From Guidelines to Clinical Decision Support: a Unified Approach to Translating and Implementing Knowledge

AMIA 2012 Fall Symposium, Chicago, IL

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- Doug Rosendale, DO, FACOS, FACS
  Senior Physician Advisor, Clinical Informatics, Office of Health Information, Veterans Health Administration

- Richard Shiffman, MD, MCIS
  Associate Director, Yale Center for Medical Informatics
Introductions and Lineup

• Doug Rosendale, DO, FACOS, FACS (Moderator)
  – Senior Physician Advisor, Clinical Informatics, Office of Health Information, Veterans Health Administration, Washington, D.C.

• Richard Shiffman, MD, MCIS
  – Professor and Associate Director, Yale Center for Medical Informatics
  – P.I., GLIDES

• Kensaku Kawamoto, MD, PhD
  – Director, Knowledge Management & Mobilization, Univ. of Utah
  – P.I., OpenCDS

• Blackford Middleton, MD, MPH, MSc
  – Director, Clinical Informatics R&D, Partners HealthCare
  – P.I., CDS Consortium

• Jacob Reider, MD
  – Acting Chief Medical Officer, Office of the National Coordinator (ONC)
  – HHS/ONC perspective
Setting the Stage:
WHY Clinical Decision Support (CDS)?

- Knowledge is Power – how do we harness information and knowledge to improve care?
- Health Complexity and Information Overload
- Various Potential Modalities
  - Alerts and reminders, Infobuttons, documentation templates, order sets, etc.
- Computational Science
- Learning Cycle of Knowledge Improvement
- Challenges
  - Including lack of unified model for CDS
Achieving Health IT Adoption and Effective Use: Approaches to Knowledge Sharing from the CDS Consortium

Blackford Middleton,
MD, MPH, MSc, FACP, FACMI, FHIMSS
Partners Healthcare System – Harvard Medical School
AMIA Fall Symposium, Nov. 4-7, 2012
Chicago, IL
Inference Methods Used in Expert Systems

- Algorithmic
- Statistical
- Pattern Matching
- Rule-based (Heuristic)
- Fuzzy sets
- Neural nets
- Bayesian
- TBD...
Knowledge Translation and Specification

Evidence

Guideline(s) → K Repres’n → Shareable K → Executable

Experience

Decision Tables → GEM

Arden

ONCOCIN → EON(T-Helper) → GLIF2 → GLIF3

GEODE-CM

MBTA

Asbru

Oxford System of Medicine

DILEMMA

PRODIGY

PRODIGY3

PROforma

PRESTIGE

1980 1990 2000

A perfect storm for Clinical Decision Support?

- Lots of clinical data going online
- Lots of genetic data coming
- Lots of personal/social data coming
- Lots of geospatial data coming
- More data exchange and interoperability
- Inexorable rise of Healthcare costs…
- Healthcare Reform
CDS Consortium: 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.
Knowledge is Like a Cake-Stack

Enterprise or Standard App Rules

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

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

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

Enterprise Order Catalogues and Classes

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

Intermediate Concept Classes

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

Enterprise Problem Lists

Taxonomies of Terms such as Skin Exam, Decub Ulcer, Pulse, Skin Turgor

Enterprise Terminologies Svs

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

Enterprise Meds (Dictionaries, Classes, Contraindications, Indications, Adverse Effects, Allergies)
Building Blocks For Rule Modularity and Reusability

Assessment Rules

Screening Rules

Management Rules

Indication State Rules

Goal State Rules

Contraindication State Rules

Disease State Rules

Observation State rules

Problem Class State Rules

Drug Class State Rules

Order Class State Rules

Classes of Observations LOINC or SNOMED

SNOMED Problem Subsets

NDF-RT Drug Classes

Other Order Classes

Observation Dictionaries LOINC or SNOMED

Problem List Dictionaries SNOMED

Drug Dictionaries RX Norm

Order Catalogues
Three Models to Accelerate Knowledge -> Practice

- Current paper-based approach

- Knowledge artifact import into EMR
  - Computer Interpretable Guideline

- Cloud-based clinical decision support services
Knowledge Translation and Specification: Four-Layer Model

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

Level 2
Semi-structured
Format: xml
+ metadata

Level 3
Structured
Format: xml
+ metadata

Level 4
Machine Execution
Format: any
+ metadata

derived from

derived from

derived from

Initial evaluation results: Structured recommendation (L3) was considered more implementable than the semi-structured recommendation (L2).

