Implementing Best Practices at Your Medical Center through Computerized Clinical Decision Support (CDS)

SGIM Evidence Based Medicine Task Force

May 7th, 2011
SGIM 34th Annual Meeting Workshop
Phoenix, AZ
Objectives

1. Identify key studies demonstrating the impact of decision support on best practices

2. Use case studies to identify key steps in the development and implementation of decision support

3. Use case studies to identify common features of decision support

4. Describe study designs used to monitor the impact of decision support
Outline

10:30-10:35  Introductions
10:35-10:45  Evidence-based Practice and CDS
10:45-11:15  Case 1: CDS in the Inpatient Setting
11:15-11:45  Case 2: CDS in the Outpatient Setting
11:45-11:55  Monitoring the Impact of CDS
11:55-12:00  Wrap Up and Evaluation
Faculty Introductions

• Devin M. Mann, MD, MS
  Boston University

• Craig A Umscheid, MD, MS
  University of Pennsylvania

• Jeffrey Schnipper, MD, MPH
  Harvard University
Audience Poll

• **Primary role**: clinician, administrator, researcher?

• **Most interested in**: development or implementation of CDS?
Supporting Evidence-based Practice Thru CDS
Drivers of Evidence-based Policy

Public reporting and pay-for-performance

- Quality of health care

Stagnant reimbursements and increasing costs

- Cost-effectiveness of health care dollar

Practice of EBM at the Organizational Level
Using CDS to Support EBM

  - Increasing influenza and pneumococcal vaccinations
  - Preventing venous thromboembolism
  - Decreasing surgical site infections by increasing use of preoperative empiric antibiotics
  - Increasing appropriate prescribing in those with renal insufficiency
  - Improving formulary adherence and reducing costs

www.himss.org/cdsguide
What is CDS?

“What providing clinicians or patients with knowledge and information, intelligently filtered or presented, to enhance patient care.”

– NOT just alerts or reminders

www.himss.org/cdsguide
Examples of CDS

- Relevant data presentation: *flowsheets*
- Order creation facilitators: *order sets*
- Reference information: *infobuttons*
- Documentation templates: *visit note*
- Protocol support: *pathways*
- Unsolicited alerts: *proactive warnings*
## Impact of CDS on Physician Performance

<table>
<thead>
<tr>
<th>Type of CDS</th>
<th>Improve Physician Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>All CDS</td>
<td>62 (64%)</td>
</tr>
<tr>
<td>Diagnostic CDS</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>Disease Prevention CDS (Reminders)</td>
<td>16 (76%)</td>
</tr>
<tr>
<td>Disease Mgmt CDS</td>
<td>23 (62%)</td>
</tr>
<tr>
<td>Dosing or Prescribing CDS</td>
<td>19 (66%)</td>
</tr>
</tbody>
</table>

### Improvement associated with:

- Auto prompt vs. self activate (73 vs. 47%, p=0.02)
- Local vs. Stock CDS (74 vs. 28%, p=0.001)

### Improvement in patient outcomes:

- 7 trials (13%)

Predictors of Improved Practice with CDS

• 48 (68%) studies showed practice improvement with CDS
• Four independent predictors of success:
  – automatic CDS
  – recommendations rather than assessments
  – CDS at the point-of-decision
  – computer based CDS

More Focused Reviews

<table>
<thead>
<tr>
<th>Table 1. Median improvements in process adherence across included studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dichotomous outcomes (number of intervention vs. control comparisons)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>All process outcomes (N = 32)</td>
</tr>
<tr>
<td>Prescription of medications (N = 21)</td>
</tr>
<tr>
<td>Prescription of recommended vaccines (N = 6)</td>
</tr>
<tr>
<td>Test ordering (N = 13)</td>
</tr>
<tr>
<td>Elements of recommended documentation (N = 3)</td>
</tr>
<tr>
<td>Other process outcomes (N = 7)</td>
</tr>
</tbody>
</table>

More Focused Reviews (cont)


CDS Five Rights Model

To improve care outcomes with CDS you must provide:

the Right Information…
   Evidence-based, useful for guiding action and answering questions

…to the Right Stakeholder…
   Both clinicians and patients

…in the Right Format…
   Alerts, Order Sets, answers, etc.

