Welcome to Workshop on Standards II

Standards in Clinical Decision Support: Activities in Health Level Seven And Beyond
Background

- **Workshop**: A seminar, discussion group, or the like, which emphasizes exchange of ideas and the demonstration and application of techniques, skills, etc.

*Random House Dictionary of the English Language*

*College Edition*

*New York: Random House, 1969*
Discussants

• **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

  *Co-Chair, HL7 Clinical Decision Support Work Group*
  *Co-Chair, Arden Syntax Work Group*
  *Discussant, Knowledge Transfer: Arden Syntax + others*
Discussants

- **Guilherme Del Fiol, MD, PhD**
  Assistant Professor, Department of Biomedical Informatics
  University of Utah

  *Co-Chair, HL7 Clinical Decision Support Work Group*

  *Discussant, Knowledge Access: Infobutton, DSS, vMR and others*
“Outline”

HL7 HIMSS CCHIT Arden RIM HSSP SOA
DSS SNOMED ICD9 HCPCS NIC NOC NDC
RxNorm SQL GEM ProFORMA ASTM CCR
CDA CCD EDIFACT LOINC CPT NANDA
BIRADS DICOM ICPC UMLS CEN HITSP
HISB ANSI ISO CTS AHIC ONC CHI
NCVHS HIPAA NDF-RT HUGN CDISC ASC
ICPC NCPDP IHE
Overview of Workshop

- **Part 1**: Overview of HL7 CDS (Jenders)

- **Part 2**: Current and proposed standards
  - Arden Syntax (Jenders)
  - GELLO (Jenders)
  - HQMF (Jenders)
  - Order Set project (Jenders)
  - Infobutton (Del Fiol)
  - DSS (Del Fiol)
  - vMR (Del Fiol)

- **Part 3**: Your input
SDO Process: HL7

• North America with 20+ international affiliates
• Subdivided into technical committees that work on standards
  – Conference calls + thrice annual meetings
• Mostly volunteer workers (400 attendees/meeting)
• Heavily consensus-based, multilayer voting approval process
• Certification of adherence to process by external authority that charters SDO (e.g., ANSI)
HL7 Structure: Clinical Decision Support

- **Clinical Decision Support Work Group** (Jenders, Del Fiol, Kawamoto, Strasberg)
  - Contribute to RIM, inform CDS aspects of other HL7 work, develop overall decision support model (Jenders, Del Fiol, Kawamoto, Strasberg)

  *Arden Syntax – particular standard for knowledge sharing*
HL7 Contacts

- **http://www.hl7.org**
  - Co-chair names/contact information
  - Mission statements
  - Meeting minutes
- **http://wiki.hl7.org**
  - Mission statements
  - Meeting minutes
JIC

- Joint Initiative Council on Global Health Informatics Standardization: Coordinate health informatics standards internationally

- 6 SDOs: CDISC, CEN, GS1, HL7, IHTSDO, ISO TC215

- = Forum for exchanging plans for standards to avoid redundant or overlapping work
**What is CDS?**

- **CDS** = “Providing clinicians or patients with clinical knowledge and patient-related information, intelligently filtered or presented at appropriate times, to enhance patient care”

- **CDS Intervention** of clinical information (knowledge and/or data) to an individual, at a specific time and place, to address a clinical objective, to enhance patient care.

  Osheroff JA, Pifer EA, Teich JM, Sittig DF, Jenders RA. Improving Outcomes with CDS Intervention.” (Delivering one or specific pieces of clinical information)
Standards Pertinent to CDS

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

- **Structure**: Knowledge representation
  - Enable sharing

- **Messaging**: Format, terminology

- _______ : Knowledge representation
Addressing the CDS Standards Challenge: HL7

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

- **Knowledge Access**
  - Infobutton, Decision Support Services

- **Knowledge Transfer Infrastructure**
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
MLM Format

• Three categories and a terminator

• Categories
  – maintenance:
  – library:
  – knowledge:
  – resources:

• Terminator
  – end:
MLM Example

title: Admission Screen for Acute Coronary Artery Disease;
filename: ACUTE_CAD_1;
version: 1.09;
institution: Columbia-Presbyterian Medical Center;
author: Robert Jenders, MD, MS (jenders@cucis.cis.columbia.edu);
date: 1996-01-24;
validation: research;

library:
knowledge:

type: data-driven;;

data:

admission := event {'32511','32467'; '32511','32472'};
inpatient_case := read last {'evoking','dam'="GYDAPMP","constraints'=" I***";
"HCASE";'K'}; /* note blank as first constraint char */

email_dest := destination {'email',
'name'="rra2@columbia.edu"};

diagnosis_text := read {'evoking','dam'="GYDAPMP"; "HDIAGNOS"; "HDIAGTXT"};
target_diagnoses := ("MI","R/O MI","MYOCARDIAL INFARCTION",
"CARDIOGENIC SHOCK","CHEST PAIN","CP","ANGINA",
"CHEST PAIN NOS","INTERMED CORONARY SYND","UNSTABLE ANGINA"
evoke: admission;;

logic:
    if inpatient_case is null then
        conclude false;
    endif;
    if any (diagnosis_text are in target_diagnoses) then
        conclude true;
    else
        conclude false;
    endif;

action:
    write "ACUTE CAD ADMISSION NOTICE" ||
    "\n\nPatient Name: " || patient_name ||
System Vendors

• Allscripts
• McKesson
• Siemens
• Medexeter
Arden Syntax: Recent Changes

• **v2.7**
  – Allow assignment to nested object attributes + specific list (array) elements
  – Enhanced object initialization: Pre-population of object attributes

• **v2.8**
  – Allow assignment to nested object attributes +
  – Enhanced object initialization: Pre-population of object attributes
Arden Syntax: Status (continued)

• **Arden v2.9 (finalized 2012)**
  - Reducing implementation of Fuzzy Arden to standard specification

• **Arden Syntax IG: 3/2014**
  - Specific examples

• **Arden v2.10: 7/2014**
GELLO = Common Expression Language

• Executable language for expressing logical rules and queries in clinical decision support applications

• Provides a standard interface to medical record systems and other data/knowledge sources
  • Executable language for expressing logical rules and queries in clinical decision support applications
    • Based on OMG OCL

• Provides a standard interface to medical record
GELLO = Common Expression Language

- **Purpose:** Share queries and logical expressions
  - Query data (READ)
  - Logically manipulate data (IF-THEN, etc)

- **Initial rationale:** Stepping stone to a RIM-compliant guideline formalism for queries and logical expressions
  - Query data (READ)

- **Initial version:** ANSI data (IF-THEN, etc) = May, 2005
  : Stepping stone to a RIM-compliant guideline formalism

- **Initial version:** Report DSG-TR-2002-001.
GELLO: Examples

- **Queries**
  - Observation.select(coded_concept='03245')
  - Observation.selectSorted(coded_concept="C0428279")

- **Expressions**
  - The variables calcium and phosphate are not null
    - calcium.notEmpty() and phosphate.notEmpty()
  - The patient has renal failure and the product of calcium and phosphate are not null
    - calcium.notEmpty() and phosphate.notEmpty()
GELLO: Status

- **2005**: R1
- **2009**: R2
- **2011**
- **2005**: Periodic demonstration projects
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 DSTU (2009) -> R2 (balloted 2012) -> QDM (US Realm) performance measurement
Quality Indicators: Sample ACOVE QIs

• **IF a vulnerable elder has had a myocardial infarction, THEN he or she should be offered a beta blocker unless there is a contraindication**

• **IF a vulnerable elder has had a myocardial infarction, THEN he or she should be offered a beta blocker unless there is a contraindication**

• **IF an ambulatory vulnerable elder has an osteoporotic fracture diagnosed, THEN physical therapy or an exercise program should be offered within 3 months**
Order Set DSTU

- **Order Set DSTU**: Format for a functional grouping of orders in support of a protocol that is derived from evidence based best practice guidelines.
  - Key aspects: Purpose, conditional logic, fully specified vs optional items, compositionality

