the clinical decision support consortium: overview

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www.partners.org/cird/cdsc

AMIA CDS-WG
July 18, 2012
Overview

• Motivation
• Knowledge engineering to accelerating the translation of knowledge into practice
• The Clinical Decision Support Consortium experience
• Challenges and barriers to overcome
US Motivation for CDS

- Providers have incomplete knowledge of their patients
  - Patient data unavailable in 81% of cases in one clinic,
    - average of 4 missing items per case.
  - 18% of medical errors are due to inadequate availability of patient information.

- Medicare beneficiaries see 1.3 – 13.8 unique providers annually, on average 6.4 different providers/yr

- Delayed translation of new knowledge to clinical practice
  - From bench to bedside, on average it takes > 17 years for new medical knowledge to be routinely applied in clinical practice

- Clinical Information Needs of Practitioners are unmet
  - Physicians in US urban and rural practices have on average more than 1 unanswered question per patient on optimal therapy diagnosis, or procedure
**The Quality of Health Care Delivered to Adults in the United States**

Elizabeth A. McGlynn, Ph.D., Steven M. Asch, M.D., M.P.H., John Adams, Ph.D., Joan Keesey, B.A., Jennifer Hicks, M.P.H., Ph.D., Alison DeCristofaro, M.P.H., and Eve A. Kerr, M.D., M.P.H.

<table>
<thead>
<tr>
<th>ADA Guideline</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test for microalbuminuria in all type 2 diabetic patients at least annually and during pregnancy.</td>
<td>23.62%</td>
</tr>
<tr>
<td>Dilated and comprehensive <strong>eye exam</strong> at diagnosis of Type 2 and annually.</td>
<td>14.21%</td>
</tr>
</tbody>
</table>

On average, Patients receive 54.9% of recommended care

Clinical Information Exceeding Human Cognitive Capacity

Figure 1 Schematic contrasting human cognitive capacity (e.g., the number of sets of facts the brain can correlate in a decision) with the explosion of new biomedical data types. SNP indicates single nucleotide polymorphism. The authors adapted this figure with permission from Stead.5
Reforming health care
This is going to hurt
STRATEGIC GOALS

- Achieve Adoption and Information Exchange through Meaningful Use of Health IT
- Improve Care, Improve Population Health, and Reduce Health Care Costs through the Use of Health IT
- Inspire Confidence and Trust in Health IT
- Empower Individuals with Health IT to Improve their Health and the Health Care System
- Achieve Rapid Learning and Technological Advancement

Beyond 2015: Transformed Health Care

Enhanced ability to study care delivery and payment systems
Empowered individuals and increased transparency
Improved care, efficiency, and population health outcomes
A perfect storm for CDS?

- Lots of clinical data going online
  - Increasing std, interop
- Lots of genetic data coming
- Lots of personal/social data coming
- Lots of geospatial data coming
- Inexorable rise of Healthcare costs…
- Healthcare Reform
Evidence for CDS

• CDS yields increased adherence to guideline-based care, enhanced surveillance and monitoring, and decreased medication errors. (Chaudhry et al., 2006)

• CDS, at the time of order entry in a computerized provider order entry system can help eliminate overuse, underuse, and misuse. (Bates et al., 2003; Austin et al., 1994; Linder, Bates and Lee, 2005; Tierney et al., 2003)

• For expensive radiologic tests and procedures this guidance at the point of ordering can guide physicians toward ordering the most appropriate and cost effective radiologic tests. (Bates et al., 2003; Khorasani et al., 2003)

• Showing the cumulative charge display for all tests ordered, reminding about redundant tests ordered, providing counter-detailing during order entry, and reminding about consequent or corollary orders may also impact resource utilization. (Bates and Gawande, 2003; Bates, 2004; McDonald et al., 2004)
Evidence for CDS (cont.)

- CITL analysis found that the most profound impact of ambulatory CPOE arises with sophisticated CDS.

- Advanced CPOE systems cost five times as much as basic CPOE, but were projected to generate 12 times greater financial return.

- CITL model projected annual savings of approximately $44 billion from reduced medication, radiology, laboratory, and ADE-related expenses.

- A reduction of more than 2 million adverse drug events (ADEs) annually with nationwide implementation of ambulatory CPOE.

