CTSI Module 8 Workshop
Biomedical Informatics, Data Standards & Practical Tools

Data Standards & Terminologies, Part IV

Coordinators: William Hsu, PhD & Corey Arnold, PhD
Medical Imaging Informatics Group
Dept of Radiological Sciences
UCLA School of Medicine
Module Objectives

**Objective:** Provide basic and clinical translational scientists with a working understanding of biomedical informatics principles and their applications in biomedical data collection, standardization, representation, and analysis.

<table>
<thead>
<tr>
<th>Intro to Biomedical Informatics</th>
<th>Data Standards &amp; Terminologies</th>
<th>Practical Tools in Informatics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familiarize participants with the basic principles of biomedical informatics demonstrated by ongoing projects and services across the CTSI sites.</td>
<td>Describe the use of data standards for representation and exchange of clinical information in the context of electronic health records and clinical decision support.</td>
<td>Provide a demonstration of CTSI-specific applications and resources that facilitate the management and analysis of clinical and experimental data.</td>
</tr>
</tbody>
</table>

- Introduce the foundational concepts of biomedical informatics and its subfields
- Understand the role of informatics in evidence-based medicine
- Distinguish the different types of health information
- Learn about UCLA CTSI efforts related to this area and whom to contact for expert consultation
- Describe the use of standards for data coding, knowledge representation and exchange of clinical information
- Discuss the importance of controlled terminologies as a specific class of standards
- Learn about health information system architecture
- Demonstrate data collection using REDCap
- Discuss software tools and resources for data collection, extraction and representation, and analysis
- Showcase resources available through the CTSI, member campuses, and the UC system
Lecture Outline

• 5/7 Part I: Informatics in healthcare and translational research (D. Bell, 1.5 hrs)
  – Introduce the fundamental concepts of biomedical informatics and its subfields
  – Learn about UCLA CTSI efforts related to this area and whom to contact for expert consultation

• 5/9 Part II: Community-based informatics research (O. Ogunyemi, 1.5 hrs)
  – Summarize the role of informatics in public health and addressing health disparity issues
  – Define disease registries, their implementation and applications, and considerations
  – Discuss development towards a national learning health care system

• 5/14 Part III: Electronic health record systems (R. Jenders, 1.5 hrs)
  – Introduce principles of health information system architecture and design
  – Describe the use of standards for data coding, knowledge representation and exchange of clinical information

• 5/16 Part IV: Clinical decision support (R. Jenders, 1.5 hrs)
  – Enumerate techniques for clinical decision support (e.g., alerts, infobuttons)
  – Present standards for clinical decision support

• 5/23 Part V: Practical tools in biomedical informatics (W. Hsu/C. Arnold, 3 hrs)
  – Demonstrate data collection using REDCap (Martin Lai, UCLA CTSI)
  – Services provided by the biostatistics core (David Elashoff, UCLA Biostatistics)
  – Discussion of advanced tools and services available (William Hsu/Corey Arnold, UCLA Medical Imaging Informatics)
Module Resources

• Recorded webcast & materials
  – http://www.ctsi.ucla.edu/education/training/webcastmodules

• CTSI virtual home
  – http://intranet.ctsi.ucla.edu/
  – Biomedical Informatics Program
    http://www.ctsi.ucla.edu/about/pages/bip2
Clinical Decision Support

Robert A. Jenders, MD, MS, FACP, FACMI
Co-Director, Center for Biomedical Informatics
Professor of Medicine, Charles Drew University

Professor, Department of Medicine
University of California, Los Angeles
Attending Physician, Harbor-UCLA Medical Center

CTSI Biomedical Informatics Module
16 May 2013
Theme: Using Standards to Improve Knowledge Sharing in CDS

- CDS technology exists but is not being used optimally
  - Need to improve knowledge sharing (transfer, reuse, service-mediated access): Reduce the cost, improve the reliability of knowledge engineering, increase the likelihood of CDS use

- **Approach: Standards**
  - Standards: Not enough; too many!
    - Fill in current gaps + convergence
    - Make it easier
      - Better knowledge transfer
      - Better knowledge access: Standard interfaces instead of standard KR
      - Provide guidance on how to use CDS
Learning Objectives

• List specific ongoing challenges that can prevent easy implementation of CDS.
• Describe the details of standards that are used to implement CDS.
• Explain the role of standards development organizations in facilitating CDS.
• Describe the implications to pharmacy of key national CDS efforts.
Need/Challenge for CDS: Changing Behavior