- **Status**: Published as HL7 DSTU 2012
Order Sets: Layers

- **I – Publish, Distribute and Track:** Metadata for authoring, maintenance and dissemination by professional standards organizations

- **II - Import:** Full text order set content permits localization and use within vendor EHR: Order tests, treatments and procedures, set Goals, record Observations

- **III – Presentation management:** Organize and restrict order session content for maximum clinical utility

- **IV - Manage as knowledge:** Coded standards-based order content supports manipulation of order sets, order segments and order items by guideline decision support engine
Order Sets: Structure

- Order set = header + body
- Header: Attributes
  - Ownership
  - Authorship
  - Maintenance
  - Scope of Use
  - Related Order Sets (Nesting)
  - Description
- Supporting Evidence
- Header: Attributes
  - Ownership
  - Authorship Milestones
Health eDecisions

• Part of ONC Standards & Interoperability Framework, launched 6/2012. US Realm = “meaningful use”

• **Two key use cases**
  – CDS Guidance Service (send patient data, receive
  “meaningful use” Incorporate CDS standards into Meaningful
  – CDS Guidance Service (send patient data, receive advice)
  to use/integrate shareable artifacts
Moving right along…

- Arden Syntax
- GELLO
- HQMF
- Order Set
- Arden Syntax Infobutton

& DSS
Discussion Questions

• **Overall**
  – Would an overall CDS implementation guide be useful?
  – Are there other national efforts that could align with HeD

• **Overall**
  – Are there other national efforts that could align with

  – Do we need a guideline representation formalism?
Discussion Questions

- **Arden**
  - Where can I get a rules engine?
  - Where can I get “rules”?

- **facto standard**
  - How will organizations use this?
  - Where can I get a rules engine?
The End

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Thanks!
Standards in Clinical Decision Support
Service-Oriented CDS

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Outline

• Context-Aware Knowledge Retrieval (Infobutton)
  – OpenInfobutton

• Decision Support Service (DSS) & Virtual Medical Record (vMR)
  – OpenCDS
1 question out of every 1-2 patients seen (Del Fiol, 2012)

> 60% of questions left unanswered

“What is the dose of Pediazole for this child?”

“Where is the hospital pain management protocol”

“I need a diabetes patient education handout”

“What is this patient’s most recent HbA1c?”

>90% of questions
DrugPoint® Summary
Donepezil Hydrochloride

**Topics**

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

**Resources**

- Micromedex
- UpToDate
- MDConsult
- Medline Plus

**Dosing & Indications**

**Adult Dosing**

- 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
- Decision enhancement or learning in over 62% of infobutton sessions
- Median session time: 35 seconds
- High user satisfaction
- Usage uptake in medications and lab results
  - 1 million sessions at Partners Healthcare in 2011

Cimino JJ. J Am Med Inf Assoc. 2009.
Why did we need a standard?

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

No Context

Electronic Health Record

Resource 1

Resource 2

Resource 3

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

http://resource2.com/
query = “azithromycin” [MeSH Terms] AND dose [All Fields]

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

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

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

- EHR
- Infobutton Manager
- HL7
  - Resource 1
  - Resource 2
  - Resource 3

Knowledge request (URL)
Knowledge Response (Atom)
Aggregate Knowledge Response
For neonates requiring systemic treatment, prompt joint management with a pediatrician and ophthalmologist is recommended by the American Academy of Pediatrics 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)*</td>
<td>Use either: Gentamicin topical OR Tobramycin topical</td>
</tr>
<tr>
<td>Gonococcal neonatal conjunctivitis</td>
<td>Ceftriaxone IV/IM</td>
</tr>
<tr>
<td>Gonococcal disseminated infection</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 oral acyclovir in neonates with laboratory confirmation of HSV infection. Considered unnecessary by other experts (because IV acyclovir levels in tears are low).
• VA [representedOrganization.id.root=1.3.6.1.4.1.3768]
• Problem list review [taskContext.c.c=PROBLISTREV]
• Diabetes Mellitus Type 2 [mainSearchCriteria.v.c=250.00 & mainSearchCriteria.v.cs=2.16.840.1.113883.6.103 & mainSearchCriteria.v.ot=Diabetes+Mellitus+type+2]
• Female [patientPerson.administrativeGenderCode.c=F]
• 65 years old [age.v.v=65 & age.v.u=a]
• ED [encounter.c.c=EMER]
• Health care provider [performer=PROV]
• Patient recipient [informationRecipient=PAT]
• Patient Spanish speaker [informationRecipient.languageCode.c=es]
Application Example