…through the Right Channel…
   Internet, mobile devices, clinical information systems

…at the Right Point in the Workflow
   to influence key decisions/actions

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Synthesis of Research Paper

Ten Commandments for Effective Clinical Decision Support: Making the Practice of Evidence-based Medicine a Reality

David W. Bates, MD, MSc, Gilad J. Kuperman, MD, PhD, Samuel Wang, MD, PhD, Tejal Gandhi, MD, MPH, Anne Kittler, BA, Lynn Volk, MHS, Cynthia Spurr, RN, MBA, Ramin Khorasani, MD, Milenko Tanasijevic, MD, Blackford Middleton, MD, MSc, MPH
Case Studies

• Each will focus on:
  1. drivers of the particular CDS implemented
  2. stakeholders involved in developing the CDS
  3. key features of the CDS development
  4. testing and release of the CDS
  5. monitoring of its impact

• At least 10 minutes at the end of each case study for questions and answers
Case 1: CDS in the Inpatient Setting
Inpatient CDS: Lessons learned from Efforts to Improve Medication Safety

Jeffrey L. Schnipper, MD, MPH, FHM
Director of Clinical Research, BWH Hospitalist Service
Associate Physician, Division of General Medicine,
Brigham and Women’s Hospital
Assistant Professor, Harvard Medical School
Goals of this Talk

- To understand the “10 Commandments” of Effective CDS
- To appreciate the most important ways CDS can improve medication safety
- To understand how to fine tune CDS to avoid alert fatigue and overriding of alerts
- To see how small usability changes and understanding of workflow can lead to large increases in the efficacy of CDS
10 Commandments of Effective CDS

• Speed is everything
• Anticipate needs and deliver in real time
• Fit into the user’s workflow
• Little things can make a big difference
• Recognize that physicians will strongly resist stopping
• Changing direction is easier than stopping
• Simple interventions work best
• Ask for additional information only when you really need it
• Monitor impact, get feedback, and respond
• Manage and maintain your knowledge base
Causes of Inpatient Medication Errors

Ordering Errors (49%)

Dispensing Errors (14%)

Administration Errors (26%)

Transcription Errors (11%)

Medication on Wards

Medication Admin Record

Transcription

Med Orders

Medication on Wards

RN

Patient

Courtesy David Bates, MD, MSc
Improving Drug Ordering with CPOE/CDS

- Streamline, structure process
  - Suggested doses from menus (9%)
  - Decreased transcription
  - Orders with all required information

- Give information at the time needed
  - Show relevant laboratory results
  - Present guidelines at time decision is being made (7%)
  - Provide guided dose algorithms

- Perform checks in background
  - Drug-allergy (4%)
  - Drug-frequency (3%)
  - Drug-drug (2%)
  - Drug-renal function (19%)
  - Drug-laboratory (27%)
  - Drug-age (9%)

Anticipate needs and deliver in real time
Medication Safety CDS Experience at BWH

• Drivers
  – Interested researchers and developers
  – Home-grown EMR
  – Cases of serious adverse drug events in our system
  – Regulatory and reporting requirements
    • e.g., Medication Reconciliation NPSG

• Stakeholders in development
  – Best when included clinicians, developers, researchers, and patient safety administrators

• Monitoring impact
  – Rigorous when “research”
  – More important in “real world” when the study is over
NEPHROS study\(^4\)

- Effect of real-time decision support for patients with renal insufficiency
- Unobtrusive, non-interruptive default suggestions of dose and frequency
  - Of 17,828 patients, 42% had some degree of renal insufficiency
    |                  | Interv | Control |
    |------------------|--------|---------|
    | Dose             | 67%    | 54%     |
    | Frequency        | 59%    | 35%     |
  - LOS 0.5 days shorter in intervention arm
• Elderly patients frequently get dosages that are too high, especially initial dosages.
• Performed RCT of decision support around dosing for psychoactive drugs.
• Was associated with:
  – More frequent recommended dose (29% vs. 19%)
  – Lower fall rate (2.8 vs. 6.4 falls/1000 pt days)
  – Lower frequency of 10-fold overdose (2.8% vs. 5%)
  – No difference in mental status change, LOS
• Clearly beneficial to suggest starting with lower dosage but more room for improvement
Safety Results of CPOE Decision Support Among Hospitals

- 62 hospitals voluntarily participated
- Simulation: CDS detected only 53% of orders which would have been fatal
- Detected only 10-82% of orders which would have caused serious ADEs
- Almost no relationship with vendor
Medication Safety: Refining the Rules

- In most systems, most alerts get overridden
  - 88-89% of serious drug-drug interactions
  - 69-91% of drug-allergy alerts

- Easy to plug in a commercial DDI/DAI database, BUT
  - Leads to lack of trust
  - Alert Fatigue
  - Crying Wolf effect

- Need to balance sensitivity and specificity
  - May make most sense to err first on side of specificity
Medication Safety: Refining the Rules

- Knowledge base creation
  - Expert panel
  - Consolidation of duplicate, drug-drug, drug-disease, drug-lab, and drug-pregnancy alerts from various sources
  - Developed 3 levels of alerts based on clinical severity
  - Tailored CDS to each level
    - Level 1: cannot proceed with order
    - Level 2: can override alert if provide reason
    - Level 3: FYI

- Result: 1,444 drug contraindications
  - 192 duplicate drug class, 351 drug-drug, 326 drug-disease, 255 drug-lab, and 320 drug-pregnancy rules
  - The distribution of alerts was 2% Level 1 alerts, 63% Level 2 alerts, and 35% Level 3 alerts
### Accept and Override Rates for Interruptive Alerts