Computer-Based Clinical Decision Support Evidence Shows…

- 55-83% decrease in hospital non-intercepted serious ADEs using CPOE
- 73% of outpatient drug interaction alerts led to change in prescriptions
- 22-78% increased adherence to preventive health reminders
- Fewer medical errors through computerized physician order entry and clinical decision support systems

Bates, JAMA 1998
Gandhi, JGIM 2001
22 Categories of Perceived Increased Medication Risk

- **Information Errors**
  - Assumed dose
  - Med d/c failure
  - Procedure-linked med error
  - Give now, and prn d/c error
  - Antibiotic renewal
  - Diluent option error
  - Allergy display
  - Conflict or duplicate med

- **HCI/Workflow Errors**
  - Patient selection
  - Med selection
  - Unclear log on/off
  - Meds after surgery
  - Post surgery suspended meds
  - Time/data loss when CPOE down
  - Med delivery error
  - Timing errors
  - Delayed nursing documentation
  - Rigid system design

*Koppel R et al. JAMA 293:10, Mar 2005*
**Types of Unintended consequences**

<table>
<thead>
<tr>
<th>Unintended consequence</th>
<th>Frequency (%)</th>
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</thead>
<tbody>
<tr>
<td>work for clinicians</td>
<td>19.8</td>
</tr>
<tr>
<td>unfavorable workflow issues</td>
<td>17.6</td>
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<tr>
<td>never ending system demands</td>
<td>14.8</td>
</tr>
<tr>
<td>problems related to paper persistence</td>
<td>10.8</td>
</tr>
<tr>
<td>untoward changes in communication patterns and practices</td>
<td>10.1</td>
</tr>
<tr>
<td>negative emotions</td>
<td>7.7</td>
</tr>
<tr>
<td>generation of new kinds of errors</td>
<td>7.1</td>
</tr>
<tr>
<td>unexpected changes in the power structure</td>
<td>6.8</td>
</tr>
<tr>
<td>overdependence on the technology</td>
<td>5.2</td>
</tr>
</tbody>
</table>

*Campbell EM, Sittig DS et al., JAMIA 2006*
Duke EPC Report on CDS: 7 Key factors for successful CDSS

- Three from Kawamoto 2005 review are confirmed as key:
  - Automatic provision of decision support as part of clinician workflow
  - Provision of decision support at time and location of decisionmaking
  - Provision of a recommendation, not just an assessment

- Meta-analysis identified four additional
  - Integration with charting or order entry system to support workflow integration
  - Promotion of action rather than inaction
  - No need for additional clinician data entry
  - Local user involvement in the development process

- Note: 15 (11.5%) of studies reviewed included all 7 factors
CITL HIT Value Assessments

- **Net US could save $150B with HIT adoption, or approximately 7.5% of US Healthcare Expenditure**
  - The Value of Ambulatory Computerized Order Entry (ACPOE)
    - $44B US nationally; $29K per provider, per year
  - The Value of HealthCare Information Exchange and Interoperability (HIEI)
    - $78B/yr
  - The Value of IT-enabled Chronic Diabetes Management (ITDM)
    - $8.3B Disease Registries; Advanced EHR $17B
  - The Value of Physician-Physician Tele-healthcare
    - $19B
  - The Value of Personal Health Records
    - $20B

[www.citl.org](http://www.citl.org)
How Does HIT Save Money?

- **EHR Effects**
  - Completeness, correctness, decision support, formulary, brand to generic, duplicate/redundant meds and tests, charge display
  - Workflow support, messaging (pt/provider), referral, A/R, team

- **CPOE Effects**
  - Reduction in hospitalization/LOS due to ADEs, clinical decision support

- **HIEI Effects**
  - Reduction in unnecessary and redundant tests and procedures
  - Labor cost savings

- **Telehealth Effects**
  - Reduction in patient transport, utilization of hospitals, and physician office visits

- **PHR Effects**
  - Administrative time savings
  - Reduction in hospitalizations and physician visit utilization
  - Improved medication safety
  - Reduction in redundant laboratory tests
Multiple Systems to Reduce Medication Error

CPOE

Bar-code

eMAR

Ordering errors, 39% of all serious medication errors
With CPOE, 55% reduction

Dispensing errors, 11% of all serious medication errors
With pharmacy bar-code scanning, 67% reduction

Administration errors, 38% of all serious medication errors
With bar-code eMAR, 51% reduction

Transcription errors, 12% of all serious medication errors
With eMAR, 100% reduction

Figure 1. Effect of Health Information Technology at Key Stages in the Process of Medication Use.