CDSC Knowledge Authoring Tool

Facilitates import GEM marked up Guideline, too
A Unified Theory for CDS

Clinical Knowledge

Structured Knowledge

Encoded and Machine-Interpretable Knowledge

Decision Support Service

EHR
An external repository of clinical content with web-based viewer

Search Criteria

Content Type...

Specialty

http://cdsportal.partners.org
CDS Consortium KM Portal Access

<table>
<thead>
<tr>
<th>Document</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes-Mellitus-SNOMED-Classification-Subset-L4</td>
<td>1</td>
</tr>
<tr>
<td>G6PD-deficiency-SNOMED-Classification-Subset-L4</td>
<td>1</td>
</tr>
<tr>
<td>Nephrotic-Syndrome-SNOMED-Classification-Subset-L4</td>
<td>3</td>
</tr>
<tr>
<td>Ischemic-Heart-Disease-SNOMED-Classification-Subset-L4</td>
<td>4</td>
</tr>
<tr>
<td>CDSC-Diabetes-L4</td>
<td>4</td>
</tr>
<tr>
<td>End-Stage-Renal-Disease-SNOMED-Classification-Subset-L4</td>
<td>5</td>
</tr>
<tr>
<td>ACDS-Response-Value-Set-L4-Diabetes-Not-on-Problem-List</td>
<td>6</td>
</tr>
<tr>
<td>ACDS-Response-Value-Set-L4</td>
<td>6</td>
</tr>
</tbody>
</table>
CDSC Services in Partners LMR
### Inbox

<table>
<thead>
<tr>
<th>Date Delivered</th>
<th>Patient</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-Dec-2010 15:03</td>
<td></td>
<td>Patient is overdue for blood pressure assessment (recommended yearly).</td>
</tr>
<tr>
<td>28-Dec-2010 15:03</td>
<td></td>
<td>Diabetic patient is overdue for HgbA1c measurement (recommended every 6 months).</td>
</tr>
<tr>
<td>28-Dec-2010 15:03</td>
<td></td>
<td>Diabetic patient is due for foot exam (recommended yearly).</td>
</tr>
<tr>
<td>28-Dec-2010 15:03</td>
<td></td>
<td>Diabetic patient is due for ophthalmologic exam (recommended yearly).</td>
</tr>
</tbody>
</table>

**Message:**

Diabetic patient is due for foot exam (recommended yearly).
Document the foot exam.
Refer to Podiatrist
Recommend giving to the patient the handout 'Diabetic Foot'

**DISCLAIMER:**

This decision support reminder may be inaccurate or based on incomplete data. The clinician should always use proper judgement while taking care of the patient, and should disregard this reminder if it seems clinically inappropriate. This decision support reminder is provided by the Clinical Decision Support Consortium as a component of a research study. It is based on the recommendations of the United States Preventive Services Task Force. For any questions please contact Lina Simo-natis (email: lsimonatis@regenstrief.org) (phone: 317-423-5535) or Brian Dixon (email: bdixon@regenstrief.org) (phone: 317-423-5532)
Screenshot of CDSC Reminders, now moved to the “Prevention/Recommendations” section.
Recommendation(s)

Patient ID: a4ac1968-73cd-4de4-97e9-73baf52126d
Organization ID: NextMD
Generated on: August 23, 2012 20:04

Recommendation 1

- Diabetic patient is due for urine microalbumin/creatinine ratio measurement (recommended yearly).
- Recommend giving to the patient the handout 'Diabetic Kidney Problems'

Recommendation 2

- Diabetic patient is due for foot exam (recommended yearly).
- Recommend giving to the patient the handout 'Diabetic Foot'

Recommendation 3

- Diabetic patient is due for ophthalmologic exam (recommended yearly).
- Recommend giving to the patient the handout 'Diabetic Eye Problems'

Recommendation 4

- Diabetic patient is overdue for HgbA1c measurement (recommended every 6 months).