<table>
<thead>
<tr>
<th>Contraindication</th>
<th>No.</th>
<th>No. (%) of Orders Canceled†</th>
<th>No. (%) of Orders Modified§</th>
<th>Total No. (%) of Alerts Accepted</th>
<th>No. (%) of Alerts Overridden †</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplicate class (Level 2 only)</td>
<td>3,875</td>
<td>681 (18)</td>
<td>2,284 (59)</td>
<td>2,965 (77)</td>
<td>910 (23)</td>
</tr>
<tr>
<td>Drug-drug</td>
<td>1,078</td>
<td>254 (24)</td>
<td>197 (18)</td>
<td>451 (42)</td>
<td>627 (58)</td>
</tr>
<tr>
<td>Level 1</td>
<td>13</td>
<td>4 (31)</td>
<td>9 (69)</td>
<td>13 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Level 2</td>
<td>1,065</td>
<td>250 (23)</td>
<td>188 (18)</td>
<td>438 (41)</td>
<td>627 (59)</td>
</tr>
<tr>
<td>Drug-lab (Level 2 only)</td>
<td>92</td>
<td>37 (40)</td>
<td>0 (0)</td>
<td>37 (40)</td>
<td>55 (60)</td>
</tr>
<tr>
<td>Drug-disease (Level 2 only)</td>
<td>19</td>
<td>9 (47)</td>
<td>1 (5)</td>
<td>10 (53)</td>
<td>9 (47)</td>
</tr>
<tr>
<td>Drug-pregnancy</td>
<td>118</td>
<td>12 (10)</td>
<td>0 (0)</td>
<td>12 (10)</td>
<td>106 (90)</td>
</tr>
<tr>
<td>Level 1</td>
<td>16</td>
<td>2 (13)</td>
<td>0 (0)</td>
<td>2 (13)</td>
<td>14 (88)</td>
</tr>
<tr>
<td>Level 2</td>
<td>102</td>
<td>10 (10)</td>
<td>0 (0)</td>
<td>10 (10)</td>
<td>92 (90)</td>
</tr>
<tr>
<td>Total</td>
<td>5,182</td>
<td>993 (19)</td>
<td>2,482 (48)</td>
<td>3,475 (67)</td>
<td>1,707 (33)</td>
</tr>
</tbody>
</table>

*Accepted alert: clinician canceled or modified order.
†Overridden alert: clinician chose to continue with prescription with an override reason that would not eliminate the drug contraindication.
‡Canceled order: clinician aborted the attempted prescription.
§Modified order: clinician indicated override reason that would eliminate the drug contraindication.
Recall that physicians will resist stopping.

Manage and maintain your knowledge base.

Ask for additional information only when you really need it.

### Most Frequent Override Reason by Clinician

<table>
<thead>
<tr>
<th>Contraindication</th>
<th>Override Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplicate class</td>
<td>Transitioning from one class to another (42)</td>
</tr>
<tr>
<td></td>
<td>Patient is on long-term therapeutic drug combination (21)</td>
</tr>
<tr>
<td>Drug-drug</td>
<td>Will monitor as recommended (16)</td>
</tr>
<tr>
<td></td>
<td>Patient has already tolerated drug combination (21)</td>
</tr>
<tr>
<td></td>
<td>Will adjust dose as recommended (14)</td>
</tr>
<tr>
<td>Drug-lab</td>
<td>Will monitor/manage as recommended (67)</td>
</tr>
<tr>
<td></td>
<td>More recent lab result available that warrants use (18)</td>
</tr>
<tr>
<td>Drug-disease</td>
<td>Patient has tolerated this drug in the past (56)</td>
</tr>
<tr>
<td></td>
<td>New evidence supports therapy of this type (22)</td>
</tr>
<tr>
<td>Drug-pregnancy</td>
<td>Patient is not pregnant (90)</td>
</tr>
<tr>
<td></td>
<td>Patient is not of child-bearing potential (5)</td>
</tr>
</tbody>
</table>
Assessment of Improvements to IT-Based Medication Reconciliation

Jeffrey L. Schnipper, MD, MPH, Claus Hamann, MD, MS, Catherine L. Liang, MPH, Marcy G. Carty, MD, MPH, Andrew S. Karson, MD, MPH, Ishir Bhan, MD, Christopher M. Coley, MD, Eric Poon, MD, MPH, Alexander Turchin, MD, MS, Stephanie A. Labonville, Pharm D, BCPS, Ellen K. Diedrichsen, Pharm D, Catherine Yoon, Carol A. Broverman, PhD, and Tejal K. Gandhi, MD, MPH
Background: Problems with Medication Reconciliation Version 1

- Problems identified with “PAML Builder” CDS
  - Lack of integration with admission order entry
  - Redundant data entry (still had to write orders)
  - Little incentive to complete PAML
    - Adherence with the tool only fair
    - Lack of audit trail within PAML
      - Pharmacists uncomfortable with making changes