Data on errors during the four phases of medication use are from Leape et al. The percent reduction in ordering errors with the use of computerized physician-order entry (CPOE) is from Bates et al. The percent reduction in dispensing errors with bar-code scanning in the pharmacy is from our previous study. The percent reduction in medication-administration errors with the bar-code eMAR technology and the percent reduction in transcribing errors are from the current study.

Inpatient CPOE ROI at the Brigham

- 10 year assessment/estimates of BWH BICS CPOE
  - Costs: $11.6M
  - Savings: $28.5M Total
  - Cumulative net savings of $16.7M
  - Net Operating savings of $9.5M given 80% prospective payment rate
- Principal elements contributing to savings:
  - Renal dosing guidance
  - Nursing time utilization
  - Specific drug guidance
  - Adverse drug event prevention

The Value of Ambulatory CDS

• Savings potential: $44 billion
  • reduced medication, radiology, laboratory, and ADE-related expenses
• Advanced CDS systems
  • Savings potential only with advanced CDS
  • cost five times as much as basic CDS
  • generate 12 times greater financial return
• A potential reduction of more than 2 million adverse drug events (ADEs) annually

Johnston, D., Pan, E. & Walker, J. J Healthc Inf Management 18, 4–8

http://www.citl.org
National Cost Savings to Providers and Other Healthcare Stakeholders

Cost Savings Source

- ADE
- Laboratory
- Radiology
- Medication

In US Millions

- All other stakeholders
- Providers (11% capitation)
Barriers to CDS

Current adoption of advanced clinical decision support is limited due to a variety of reasons, including:

- Limited implementation of EMR, CPOE, PHR, etc.
- Difficulty developing clinical practice guidelines.
- Lack of standards.
- Absence of a central knowledge resource.
- Functional limitations of CDS in commercial EHRs.
- Challenges in integrating CDS into the clinical workflow.
- A limited understanding of organizational and cultural issues relating to clinical decision support.
Knowledge is Like a Cake-Stack

Enterprise or Standard App Rules

Enterprise or Standard App Templates, Flowsheets, Forms, Order Sets, etc

Enterprise Order Catalogues and Classes

Intermediate Concept Classes

Enterprise Problem Lists

Enterprise Terminologies Sys

If Braden Score < 11
da Low Air Loss Bed, etc
If Abn Vasc Exam à Vascular Consult

Collections of Concepts –
Braden Assessment à Full Nursing Assessment
Collections of Orders – Order Sets

Med Orders, Special Beds, Topicals
Consults - Neurology or Vascular

Dorsalis Pedis Pulse à Present or Absent
Posterior Tibial Pulse à Present or Absent
Color à Pink, Pale, or Rubor on Dependency
Ankle Brachial Index à range 0.7 à 1.0

Taxonomies of Problems such as
CAD, Diabetes, Peripheral Vascular DZ

Taxonomies of Terms such as
Skin Exam, Decub Ulcer, Pulse, Skin Turgor
Three Models to Accelerate Knowledge -> Practice

• Current paper-based approach

• Knowledge artifact import into EMR

• Cloud-based clinical decision support services
CDSC Goal and Significance

**Goal:** To assess, define, demonstrate, and evaluate best practices for knowledge management and clinical decision support in healthcare information technology at scale – across multiple ambulatory care settings and EHR technology platforms.

**Significance:** The CDS Consortium will carry out a variety of activities to improve knowledge about decision support, with the ultimate goal of supporting and enabling widespread sharing and adoption of clinical decision support.

1. Knowledge Management Life Cycle
2. Knowledge Specification
3. Knowledge Portal and Repository
4. CDS Public Services and Content
5. Evaluation Process for each CDS Assessment and Research Area
6. Dissemination Process for each Assessment and Research Area

AHRQ contract HHSA290200810010  http://www.partners.org/cird/cdsc/
Key Research Questions

• How do we **improve** the translation of knowledge in clinical practice guidelines into actionable CDS in healthcare information technology?

• How do we optimally **represent** knowledge and data required to make actionable CDS content in both human and machine readable form?

• How do we **collate, aggregate, and curate** knowledge content for CDS in a knowledge portal used by members of the CDS Consortium? How may we use such a tool to support knowledge management and collaborative knowledge engineering for clinical decision support at scale, across multiple healthcare delivery organizations, and multiple domains of medicine?

• How do we **demonstrate** broad adoption of evidence-based CDS at scale in a wide array of HIT products used in disparate ambulatory care delivery settings?

• Further, how do we **deploy** clinical decision support services in healthcare information technology in a manner that improves CDS impact?