- **USA:** Only 54.9% of adults receive recommended care for typical conditions
  - community-acquired pneumonia: 39%
  - asthma: 53.5%
  - hypertension: 64.9%


- **Delay in adoption:** 10+ years for adoption of thrombolytic therapy

Challenge for CDS:
Explosion in Data + Knowledge

Drivers for CDS: Meaningful Use

- Monetary incentive program created by ARRA HITECH (2009): Payments by CMS for participation
- **Key ingredients:** Use information technology “meaningfully” (eRx), health data exchange, reporting quality measures
- **Phases**
  - Stage I (2011-2012): Hospitals report 20/24 quality measures
  - Stage II (2013) + Stage III (2015)
- **Other programs:** NCQA, NQF
A Rationale for Standardization: CDS

A Roadmap for National Action on Clinical Decision Support

June 13, 2006

Prepared by:
Jerome A. Osheroff, MD
Jonathan M. Teich, MD, PhD
Blackford F. Middleton, MD, MPH, MSc
Elaine B. Steen, MA
Adam Wright
Don E. Detmer, MD, MA

CDS National Roadmap: Three Pillars

• Enhanced health and health care through CDS
  – Best knowledge available when needed
  – High adoption & effective use
  – Continuous improvement of knowledge & CDS methods

Improving Outcomes with Clinical Decision Support: An Implementer’s Guide


- **Goal:** Provide practical advice to health care organizations
  - Choosing decision support goals
  - Choosing technology to advance those goals
  - Developing a deployment strategy

Standards Pertinent to CDS

- **HL7**
  - v2.x, v3 messaging
  - CDA: Structured documents
  - SPL: Structured product labels
  - CCOW: Desktop interoperability
  - EHR Functional Model & Specification

- **Others**
  - Terminology: SNOMED, LOINC, ICD, etc
  - KR: GEM, others
The goal of the Newborn Screening Coding and Terminology Guide is to promote and facilitate the use of electronic health data standards in recording and transmitting newborn screening test results. The Web site includes standard codes and terminology for newborn tests and the conditions for which they screen, and links to other related sites. The codes and vocabulary standards are provided in a series of tables that you can view on the Web and/or download for your own use. These tables cover conditions recommended for screening by the Secretary's Advisory Committee on Heritable Disorders in Newborns and Children (SACHDNC) or by a state within the U.S.

Use of these standards can speed the delivery of newborn screening reports, facilitate the care and follow-up of infants with positive test results, enable the use (and comparison) of data from different laboratories, and support the development of strategies for improving the newborn screening process.

This Web site also includes draft guidance for creating an HL7 version 2.x message using these codes with examples. If you would like us to notify you about updates to this guidance and other new content, please subscribe to the RSS feed for Updates, or join the NBS-Announcements e-mail list from the U.S. National Library of Medicine.

You can reach these various resources by picking a choice below.

**Views**: Generate customized Web views from the tables of conditions and analytes/measurements maintained by the U.S. National Library of Medicine (NLMP®).

- **Conditions** — Conditions that are targeted by newborn screening
- **Analytes/Measurements** — Tests that are used as markers for newborn screening conditions
- **Tailored Views** — Specify subsets, or see relationships between conditions and analytes/measurements

**Downloads**: Download the tables of newborn screening conditions, of markers for these conditions and/or of mappings between conditions and their markers.

**Resources**: Find additional information about newborn screening and related codes and data standards, including the Newborn Screening Draft Detailed Use Case that was developed by the Office of the National Coordinator for Health Information Technology (ONC).

**Code and Terminology Standards**: View terms of use and other information about codes and terminologies listed and referenced on this Web site,
CDEs

- **Challenge:** Burgeoning electronic means for capturing data, but those data are not necessarily standardized
  - Example: REDCap
- **Goal:** Create standard libraries of instrument items and coded answer lists
  - Example: PROMIS (now coded in LOINC)
- **Multiple efforts underway**
  - NIH: ORDR, NINDS, NCI
- **Challenge:** Decentralized efforts not coordinated

# My Family Health History

**Create A New Family History**

Select "Create My History" to create your personal profile, enter your health information, and tell us how many people are in your immediate family. You can add other family members and enter their health histories later.