Monitor impact, get feedback, and respond
Fit within users’ workflow
Intervention: Changes in Version 2

• Tight integration with admission order entry
  – PAML medications to be continued with or without changes create an admission order set
  – Information pre-populated when possible

• Enforcement of compliance
  – 24 hours after admission, primary team cannot write orders in CPOE if PAML not built
  – Exclusion for emergency orders, consultant orders
  – Weekly report to track and notify likely violators

• Audit trail for all changes to the PAML
  – Who, when, what clinical role
### Pre-Admission Medication List (PAML)

**Last signed by:** SCHNIPPER, JEFFREY LAWRENCE, M.D., M.P.H. on: 03/24/2010 at: 09:41

**Show hidden PAML columns >>**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Medication Taken at</th>
<th>Medication Details</th>
<th>Planned action on admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaminophen (Tylenol) 650 MG PO Q4H</td>
<td>Home</td>
<td></td>
<td>Discontinue</td>
</tr>
<tr>
<td>Amiodipine 5 MG PO QD</td>
<td>Home</td>
<td>Hold</td>
<td></td>
</tr>
<tr>
<td>Atenolol 50 MG PO QD</td>
<td>Home</td>
<td>Hold</td>
<td></td>
</tr>
<tr>
<td>Bupropion HCl Sustained Release (12 Hr Tab) (Wellbutrin Sr) 150 MG PO BID pm…</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buspirone HCl 15 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cephalexin (Keftox) 250 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clonazepam (Klonopin) 0.5 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clonazepam (Klonopin) 1 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clonazepam (Klonopin) 1 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clonazepam (Klonopin) 0.2 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clonazepam (Klonopin) 0.2 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clonazepam (Klonopin) 0.1 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clopidogrel (Plavix) 75 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diazepam 10 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diazepam 2.5 MG PO QD</td>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duloxetine (Cymbalta) 20 MG PO BID</td>
<td>Home</td>
<td></td>
<td>Cont as written</td>
</tr>
</tbody>
</table>

### Meds from Electronic Sources

**Last signed by:** SCHNIPPER, JEFFREY LAWRENCE, M.D., M.P.H. on: 03/24/2010 at: 09:41

<table>
<thead>
<tr>
<th>Source</th>
<th>Medication (by Generic or Class)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMR</td>
<td>Duloxetine (Cymbalta) 60 MG PO BID</td>
<td>02/04/10</td>
</tr>
<tr>
<td>LMR</td>
<td>Interferon-Beta-1a Sc (Rebif Sc) 22 MG SC THREE TIMES A WEEK</td>
<td>02/04/10</td>
</tr>
<tr>
<td>LMR</td>
<td>Fluoxetine HCl (Prozac) 10 MG PO QD</td>
<td>01/25/10</td>
</tr>
<tr>
<td>LMR</td>
<td>Acetaminophen (Tylenol) 650 MG PO Q4H</td>
<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Amiodipine 5 MG PO QD</td>
<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Atenolol 25 MG PO QD</td>
<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Atenolol 50 MG PO QD</td>
<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Azathioprine (Imuran) 25 MG PO QD</td>
<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Bupropion HCl Sustained Release (12 Hr Tab) (Wellbutrin Sr) 150 MG PO BID pm…</td>
<td>02/06/09</td>
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<tr>
<td>LMR</td>
<td>Buspirone HCl 15 MG PO QD</td>
<td>02/06/09</td>
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<td>LMR</td>
<td>Cephalexin (Keftox) 250 MG PO QD</td>
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</tr>
<tr>
<td>LMR</td>
<td>Clonazepam (Klonopin) 0.5 MG PO QD</td>
<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Clonazepam (Klonopin) 1 MG PO QD</td>
<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Clonazepam (Klonopin) 0.2 MG PO QD</td>
<td>02/06/09</td>
</tr>
<tr>
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<tr>
<td>LMR</td>
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<td>02/06/09</td>
</tr>
<tr>
<td>LMR</td>
<td>Diazepam 2.5 MG PO QD</td>
<td>02/06/09</td>
</tr>
</tbody>
</table>

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**OETEST.WILHELMINA**

11489929 (BWH) 05/01/1930 (79yrs) F

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**Help**

- Add med
- Modify
- Remove
- Add Comments
- Feedback to IS
- Error

**Print**

- Sign
- Print
- Copy

**View Notes**
PAML to Orders

Orders for this Session

{New session}

New Order Options

A Allergies/Sens  I IV fluids  T D/C-ATO/Diagnosis/Weight
B Blood products L Laboratory V VS/Monitoring/Restraint
C Consults M Medications Z Chemotherapy
D Dietary O Oxygen/Resp therapy P Percipio
G General care R Radiology/EKG/EEG X PAML to Orders
H TPN S Sets/Templates

Sign  Edit/review  Kill session

Type Alt-S to sign. Use Alt-E to edit or review this session. Make sure <Ok> is marked to enter orders from menu.
Admission Order Set from PAML