• How do we take the learnings garnered through the course of these investigations and broadly **disseminate** them broadly to key stakeholders?
CDSC Conceptual Approach

CDSC Evidence-based Guidelines (e.g., DM, HTN, CAD) Level 1

Level 2 and Level 3 Specifications

Translation

Dissemination

KM Portal and Repository

Collaboration

Refinement

CDS Services

EMR

End user access

Provider Dashboard

Developer Dashboard

Performance Measures
Four-Layer Knowledge Model

Level 1
Unstructured
Format: .jpeg, .html, .doc, .xl
+ metadata

Level 2
Semi-structured
Format: xml
+ metadata

Level 3
Structured
Format: xml
+ metadata

Level 4
Machine Execution
Format: any
+ metadata

CDSC KM Portal
# Catalogue of Content to Date

Alerts • Value Sets • Order Sets • Document Templates • Infobuttons

<table>
<thead>
<tr>
<th>Contributor</th>
<th>Artifact Type</th>
<th>On Portal Today</th>
<th>Examples</th>
</tr>
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<tbody>
<tr>
<td>CDSC</td>
<td>L1 specs - Alerts</td>
<td>3</td>
<td>• PHS DIABETES MELLITUS L1</td>
</tr>
<tr>
<td>CDSC</td>
<td>L2 specs – Alerts</td>
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<td>• USPSTF HYPERTENSION L1</td>
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<td>• Annual BP Screening, Overdue</td>
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<td>ACDS</td>
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<td>• Diabetes Mellitus, Overdue Foot Exam</td>
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<td>ACDS</td>
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<td>• Smoking Status</td>
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<td>ACDS</td>
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<td>• Medication-Related Patient Education</td>
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<td>ACDS</td>
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<td>3</td>
<td>• Obesity Management</td>
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<td>ACDS</td>
<td>L3 specs – Relevant Data Display</td>
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<td>• Drug-Lab (which labs should be displayed when ordering a specific med)</td>
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<td>ACDS</td>
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<td>• ACDS-Recommendation-Response-Value-Set-L4-Hypertension.xlsx</td>
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<td>Totals</td>
<td></td>
<td>84</td>
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</table>
CDSC Cloud-Based CDS Services

- Partners HealthCare - Longitudinal Medical Record (LMR)
- Regenstrief Institute - CareWeb, G3
- NextGen customer – WVP Health Authority
- GE customer – University of Medicine and Dentistry of New Jersey (UMDNJ)
- Epicicare EMR in PECARN Network
CDS Demonstrations
Toward a National Knowledge Sharing Service

CDS Consortium
PECARN TBI CDS

WVP Health Authority (NextGen)
Salem, OR
Kaiser Roseville
UC Davis
Kaiser Sacramento
Kaiser San Rafael
Kaiser San Francisco
California

Wishard Hospital
Indianapolis, IN

CDS Demonstrations

NYP
NY

UMDNJ (GE)
Newark, NJ

PHS

Children’s Hospital
Colorado

Cincinnati Children’s
Nationwide Children’s
Ohio

PECARN TBI CDS
Examples
The following are examples of ECRS providing decision support within the ambulatory medical records of two members of the CDS Consortium.

Partners HealthCare EHR

Regenstrief Medical Record

- Patient 65yrs or older, due for Pneumovax
- Patient 50 years old or greater, recommend influenza vaccination
- Pt is overdue for colonoscopy (rec: g 10yrs). Famhbc indicates average risk for colorectal cancer
- Diabetic patient is overdue for HgbA1c measurement (recommended every 6 months)
- Diabetic patient with renal disease, consider starting angiotensin-converting enzyme inhibitor (ACE-I)
- Patient has CAD or equivalent, consider starting anti-platelet therapy, but potential contraindications exist
- Patient is overdue for blood pressure assessment (recommended yearly)
Epidemiology of CDS: CDS/Reminder Lifecycle

Patient becomes member of eligible population
Reminder logic becomes true
Reminder displayed
Reminder accepted
Right action documented
Clinical outcome

Measurement Period

T₀

T¹

“Prevalence”
Patients with Type2 DM

“Logic”
Overdue for A1C Test

“Display”
Reminder displayed to user

“Acknowledged”
User clicks on reminder and chooses coded response

“Performance”
A1C test result documented

“Outcome”
A1C <= 7.0
### CDS Dashboard - Provider View

**Reporting period:** 1/01/2010 to 2/28/2010

**BIMA**

**LINDER, JEFFREY A, M.D., M.P.H.**

This report provides information on clinical performance measures and feedback on your response to LMR reminders. The patient population measured for performance is your current patient panel as defined in Report Central (see the My Panel report). Reminder performance is calculated relative to patients where you have been displayed a reminder during the reporting period.