<table>
<thead>
<tr>
<th>Name</th>
<th>Relationship to Me</th>
<th>Add History</th>
<th>Update History</th>
<th>Remove Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>My Family</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self</td>
<td></td>
<td></td>
<td>![Update History Button]</td>
<td></td>
</tr>
</tbody>
</table>
Welcome to the NLM Personal Health Record (PHR)

With the NLM PHR you can

- Organize and keep track of your health information, including medical conditions, medications, vaccines, and test results
- Organize and keep track of your dependent's information (e.g. children, elderly parents)
- Receive personalized health reminders about screening tests, vaccines, and other important issues
- Print medical summaries to share with your physicians or other family members

If you are having a medical emergency, you should dial 911, go to the nearest emergency room, or call your doctor.
### Urinalysis Panel

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Previous</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UA dipstick Panel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appearance of Urine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color of Urine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose in Urine by Test strip</td>
<td></td>
<td></td>
<td>mg/dL</td>
<td>neg</td>
</tr>
<tr>
<td>Bilirubin in Urine by Test strip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketones in Urine by Test strip</td>
<td></td>
<td></td>
<td>mg/dL</td>
<td>0-999</td>
</tr>
<tr>
<td>Specific gravity of Urine by Test strip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH of Urine by Test strip</td>
<td></td>
<td></td>
<td>mg/dL</td>
<td>(REF=NEG)</td>
</tr>
<tr>
<td>Protein in Urine by Test strip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrite in Urine by Test strip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin in Urine by Test strip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leukocyte esterase in Urine by Test strip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Urinalysis microscopic panel in Urine sediment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Casts panel in Urine sediment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Crystals panel in Urine sediment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Microorganisms panel in Urine sediment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cells panel in Urine sediment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other elements in Urine sediment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Medical Conditions

<table>
<thead>
<tr>
<th>Medical condition</th>
<th>Status</th>
<th>Started</th>
<th>Stopped</th>
<th>Description/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>Active</td>
<td>1982 May 01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cholesterol - high</td>
<td>Active</td>
<td>2011 Jan 26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common duct stone</td>
<td>Inactive</td>
<td>2011 Jan 03</td>
<td>2011 Jan 26</td>
<td>Mild intermittent</td>
</tr>
</tbody>
</table>

### Drugs

<table>
<thead>
<tr>
<th>Status</th>
<th>Drug</th>
<th>Instructions</th>
<th>Started</th>
<th>Stopped</th>
<th>Why stopped</th>
<th>Resupply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>BACTRIM (Oral-pill) -- 800-160 mg Tabs</td>
<td>1 tab po bid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>XOPENEX (Inhalant) -- 0.045 mg/puff MDI</td>
<td>2 puffs qid prn wheezing</td>
<td>2000 Oct 05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Questions to Ask Your Doctor

<table>
<thead>
<tr>
<th>Category</th>
<th>Status</th>
<th>Question</th>
<th>Date entered</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medications</td>
<td>Not Asked</td>
<td>Can my inhaler give me palpitations?</td>
<td>2011 Jan 26</td>
<td></td>
</tr>
</tbody>
</table>
Further Data Aggregation: HIEs, Registries

• **Information Exchanges**
  – Locate and move data among partners
  – Clinical data: HIEs (e.g., Indiana)
  – Research data: PBRNs, other (RTRN)
  – Ultimate realization: NHIN
    • Promising mechanism for implementation: Direct Project

• **Registries**: Pool exchanged data
  – Cancer and immunization = most common
  – Ultimately connect via HIEs

SDO Process:
Health Level Seven International

- North America with 20+ international affiliates
  - JIC: Coordinate with other SDOs
- Subdivided into technical committees that work on standards
- Mostly volunteer workers
- Heavily consensus-based, multilayer voting approval process
- Certification of adherence to process by external authority that charters SDO (e.g., ANSI)
- Effect: Achieved through implementation/use
HL7 CDS Standards

- **Current (or DSTU)**
  - Arden Syntax
  - GELLO
  - HQMF
  - Infobutton
  - DSS
  - Virtual Medical Record (vMR)
  - Order Set

- **Proposed**
  - Clinical Decision Support Knowledge Artifact Implementation Guide
State of the Practice: Putting CDS Standards Together to Deliver Decision Support

- **Knowledge Transfer**
  - Procedural/Executable: Arden Syntax, GELLO
  - Declarative: HQMF, Order Set

- **Knowledge Access**
  - Infobutton, Decision Support Services, Clinical Decision Support Knowledge Artifact Implementation Guide