<table>
<thead>
<tr>
<th>ViewOrders</th>
<th>PtLookup</th>
<th>Feedback</th>
<th>Help</th>
<th>Goodbye</th>
</tr>
</thead>
<tbody>
<tr>
<td>OETEST, WILHELMINA 79F 16356792</td>
<td></td>
<td>Adm: 11/01/91</td>
<td>Room: 17A-501</td>
<td></td>
</tr>
</tbody>
</table>

**PAML Medication Template**

A [X] cont as written  DULOXETINE 20 MG PO BID
Verifying Admission Order from PAML

Anticipate needs and deliver in real time

Speed is everything

Dose: 20 MG
Frequency: BID
Start Time: TODAY
Duration: TODAY Doses
PRN: No
Hold if: No
Instructions:

ALLERGIES/SENSITIVITIES: NSAIDs, Aspirin, IV Contrast, Sulfa, Codeine, Egg

Type the letter of the field you wish to change.

Original PAML entry: DULOXETINE 20 MG PO BID
Planned action on admission: CONTINUE AS WRITTEN
Results: Compliance

• Marked increase in compliance
  – PAMLS built within 24 hours increased from 46% to 89% (p < 0.001)
## Results: Potential ADEs

<table>
<thead>
<tr>
<th>Outcome</th>
<th>PADES, No. (per Patient) Version 1 (N=162)</th>
<th>PADES, No. (per Patient) Version 2 (N=283)</th>
<th>Unadjusted RR (95% CI)</th>
<th>Adjusted and Clustered RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All PADEs</td>
<td>170 (1.05)</td>
<td>91 (0.32)</td>
<td>0.31 (0.24,0.40)</td>
<td>0.55 (0.35, 0.88)</td>
</tr>
<tr>
<td>PADEs by type of error</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History errors</td>
<td>125 (0.77)</td>
<td>55 (0.19)</td>
<td>0.25 (0.18,0.35)</td>
<td>0.49 (0.30,0.81)</td>
</tr>
<tr>
<td>Reconciliation errors</td>
<td>52 (0.32)</td>
<td>36 (0.13)</td>
<td>0.40 (0.26,0.61)</td>
<td>0.56 (0.28,1.12)</td>
</tr>
<tr>
<td>PADEs by time of occurrence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PADEs at admission</td>
<td>44 (0.27)</td>
<td>20 (0.07)</td>
<td>0.26 (0.15,0.44)</td>
<td>0.59 (0.28,1.22)</td>
</tr>
<tr>
<td>PADEs at discharge</td>
<td>126 (0.78)</td>
<td>71 (0.25)</td>
<td>0.32 (0.24,0.43)</td>
<td>0.52 (0.31,0.87)</td>
</tr>
</tbody>
</table>
Conclusions

• Improvements in medication reconciliation tool associated with marked improvements in medication safety

• Possible mechanisms
  – Integration with workflow at admission
  – Enforcement of compliance
  – Changes in role of pharmacist
  – Greater acceptance of process over time

Little things can make a big difference
Conclusions

- Remember the 10 Commandments of effective CDS
- 11th Commandment?: Avoid decision support if the data to support it are unreliable and can’t be made more reliable
- 12th Commandment?: choose your decision support battles wisely

Questions?
Comments?
Thanks!


Case 2: CDS Research in the Outpatient Setting

Devin M. Mann, MD, MS
Assistant Professor
Section of Preventive Medicine & Epidemiology
Boston University
Goals

• To describe how CDS can be used to integrate EBM into primary care practice
• To describe the steps of building and implementing a CDS tool in primary care
• To understand how usability testing is critical to successful CDS implementation
What is the problem

• Failure to systematically implement EBM
• CDS has great potential to do this BUT:
  • Limited use
    – Poor integration into EHR
    – Inadequate training of users
    – Dependency on provider recall
    – Repeated workflow disruption
• Most CDS tools fail because they are underutilized
  • Need to demonstrate effectiveness before can implement widely (and devote resources to it)

"Refereed paper"

Documentation-based clinical decision support to improve antibiotic prescribing for acute respiratory infections in primary care: a cluster randomised controlled trial

"Bending the Curve Towards Transformed Health"

Achieving Meaningful Use of Health Data

2009 2011 2013 2015

Advanced clinical processes
Data capture and sharing

Improved outcomes

made 21,961 ARI visits to study clinics. Intervention clinicians used the ARI Smart Form in 6% of 11,954 ARI visits. The antibiotic prescribing rate in the intervention clinics was 2.8% lower than in the control clinics (95% CI 0.7–4.9) (p = 0.01)."
Keys to successful CDS

• Seamless workflow
  – Fully EHR integrated
  – Usability

• Perceived as value adding by providers
  – Tailored not generic support
  – Worth the extra work (or even better saves time)
  – Outcome is consistent with provider values

• Simple
  – Training can help make it simple
Bringing CDS research to the clinic