#### Current performance rate

Current performance rate is the performance on the clinical measure for the last measurement month.

#### Performance trend

Performance trend is a display of the performance value by month in a graph for the overall report time frame.

#### Reminder Historical Performance

Reminder Historical Performance shows the denominator (times displayed) as total patients over the report time period where reminders have been shown to you in LMR for this measure. If the patient was in compliance of the measure within 30 days of the reminder then they appear in the numerator (Times performed). The same patient may appear across multiple months in the total.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Measure</th>
<th>Current Patients</th>
<th>Number in Compliance</th>
<th>% Paid</th>
<th>% LHD</th>
<th>% Performance Trend</th>
<th>Reminder for 6/30/2010</th>
<th>Times Displayed</th>
<th>Times Performed</th>
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<tr>
<td>Diabetes</td>
<td>Diabetes with poor management, HbA1c completed in the past 3 months</td>
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<td>5</td>
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<td>2.3%</td>
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<td>15</td>
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<td>16</td>
<td>47.1%</td>
<td>44.1%</td>
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<td>Diabetes w/ Renal Failure</td>
<td>Diabetes, Microalbuminuria ratio &gt; 50 and on ACEI</td>
<td>14</td>
<td>12</td>
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<td>71.2%</td>
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<td>Diabetes w/ Renal Failure</td>
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<td>4</td>
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<td>0</td>
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<td>3.0%</td>
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**Generated by: LINDER, JEFFREY A, M.D., M.P.H. on 1/27/2010**

* Based on Report Central panel definition

** Based on evaluation during the last month as the reporting period

** Reporting period: 01/01/2010 to 02/28/2010

Page 1 of 2
Challenges and Barriers to Overcome

- Guideline development for Clinical Decision Support (CDS)
- Knowledge representation standards
- Knowledge management at scale (CMT, value sets, patient state classifiers building blocks)
- Patient data exchange (CCD/VMR)
- Workflow insertion points (EMR functionality)
- CDS performance measurement and feedback
- Usability and fine-tuning
Future Directions

• Continue PHS LMR and Regenstrief CareWeb Phase 3 pilots

• Implement knowledge sharing and CDS Services Demonstration with NextGen, GE, and OpenCDS

• Port collaborative knowledge engineering tools and rules engine to Open Source technologies

• Expand breadth of coverage of CDS content, and knowledge artifacts type (Infobuttons, order sets, data display, documentation templates)

• Develop sustainability model
CSDC Long-Term Vision

• Provide free access to our knowledge management (KM) portal that contains artifacts (rules and guidelines) for various CDS activities.

• Provide a unique collaboration platform allowing all participants to collaborate together on clinical knowledge development.

• Seek to set the new standard through example: we will make our content, which is of the highest standard and quality, accessible to all, regardless of physical location, organizational affiliation, and resource availability.
CSDC Long-Term Vision (cont.)

- Lead significant HIT efforts in a new direction: open-source.
- Aim to solve tough health and health care problems while reducing cost.
- Knowledge sharing approach aims to decrease the ever prevalent healthcare disparity, making it accessible by all, physicians and patients included.
- Continue to roll-out the CDSC web-based CDS services in more vendor systems with more clinical content.
The Nationwide Health Information Network

Mobilizing Health Information Nationwide

And knowledge!

The Internet

Standards, Specifications and Agreements for Secure Connections
Acknowledgements

**Principal Investigator:** Blackford Middleton, MD, MPH, MSc

**CDSC Team Leads:**
- **Research Management Team:** Lana Tsurikova, MSc, MA
- **KMLA/Recommendations Teams:** Dean F. Sittig, PhD
- **Knowledge Translation and Specification Team:** Aziz Boxwala, MBBS, PhD
- **KM Portal Team:** Tonya Hongsermeier, MD, MBA
- **CDS Services Team:** Howard Goldberg, MD
- **CDS Demonstrations Team:** Adam Wright, PhD
- **CDS Dashboards Team:** Jonathan Einbinder, MD
- **CDS Evaluation Team:** David Bates, MD, MSc
- **Content Governance Committee:** Saverio Maviglia, MD, MSc
“I conclude that though the individual physician is not perfectible, the system of care is, and that the computer will play a major part in the perfection of future care systems.”

Clem McDonald, MD NEJM 1976

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