- **Infrastructure**
  - vMR
Arden Syntax for Medical Logic Modules

- Modular knowledge bases which are independent from one-another
- Share medical knowledge, not just reuse
- Procedural representation of medical knowledge
- Discrete units of knowledge = Medical Logic Module (MLM)
- Explicit definitions for data elements
- HL7 / ANSI / ISO Standard
- Current version: 2.9 (published 2012)

Arden Syntax

• ASTM v1 1992, HL7 v2 1999, v2.1 (ANSI) 2002 … v2.9 2013

• Formalism for procedural medical knowledge

• Unit of representation = Medical Logic Module (MLM)
  – Enough logic + data to make a single decision
  – Generate alerts/reminders

• Adopted by several major vendors

Arden Syntax: Evolving with User Demand

• Moving away from relatively simple, clinician-friendly expressions to more powerful computability
• v2.7: Complex objects
• v2.8 (2011): Switch statement, complex list operators
• v2.9 (2012): Fuzzy logic; complete XML representation format
• Active implementations
  – Fuzzy logic in infection control (U Vienna)
  – VA: Prototype implementation of health maintenance reminders via remote KB with GELLO to access data via “curly braces”
Expression Languages: GELLO

- **Purpose**: OMG OCL-based formalism to share queries and logical expressions
  - Query data (READ)
  - Logically manipulate data (IF-THEN, etc)
- **Initial rationale**: Stepping stone to a RIM-compliant guideline formalism
- **Status**: R1 2005, R2 2010. Tools created, multiple projects undertaken. Integrated with vMR

Healthcare Quality Measure Format (HQMF)

• Increasing mandates for clinical performance measurement

• Implementation of quality indicators (QIs) can be costly
  – Need to translate published QI to computable form
  – Need to collect digital data in structured format

• Solution: HQMF (2009) -> R2 (2012 now being balloted)

• Active use: eMeasures for CLABSIs (CDC); retooling quality measures into HQMF (AHRQ); implementation guide (current HL7 ballot)
HQMF

Measure Development

eMeasure Specification

Providers

Quality report

Quality report

Quality report

feedback

Quality Organizations
Order Set Standard

• An **order set** is a functional grouping of orders in support of a protocol that is derived from evidence based best practice guidelines.
  – Document with possibly executable and conditional parts

• **Challenge:** All hospitals have them, but sharing and importation are difficult

• **Solution:** Standardized format (published 2012) that are interoperable: Shareable and importable in CPOE
Health eDecisions

- Part of ONC Standards & Interoperability Framework, launched 6/2012
- Two key use cases
  - CDS Guidance Service (send patient data, receive advice)
  - Sharing knowledge artifacts (order sets, event-condition-action rules, document templates)
- Focus: Incorporate CDS standards into Meaningful Use regulation
- Current effort: Implementation guide showing how to use/integrate shareable artifacts; gap analysis with current standards
Infobutton: The Problem

• >1 question out of every 2 patients seen
• >50% left unanswered
• Online resources able to answer up to 90% of questions
• Barriers limit use of resources
• Integration with EHR may lower barriers

Aricept (Donepezil HCl)

- **Adult Dose**
  - Adverse Effects
  - Contraindications
  - Drug Interaction
  - Pregnancy Category
  - Precautions
  - How Supplied

**More topics...**

**Choose a resource:**
- Micromedex
- UpToDate
- MDConsult
- Medline Plus

---

**DrugPoint® Summary**

**Donepezil Hydrochloride** *(see details in DRUGDEX®)*

**Dosing & Indications**

- Adult Dosing *(see details in DRUGDEX®)*

- Alzheimer's disease - Dementia (Mild to Moderate): tablets/solution, 5 or 10 mg ORALLY once daily at bedtime, with or without food
- Alzheimer's disease - Dementia (Mild to Moderate): orally disintegrating tablets, 5 or 10 mg dissolve ORALLY on the tongue once daily
- Alzheimer's disease - Dementia (Severe): tablets, 10 mg ORALLY once daily at bedtime, with or without food
- Alzheimer's disease - Dementia (Severe): orally disintegrating tablets, 10 mg dissolve ORALLY on the tongue once daily
Impact of Infobuttons

- Answers to over 85% of questions
- High positive impact in over 62% of infobutton sessions
  - Decision enhancement or learning
- Median session time: 35 seconds
- Usage uptake in medications and lab results

Cimino JJ. AMIA Ann Fall Symp. 2008.
Why did we need a standard?