- Decide on what EBM you want to deliver with CDS
- **Assemble** the Team/stakeholders
  - Division chief
  - CMIO
  - Medical director
  - Research team
- Design specifications
- Usability
- Implementation
- Monitoring & Evaluation
Clinical Prediction Rules

• Underutilized EBM tools
  • Ideal CDS candidates
    • Simple
    • Valid & valued
    • Tailored to the patient
    • Point-of-care e.g. “in the moment”

Table 1: Wells’ criteria for assigning pretest probability for pulmonary embolism

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical symptoms or signs of DVT</td>
<td>3</td>
</tr>
<tr>
<td>PE more likely than other diagnosis</td>
<td>3</td>
</tr>
<tr>
<td>Heart rate &gt;100 bpm</td>
<td>1.5</td>
</tr>
<tr>
<td>Immobilization or surgery within last 4 wk</td>
<td>1.5</td>
</tr>
<tr>
<td>History of DVT or PE</td>
<td>1.5</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>1</td>
</tr>
<tr>
<td>Malignancy</td>
<td>1</td>
</tr>
</tbody>
</table>

Clinical probability of PE Points

- Low: 0-2
- Moderate: 2-3
- High: www.medicalgeek.com
Clinical prediction rules

- Walsh clinical prediction rule for Streptococcus pharyngitis
  - Recent cough (-1)
  - Strep exposure (+1)
  - Tonsilar exudates (+1)
  - Enlarged, tender cervical nodes (+1)
  - Fever > 100.8F (+1)

- Heckerling clinical prediction rule for Pneumonia
  - Fever > 100.8F (+1)
  - Tachycardia (+1)
  - Rales (+1)
  - Decreased breath sounds (+1)
  - No asthma (+1)
Building a Clinical Decision Support

Prototype → Phase I Usability Testing → Redesign/Fixes → Phase II Usability Testing → Redesign/Fixes → Randomized Control Trial
Usability

• What is it?
  – Observing users interacting with a new technology
    • Best if live or near live environment
    • Think aloud protocols

• Why is it important?
  – Key to successful implementation
    • Identifies barriers and solutions before implementation
    • Helps integrate providers' perceptions

• Why isn’t it done more?
  – Slows implementation in the short term
  – Lack of resources (human and financial)
  – Overconfidence in what the users need
Usability Testing

• Scripted walkthroughs
  – Think aloud
  – Thematic protocol analysis

• Clinical simulations
  – Timeline analysis

• Code transcripts & annotate with screencapture
What usability looks like
# Usability Results

**Table 1: Strep Throat (Strep) and Pneumonia (PNA) Scenarios using Epic's iCPR Tool**

| Id | Description | KK | KS | BE | FF | HT | MF | RM | DS | Total | Positivity | Comment | Visibility | Navigation | Workflow | SmartSet |
|----|-------------|----|----|----|----|----|----|----|----|-----|--------|------------|---------|------------|------------|----------|----------|
| 16 | Clear       | N  | N  | N  | N  | N  | N  | N  | N  | N   | 7:10:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 17 | Amount of clicking | N  | N  | N  | N  | N  | N  | N  | N  | N   | 8:10:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 18 | Amount of Reading | N  | N  | N  | N  | N  | N  | N  | N  | N   | 8:10:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 19 | Expected Automatic Association | N  | N  | N  | N  | N  | N  | N  | N  | N   | 8:16:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 20 | Need to do things quickly | N  | N  | N  | N  | N  | N  | N  | N  | N   | 8:20:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 21 | Rapid Strep Test Results SmartSet Appears out of no where | N  | N  | N  | N  | N  | N  | N  | N  | N   | 13:06:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 22 | Streamlines Practice | N  | N  | N  | N  | N  | N  | N  | N  | N   | 15:00:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 23 | Streamlines Practice | N  | N  | N  | N  | N  | N  | N  | N  | N   | 19:00:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 24 | ICD-9 and Patient Information | N  | N  | N  | N  | N  | N  | N  | N  | N   | 21:30:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 25 | Embedding of Note Saves Time | N  | N  | N  | N  | N  | N  | N  | N  | N   | 21:00:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 26 | What the codes stand for | N  | N  | N  | N  | N  | N  | N  | N  | N   | 21:01:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 27 | Workflow of Diagnosis Displayed | N  | N  | N  | N  | N  | N  | N  | N  | N   | 21:01:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 28 | Can Edit Using.it | N  | N  | N  | N  | N  | N  | N  | N  | N   | 23:41:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 29 | Complete Progress Note Option | N  | N  | N  | N  | N  | N  | N  | N  | N   | 23:41:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 30 | Progress note import | N  | N  | N  | N  | N  | N  | N  | N  | N   | 26:41:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 31 | Billing, mandatory or suggested codes within SmartSet | N  | N  | N  | N  | N  | N  | N  | N  | N   | 27:20:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 32 | Easy to Use | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y   | 27:20:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 33 | Sometimes useful | N  | N  | N  | N  | N  | N  | N  | N  | N   | 5:00:00  | Positive   | KK       | KK        | KK        | KK       | KK       |
| 34 | Makes Sense | N  | N  | N  | N  | N  | N  | N  | N  | N   | 5:00:00  | Positive   | KK       | KK        | KK        | KK       | KK       |
| 35 | Lots of clicking | N  | N  | N  | N  | N  | N  | N  | N  | N   | 15:04:00 | Positive   | KK       | KK        | KK        | KK       | KK       |
| 36 | Line Encourages Ordering | N  | N  | N  | N  | N  | N  | N  | N  | N   | 19:27:00 | Negative   | KK       | KK        | KK        | KK       | KK       |
| 37 | Automatically Order X-Ray | N  | N  | N  | N  | N  | N  | N  | N  | N   | 18:27:00 | Negative   | KK       | KK        | KK        | KK       | KK       |