Legal disclaimer: This text needs to be replaced with the appropriate text based on the signed legal agreement requirements.
# SHARP-C “SMArt” Container

The SHARP-C “SMArt” Container is an application designed to manage patient immunization records. The following is a screenshot of the Immunization Record SMART Application interface:

## Immunization Record SMART Application

### Immunizations Tab

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Due</th>
<th>Doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTAVIRUS</td>
<td>5/1/12</td>
<td>5/24/07</td>
</tr>
<tr>
<td>DTAP</td>
<td>3/1/12</td>
<td>9/27/07</td>
</tr>
<tr>
<td>HepB</td>
<td>1/2/12 - 2/1/12</td>
<td>9/27/07</td>
</tr>
<tr>
<td>POLIO</td>
<td>3/1/12</td>
<td>1/27/11, 5/27/11</td>
</tr>
<tr>
<td>HPV</td>
<td>1/1/23 - 1/1/24</td>
<td></td>
</tr>
<tr>
<td>MENING</td>
<td>1/1/23 - 1/1/24</td>
<td></td>
</tr>
<tr>
<td>HepA</td>
<td>1/1/13 - 7/1/13</td>
<td></td>
</tr>
<tr>
<td>ZOSTER</td>
<td>Not indicated - Patient not yet indicated for ZOSTER vaccine</td>
<td></td>
</tr>
<tr>
<td>VARICELLA</td>
<td>1/1/13 - 4/1/13</td>
<td></td>
</tr>
<tr>
<td>M1B</td>
<td>3/1/12</td>
<td></td>
</tr>
<tr>
<td>MMR</td>
<td>1/1/13 - 4/1/13</td>
<td></td>
</tr>
<tr>
<td>Pneumococcal PCV</td>
<td>3/1/12 - 4/1/12</td>
<td></td>
</tr>
<tr>
<td>FLU</td>
<td>Not Indicated - Current date is not within influenza season</td>
<td></td>
</tr>
</tbody>
</table>

### Referencing Tab

The application also includes a references tab which is not shown in the screenshot provided.
CDS Consortium Demonstrations
Toward a National Knowledge Sharing Service

Kaiser Roseville
UC Davis
Kaiser Sacramento
Kaiser San Rafael
Kaiser San Francisco
California

Mid-Valley IPA (NextGen)
Salem, Oregon

Wishard Hospital
Indianapolis, IN

Cincinnati Children’s
Nationwide Children’s
Ohio

Children’s Hospital
Colorado

CDS Consortium
PECARN TBI CDS

Kaiser

NYP
NY

UMDNJ (GE)
Newark, NJ

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CDSC within Unified Theory

- Clinical guidelines
- Local protocols
- Experience

CDSC “L2”
- GEM Import

CDSC “L3”
- Duodecim Import
- GRADES Import

CDSC “L4”
- CDS cloud service

Clinical Knowledge

Structured Knowledge

Enclosed and Machine-Interpretable Knowledge

Decision Support Service

CDS Performance Data

EHRs

HeD Use Case 1

HeD Use Case 2
The Nationwide Health Information Network

- Health Bank or PHR Support Organization
- Community Health Centers
- CDC
- VA
- DoD
- SSA
- CMS

Mobilizing Health Information Nationwide

And knowledge!

The Internet

Standards, Specifications and Agreements for Secure Connections
Acknowledgements

AHRQ: HHSA290200810010

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, 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
Where are we?

Thank you!
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www.partners.org/cird
Conclusions and Driving Questions

- Need for common approach to CDS
  - How do we unite around an agreed upon approach so we can focus on providing VALUE to patients?
- Critical role of HHS and ONC
  - What more can the government do?
- Need for academic-private-public collaboration
  - How can we foster more productive collaborations?
- Don’t let perfection be the enemy of the good
  - How can we make progress today?
- A perfect storm is coming…
  - How can we best align with ARRA, HITECH, ACOs, payment reform, etc. to advance CDS and patient care?