Azithromycin
Female
75 years old
Medication order entry
Chronic kidney disease
User: MD
Setting: ED
Dose

Electronic Health Record

http://resource1.com/
search = “azithromycin AND dose


http://resource3.com/
searchConcept = 3333 ^ azithromycin
filter = 11 ^ dosage

No Context

Infobutton Manager

Resource 1

Resource 2

Resource 3

CDU
## Context Dimensions

<table>
<thead>
<tr>
<th><strong>Patient</strong></th>
<th><strong>User</strong></th>
</tr>
</thead>
</table>
| - Concept of interest  
- Gender / age  
- Vital signs / renal function  
- Problems / medications | - Patient vs. provider  
- Discipline / specialty |

<table>
<thead>
<tr>
<th><strong>EHR Task</strong></th>
<th><strong>Organization</strong></th>
</tr>
</thead>
</table>
| - E.g., order entry, problem list entry, lab results review | - Care setting  
- Service delivery location  
- Location of interest |
Standards-Based Approach

- Aggregate Knowledge Response
- Knowledge Response (Atom)
- Knowledge Request (URL)

EHR

Infobutton Manager

Resource 1

Resource 2

Resource 3
For neonates requiring systemic treatment, prompt joint management with a pediatrician and ophthalmologist is recommended by the American Academy of Ophthalmology.

1. Commence pathogen-directed therapy according to results of diagnostic tests (see table below).

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlamydial infection</td>
<td>- Erythromycin oral</td>
</tr>
<tr>
<td>Gram-positive organisms</td>
<td>- Erythromycin topical</td>
</tr>
<tr>
<td>Gram-negative organisms (other than suspected gonococcus)⁹</td>
<td>Use either:</td>
</tr>
<tr>
<td></td>
<td>- Gentamicin topical</td>
</tr>
<tr>
<td></td>
<td>- Tobramycin topical</td>
</tr>
<tr>
<td>Gonococcal neonatal conjunctivitis</td>
<td>- Ceftriaxone IV/IM</td>
</tr>
<tr>
<td>Gonococcal disseminated infection</td>
<td>- Ceftriaxone IV/IM</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>- Cefotaxime IV/IM</td>
</tr>
<tr>
<td>HSV conjunctivitis, blepharoconjunctivitis, or superficial keratoconjunctivitis</td>
<td>- Acyclovir IV</td>
</tr>
</tbody>
</table>

*The use of concomitant topical antivirals is controversial.
- The American Academy of Pediatrics recommends use of IV acetaminophen.
- Considered unnecessary by other experts (because IV acetaminophen levels in tears)
Interviews with HL7 Infobutton Implementers

**Strengths:**
- Simplicity
- Built over widely adopted standards

**Challenges:**
- Access to documentation & quick start guidance
- Competing priorities

**Benefits:**
- Adds business value
- Simple mechanism to support decision-making

**Adoption:**
- Knowledge publishers: High
- EHR vendors: Slow
- Meaningful Use to expedite

Meaningful Use Stage 2

• Required CDS capability
  – MAY use Infobutton Standard for provider reference information
  – MUST use Infobutton Standard for patient education

• Significant interest increase among EHR vendors
Decision Support Service (DSS): Overview

• **Function:**
  – Evaluates patient data *(inputs)* and returns machine-interpretable conclusions *(outputs)*

• **Normative HL7/ANSI standard**
DSS: Architectural Overview

Decision Support Service

Knowledge Modules

Client Decision Support Apps

Queries for required pt data

Patient Data Sources

Institution A

Patient data (e.g., care summary), modules to use

Conclusions about patient

Institution B

Client Decision Support Apps

Queries for required pt data

Patient Data Sources
DSS – Primary Service Operations

1. Evaluate Patient
   Modules to use, required data
   Patient-specific evaluation results

2. Find Knowledge Modules
   Search criteria
   Modules meeting criteria

3. Get Data Requirements
   Module of interest
   Data requirements

4. Get Evaluation Result Semantics
   Modules of interest
   Output specification
HL7 DSS – Tools and Use

• Tools
  – OpenCDS: open-source reference implementation

• Known users of DSS standard (partial list)
  – Alabama Department of Public Health
  – CDS Consortium/Partners HealthCare
  – eClinicalWorks
  – HLN Consulting, LLC
  – HP Advanced Federal Healthcare Innovation Lab
  – New York City Department of Health & Mental Hygiene
  – University of Utah Health Care
  – VHA Knowledge Based Systems Office
Virtual Medical Record (vMR)