**Table 2: Aggregate Response System Positivity**

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<th>Positivity</th>
<th>Total</th>
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</thead>
<tbody>
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**Positive Subtotal**

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<td>4</td>
</tr>
</tbody>
</table>
Usability Results

- Usability: 33
- Navigation: 26
- Content: 25
- Usefulness: 9
- Understandability: 9
- Visibility: 27

Code frequency:

- Alerting: 100
- Risk Calculator: 50
- Progress Note: 30
- Patient Instructions: 20
- Bundled order set: 10
- Global: 50
## Usability Results

### Domains

<table>
<thead>
<tr>
<th>Domain</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability</td>
<td>“It’s becoming a lot of clicking and reading and you want to do this thing quickly, especially if you have a lot of patients waiting”</td>
</tr>
<tr>
<td>Visibility</td>
<td>“I just see that BPA (alert) here, normally I probably wouldn’t see it since I don’t usually look here, but if it had been more prominent I might have seen it, if it had popped up.”</td>
</tr>
<tr>
<td>Workflow</td>
<td>“I think it depends on when you start using the tool, because if you use it right from the beginning ... you could get distracted and forget to go through other questions maybe ... I just think these (order) sets should come when YOU ask for them, not from the walk-in diagnosis”</td>
</tr>
<tr>
<td>Content</td>
<td>“I think the soup issue might be an issue with my patients, we see patients over 50 with hypertension and we wouldn’t really tell them to take chicken soup because it is full of sodium.”</td>
</tr>
<tr>
<td>Understandability</td>
<td>“supportive care is weird (phrasing) because it is saying pneumonia, and the patient does not have it.”</td>
</tr>
<tr>
<td>Usefulness</td>
<td>“I don’t like this one (order set) as much ... I realize this is all about evidence based medicine ... (but) I just think there is more in a clinical picture and this thing is pushing you in a direction without taking into account (full clinical picture).”</td>
</tr>
<tr>
<td>Navigation</td>
<td>“a prompt of some sort, would be good. I would need a prompt, I don’t know where to go next”</td>
</tr>
</tbody>
</table>

### Actions

- Minimize/remove “hard stops” and active triggers
- Add OTC medication as e-prescriptions
- Simplify patient instructions
- Reduce and simplify headings and instructions for alerts
- Retrain medical assistant to perform “real time” strep testing result entry
- Add atypical workflow cases to training
- Eliminate chest x-ray as default option
- Adjust default antibiotics
What usability taught us

• Designers are not providers
  – Confusion
  – Lack of intuitiveness

• You can not anticipate every scenario

• Providers have different styles
  – Need to see a spectrum
  – Compromises will be required

• EHR systems have constraints
  – Workflow integration vs flexibility
Intervention Flow

Point-of-care

Input Guided Activation → Clinical Prediction Rule Calculator

Low risk

Low risk bundled ordering

Intermediate risk

Intermediate ordering set

High risk

High risk bundled ordering
Clinical Prediction Rule Smartset: STREP (Score 3-4)

From BestPractice: Clinical Prediction Rule: Strep prediction tool score is between 3 and 4 indicating the patient is at a high risk of having Strep. Click ACCEPT to open Smartset for high risk strep supportive care orders and documentation.

- **Differential Diagnoses**
  - Streptococcal sore throat

- **Medications**
  - **Antibiotics for Strep Pharyngitis**
    - penicillin v potassium 250 mg Oral Tab (Drug-Allergy (Active and Inactive Ingredients) Level 3 PENCILLINS)
      - 1 tablet, EVERY 6 HOURS, Starting 2/22/11 for 10 days, Disp: 30 tablet, R-0
    - azithromycin 250 mg Oral Tab
      - 5 tablet = 500 mg, Oral, DAILY starting 2/22/11, Disp: 8 tablet, R-0
    - Amoxicillin 575 mg Oral Tab
      - 1 tablet, Oral, 2 TIMES DAILY, Starting 2/22/11 for 10 days, Disp: 20 tablet, R-0
    - Cephalaxin 500 mg Oral Tab
      - 500 mg, Oral, 2 TIMES DAILY, Starting 2/22/11 for 10 days

