of the effect
  
  • Clinical status of the patient
  
  • Probability of the occurrence
  
  • Risk factors of the patient
  
  • Strength of evidence

• **For many of these factors, data are limited**
  
  • We often don’t have data to provide the probability of occurrence for a given set of risk factors
  
  • Even if we did, below what level of probability of occurrence is it considered safe to suppress an alert?

Alert Fatigue

Question 5:
What's the best way to show you the coins (alerts) in your workflow?
Reducing Alert Fatigue

- Seidling et al looked at factors influencing alert acceptance [taking appropriate action] (JAMIA 2011; 18:479-484 [7])
  - Display of the alert (OR 4.75)
  - Setting [inpatient/outpatient] (OR 2.63)
  - Level of the alert (OR 1.74)
- Display of the alert refers to such characteristics as how alerts are grouped, where alert appears relative to medication order, visibility, legibility, color, shape and icon
- In other words, the most important factor in alert acceptance was the design of the alerting system

Horsky et al [8] published some design recommendations:

- Color (e.g. reserve red for severe situations)
- Size (e.g. variable depending on content length)
- Layout (e.g. simple geometry)
- Font (e.g. draw attention to drug names)
- Language (clear and concise, with links to additional information)

- Interruptive vs Non-Interruptive
  - Use Non-Interruptive for low severity alerts

Russ et al[9] tested a redesign of medication alerts in the VA CPRS system using a simulation study.

Changes included:

• Streamlining the information
• Reducing textual information overload

Redesigned alerts had improved usability scores for:

• Overall satisfaction
• Information quality (!)
• Interface quality

Duke, Li and Dexter[10]

- Enhance alert display with patient context
- Intervention group - display most recent potassium and creatinine along with potassium-related alerts
- Control group - standard alerts
- Hypothesis: Adherence rate would be higher in high risk patients (elevated baseline potassium and/or creatinine)
- Results: No significant difference in adherence rates
- Possible explanations:
  - Physicians ignored the alerts entirely
  - Physicians did not gauge patient risk accurately
  - High risk patients were carefully monitored, so less cause for concern

Question 6: What actually happens when coins (alerts) are shown to users? What can we learn from the data?
Institutions should study their alert logs to identify areas for improvement.

Health system - 1354 pregnancy alerts in one week.

• Through simulation, identified a new filter setting that would cut down the number of alerts by 60%.
  • OR rate would still be high, but alerts per order would be reduced.
• EMR issue: precautions for Placenta Previa were triggered for all pregnant patients, leading to unnecessary alerts.
  • Solution: EMR updated its software.
• Workflow issue:
  • MMR vaccine - orders were given immediately post-partum, but nobody told the EMR that the patient was no longer pregnant.
Pharmacy - 70% of alerts were duplicate therapy alerts.

- Problem: Patient comes in with a new prescription for a drug with 0 refills remaining, but the old prescription is still active → generates duplicate therapy alert.

- Solution: Implement a days allowance (e.g. if patient comes in within 14 days of the end of the old prescription period, suppress the alert).

- Problem: Numerous alerts for patients taking three anti-hypertensive drugs.

- Solution: Change the allowance for this class of medications (e.g. only alert if four or more anti-hypertensive drugs).
Health system

- 89,426 Drug-Disease precaution alerts in 6 months
- 60,600 (68%) were below our recommended filter threshold
- Solution: Implement our recommended filter settings
Question 7:
Is there an alternative to showing you a bunch of coins (alerts) within your workflow?
Reducing Alert Fatigue

• Don’t show an alert at all, but instead institute surveillance monitoring for adverse effects
• Alert a provider at the first sign of an adverse effect
• Monitoring could involve vital signs, lab test and other observations about the patient, some of which may require NLP analysis of free text notes
Question 1: Where do you draw the line?

- Strike a balance between precision and recall, but don't ignore recall. Patient safety is at stake.

- Our research suggest that both precision and recall can (simultaneously) be above 0.65.

- Don't go for 0.90 precision at the expense of a huge drop in recall (e.g. recall of 0.20).
Question 2: How should we evaluate provider responses to alerts?

- Look at the override rate, but realize that it doesn't tell the whole story.
- Override ⬧ alert - probably appropriate
- Override ⬨ alert
  - May still have implemented its recommendations (e.g. implement monitoring) [overridden literally but not functionally]
  - May be inappropriate
Question 3: Do people agree on which coins (alerts) should be gold-colored?

• Make some decisions at the institutional level.
• Allow end users to make some of their own decisions.
  • Consider guideposts (e.g. end user cannot suppress highest severity alerts).
  • Don't show me this alert again [for 6 months].
  • Don't show me this alert again for this patient [for 6 months].
Question 4: Does the color assignment depend on the patient and other context factors?

- Use context whenever possible.
- Dose checking - include the indication, patient age, patient weight, and patient renal function.
- Interaction checking - include the route, patient age, patient gender, and patient's problem list.
Question 5: What's the best way to show you the coins (alerts) in your workflow?

- Pay attention to the design of the alerts (color, size, layout, font, language)
- Distinguish between interruptive (more severe; interrupts workflow) and informative alerts (less severe; appears on screen but does not interrupt workflow).
- Consider displaying context information (e.g. recent lab results).
Recommendations

Question 6: What actually happens when coins (alerts) are shown to users? What can we learn from the data?

• Study your institution's alert data.
• Measure and improve.
• What are the most common alerts being overridden? Why?
Question 7: Is there an alternative to showing you a bunch of coins (alerts) within your workflow?

• For rare adverse drug events, consider surveillance monitoring (e.g. Sentri7 from Pharmacy OneSource - also part of Wolters Kluwer Health) in lieu of prospective alerting.

• Create rules such as:

  • If (Drug X AND Drug Y) AND (AST > 35 OR ALT > 40) THEN Send Alert to Provider
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