<feed>
  <title type="text">MedlinePlus</title>
  <subtitle type="text">type 2 Diabetes Mellitus </subtitle>
  <updated>2013-03-26T12:13:12.013-06:00</updated>
  <category scheme="REDS_MT010001UV" term="MATCHED"/>
  <category scheme="mainSearchCriteria.v.c" term="250.00"/>
  <category scheme="mainSearchCriteria.v.cs" term="2.16.840.1.113883.6.103"/>
  <category scheme="mainSearchCriteria.v.dn" term="type 2 Diabetes Mellitus "/>
  <category scheme="informationRecipient" term="PAT"/>
  <entry>
    <title>Diabetes Type 2</title>
    <link href="http://www.nlm.nih.gov/medlineplus/diabetestype2.html" rel="alternate"/>
    <summary type="html">&lt;p&gt;&lt;a href="http://www.nlm.nih.gov/medlineplus/diabetes.html"&gt;Diabetes&lt;/a&gt; means your blood glucose, or blood sugar, is too high. With type 2 diabetes, the more common type, your body does... &lt;/summary&gt;
  </entry>
</feed>
<aggregateKnowledgeResponse>
  <feed>
    <title type="text">American Diabetes Association</title>
    ...
  </feed>
  <feed>
    <title type="text">MayoClinic</title>
    <subtitle type="text">type 2 Diabetes Mellitus</subtitle>
    <updated>2013-03-26T12:13:12.013-06:00</updated>
    <category scheme="REDS_MT010001UV" term="OTHER"/>
    <category scheme="taskContext.c.c" term="PROBLISTREV"/>
    <category scheme="mainSearchCriteria.v.c" term="250.00"/>
    <category scheme="mainSearchCriteria.v.cs" term="2.16.840.1.113883.6.103"/>
    <category scheme="mainSearchCriteria.v.dn" term="type 2 Diabetes Mellitus"/>
    <entry>
      <title type="text">Patient education</title>
      <link href="http://www.google.com/search?hl=en&amp;btnI=Im+Feeling+Lucky&amp;q=type 2 Diabetes Mellitus +site:www.mayoclinic.com/health/&amp;"/>
    </entry>
  </feed>
  <feed>
    <title type="text">MedlinePlus</title>
    ...
  </feed>
</aggregateKnowledgeResponse>
**Pneumonia:**

Your examination indicates that you have pneumonia. This is an infection of the lung tissue, usually caused by bacteria or a virus. Symptoms include cough, fever, shaking chills, chest pain, shortness of breath, and coughing up bloody sputum.

Treatment for bacterial pneumonia includes rest, antibiotics for 10 to 14 days, increasing your clear liquid intake, a cool mist humidifier at your bedside, and fever medication. Often, a repeat chest X-ray is performed in a few weeks—even if you feel better—to ascertain whether the infection has completely resolved and no underlying lung problem is present.

You should call your doctor if you develop persistent vomiting, high fever that does not respond to fever medication, increasing shortness of breath, confusion, or lethargy. Also, failure to improve within two to three days is an indication for re-examination.

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**Asthma**

You have been diagnosed as having asthma. This is a condition where there is episodic tightness in the bronchial tubes. Allergies, infections, and polluted or cold air may be contributing factors.

Emergency treatment of a severe asthma attack may include bronchodilator aerosol and short-term corticosteroids. You may feel lightheaded, have a decreased exercise tolerance and a rapid pulse for an hour or two. Rest and get plenty of fluids.