• **Goal:** Provide common information model upon which interoperable clinical decision support resources (e.g., rules) can be developed

• **Linked to the overall HL7 Reference Information Model (RIM)**
Project History

• Analysis of data required by 20 CDS systems from 4 countries (Kawamoto et al., AMIA 2010)

• Refinement of vMR via implementation within OpenCDS

• Release 1 adopted in Sept. 2011 as HL7 standard

• Release 2 being prepared for ballot
vMR Problem Model

**DeniedProblem**

**Problem**
- ageAtOnset : PQ [0..1]
- importance : CD [0..1]
- problemStatus : CD [0..1]
- severity : CD [0..1]
- wasCauseOfDeath : BL [0..1]

**ProblemBase**
- affectedBodySite : BodySite [0..*]
- diagnosticEventTime : IVL_TS [0..1]
- problemCode : CD
- problemEffectiveTime : IVL_TS [0..1]

**ClinicalStatement**
- dataSourceType : CD [0..1]
- id : II
- templateId : II [0..*]

**BodySite**
- bodySiteCode : CD
- laterality : CD [0..1]

+ relatedClinicalStatement 0..*
HL7 vMR – Tools and Use

• **Tools**
  – OpenCDS: open-source reference implementation

• **Known users of vMR standard (partial list)**
  – Alabama Department of Public Health
  – eClinicalWorks
  – HLN Consulting, LLC
  – HP Advanced Federal Healthcare Innovation Lab
  – Intermountain Healthcare Homer Warner Center
  – Medical-Objects
  – New York City Department of Health & Mental Hygiene
  – University of Utah Health Care
  – VHA Knowledge Based Systems Office
OpenCDS

• Provides a reference implementation of the HL7 DSS and vMR standards

• 1.1 release freely available under Apache 2 open-source license

http://www.opencds.org
Featured Collaborators
OpenCDS Knowledge Authoring - Rules

WHEN
1. Initialize - Note that all criteria below must be met for the rule to fire.
2. Pt.Age.Low - Patient age is greater than or equal to 42 years
3. Pt.Age.High - Patient age is less than or equal to 69 years
4. Pt.Gender - Patient gender is Female
5. Pt.Enc.Past.Count - Patient has had a Outpatient encounter 1 or more times in the past 2 year(s)
6. not(
7. Pt.Proc.Past - Patient has had a Bilateral mastectomy
8. or
9. Pt.Proc.Past.Lat - Patient has had a Mastectomy with a laterality of Bilateral
10. or
11. Pt.Proc.Past.Count - Patient has had a Unilateral mastectomy 2 or more times in the past 200 year(s)
12. )

THEN
1. Assert that NQF 0031 denominator criteria met

(show options...)
### OpenCDS Knowledge Authoring – Decision Tables

<table>
<thead>
<tr>
<th>#</th>
<th>Desc</th>
<th>Vaccine</th>
<th>Gender</th>
<th>Dose #</th>
<th>Min Age</th>
<th>Units1</th>
<th>Max Age</th>
<th>Units2</th>
<th>Index Dose #</th>
<th>Min Interval</th>
<th>Units3</th>
<th>Rec Interval</th>
<th>Units4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>HPV</td>
<td>Female</td>
<td>1</td>
<td>9</td>
<td>Yr</td>
<td>26</td>
<td>Yr</td>
<td>1</td>
<td>24</td>
<td>Day</td>
<td>61</td>
<td>Day</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>80</td>
<td></td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>164</td>
<td></td>
<td>182</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td></td>
<td>Male</td>
<td>1</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>24</td>
<td>Day</td>
<td>61</td>
<td>Day</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>24</td>
<td>Day</td>
<td>61</td>
<td>Day</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>80</td>
<td></td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>164</td>
<td></td>
<td>182</td>
<td></td>
</tr>
</tbody>
</table>
Summary

• Explosion in (structured) data plus regulatory & economic environment driving CDS

• Standards = essential for disseminating knowledge using CDS, but universal agreement lacking

• Two key approaches
  – Knowledge transfer
  – Knowledge access

• Pharmacists play a key & increasing role
Thanks!

jenders@ucla.edu
jenders@cdrewu.edu
http://jenders.bol.ucla.edu