- **Supportive Therapies for symptomatic relief**
  - **Supportive Therapies**
    - STREP Supportive Care - Rest/Relaxation, etc
    - STREP Supportive Therapy: Use Tylenol, Lozenges, etc
    - acetaminophen 650 mg Oral Tb3R
      - 650 mg, Oral, Disp: 60 tablet, R-0
    - Benzoic acid-Menthol (LOZENGES) 6-10 mg MW Loz
      - 1 lozenge, Oral, Disp: 10 lozenge, R-0
    - ibuprofen 400 mg Oral Tab
      - 1 tablet = 400 mg, Oral, 4 TIMES DAILY starting 2/22/11, Disp: 55 tablet, R-0

- **Progress Note Documentation (select one)**
  - **Progress Notes**
    - CPR Score Only
    - Complete Progress Note

- **Patient Information/Instructions**
  - **Patient Instructions**
    - Patient Instructions - English
    - Patient Instructions - Spanish
Training

• Training the provider will help avoid frustration, resistance and workarounds
  – Groups preferred
  – Walk through typical cases
    • Don’t rely on email blasts with instructions
    • Don’t rely on “figuring it out”
  – Show atypical cases (picked up in usability)
  – Do not train too far in advance
  – Video refreshers?
Implementation

- Will need to work with your IT/CDS members and their protocols (varied)
- When you “go live” make everyone aware
  - Stealth is not helpful
  - You can’t anticipate all affected groups so be liberal in your awareness campaign
  - Have troubleshooters on hand
Monitoring

• Active surveillance of issues
  – “Ears on the ground”
  – Instant feedback capability
  – Process evaluation reports
    • What parts are getting used
  – Focus groups
  – Live usability

• Address issues before frustration builds
If you build it right, they will come

<table>
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<tr>
<th></th>
<th>Strep</th>
<th>PNA</th>
<th>Total</th>
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<tbody>
<tr>
<td>Tool Activated During Encounter</td>
<td>128</td>
<td>94</td>
<td>222</td>
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<tr>
<td>Provider Accepts Calculator</td>
<td>103 (81%)</td>
<td>59 (63%)</td>
<td>162 (73%)</td>
</tr>
<tr>
<td>Provider Accepts Bundled Orders</td>
<td>86 (84%)</td>
<td>48 (82%)</td>
<td>134 (83%)</td>
</tr>
</tbody>
</table>
Lessons Learned

- Clinical prediction rules can be integrated into primary care with CDS
  - Choose an EBM tool that providers value
  - Assemble the right team
  - Build CDS around workflow – not vice versa
- Usability testing and training are important drivers of acceptance by providers
- To be determined – does use lead to outcomes?
Measuring the Impact of Clinical Decision Supports
CDS Impact

• Most common
  – Uncontrolled before-after study at single site
• Evidence pyramid

Shojania et al. Health Affairs. 2005
CDS Impact

• Alternatives to Pre-Post Studies
  – Randomized Controlled Trials
  – Practical designs
    • Time-series design
      – Multiple time points before and after intervention
    • Controlled before-after design
      – Multiple units or sites, some with intervention and some without

Shojania et al. Health Affairs. 2005
Time-Series Design

Monthly GP total X-ray referrals in Grampian, Scotland

Possible Intervention Effects
Hypothetical Changes in Level and Slope of a Time-Series

Analysis of an intervention effect using segmented linear regression

Assumption:
Extrapolating the pre-intervention level and trend reflects the (counterfactual) outcome that would have occurred had the intervention not happened.

Adapted from Schneeweiss et al, Health Policy 2001
## Controlled Before-After Design

<table>
<thead>
<tr>
<th>Hospital Ward</th>
<th>Infection rate BEFORE</th>
<th>Infection rate AFTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>50%</td>
<td>25%</td>
</tr>
<tr>
<td>Control 1</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Control 2</td>
<td>50%</td>
<td>25%</td>
</tr>
</tbody>
</table>
Measurement Take Home Points

• To improve the certainty of the impact of your intervention, consider:
  1. pre-intervention (baseline) measurements
  2. multiple time points before and after the intervention
  3. control groups
Wrap Up
Workshop Take Home Points

• CDS can improve practice of EBM
• Successful development and implementation of CDS requires:
  – Multidisciplinary team approach
  – Development phase with usability according to “commandments”
  – Longitudinal monitoring, evaluation and feedback
• Practical study designs can be used to measure CDS impact
Questions?
Communication Network:

dmann@bu.edu
Session Evaluation
General References

• National CDS Roadmap
  – http://www.jamia.org/cgi/content/abstract/14/2/141

• CDS Implementation Guide for Providers
  – (www.himss.org/cdsguide)

• Recent Systematic Reviews on CDS
Inpatient References