Home treatment of asthma requires bronchodilator drugs. These can be administered by injection, inhalation, or by mouth. Antibiotics and corticosteroids may be required for some patients. You should avoid chemical fumes, smoke (including second-hand cigarette smoke), dust, pollen, and exercising in very cold or dry air. If you smoke, stop!!

Call the doctor if you develop fever, increased wheezing, chest pain, or severe shortness of breath.
Fumar

No hay otra manera de decirlo: Fumar es dañino para la salud. Daña casi todos los órganos del cuerpo. El cigarrillo causa el 87 por ciento de las muertes por cáncer de pulmón. También es responsable de muchos otros cánceres y problemas de salud. Entre estos se incluyen las enfermedades pulmonares, cardíacas, vasculares, derrames cerebrales y cataratas. Las mujeres que fuman tienen más probabilidades de tener ciertos problemas durante el embarazo o que el bebé muera por síndrome de muerte infantil súbita (SIDS, por sus siglas en inglés). El humo también perjudica a otras personas que respiran el humo en forma pasiva. Ellos pueden tener muchos de los mismos problemas que tienen los fumadores.

Dejar de fumar puede reducir el riesgo de presentar estos problemas. Entre más pronto deje de fumar, mayor será el beneficio para su salud.

NIH: Instituto Nacional del Cáncer

Encuentre más información sobre este tema:

- Tabaquismo y el asma
- Tomar la decisión de dejar el tabaco
US EHR Certification (Meaningful Use)

- **Infobuttons:** Required CDS capability
  - Provider reference information
  - Patient education

- Widely adopted among large content providers

- Rapid adoption among EHR vendors
OpenInfobutton

- Funded by VA Innovations Project
- Open source infobutton manager
  - Foster wide adoption & innovations
  - HL7 reference implementation
  - Integrated with major knowledge resources
  - Licensed under APACHE 2.0

http://www.OpenInfobutton.org
Del Fiol et. al, Medinfo 2013
OpenInfobutton Implementations

- Intermountain Healthcare (Utah)
  - Live system-wide
- University of Utah
  - Integrated with Epic
- VA VistA and iEHR
  - Pilot
- Regenstrief Institute (Indiana)
  - Upcoming
- Duke University (North Carolina)
  - Medical library search page
Outline

• Context-Aware Knowledge Retrieval (Infobutton)
  – OpenInfobutton

• Decision Support Service (DSS) & Virtual Medical Record (vMR)
  – OpenCDS
Decision Support Service (DSS)

• Business purpose:
  – To facilitate implementation and maintenance of clinical decision support (CDS) applications

• Approach:
  – Evaluates patient data (inputs) using knowledge modules and returns machine-interpretable conclusions (outputs)
DSS – Architectural Overview

1. Knowledge Modules
2. Client Decision Support Apps

Conclusions about patient

Patient data, knowledge modules to use

Queries for required pt data

Institution A

Institution B

Decision Support Service

Trigger

Queries for required pt data

Patient Data Sources
Underlying Interaction (Overview)

1: View patient record (MRN XYZ - Jane Doe's MRN)

2: Get data requirements (disease management KMs)

3: Data requirements for specified KMs

4: Get data required by disease management KMs (MRN XYZ, data requirements)

5: Requested data

6: Evaluate patient (identifiers of selected disease management KMs, data required by each KM)

7: KM evaluation results

8: Use KM evaluation results to generate care recommendation section of patient summary

9: Patient summary, including care recommendations
Virtual Medical Record

- Use of a common patient data model
  - Key requirement for sharing CDS services and CDS knowledge
- Lack of a common vMR has been a major barrier to sharing knowledge and scaling CDS
Example Challenge without VMR

Observation
Code = BP
Value = 120/80 mmHg

Blood Pressure
Systolic = 120 mmHg
Diastolic = 80 mmHg

Observation
Code = BP
Observation
Code = SBP
Value = 120 mmHg
Observation
Code = DBP
Value = 80 mmHg

Vital Sign
Type = BP
Value = 120/80
Units = mmHg
Problem Model – CCD vs. VMR

```
<entry typeCode="DRIV">
  <act classCode="ACT" moodCode="EVN">
    <templateld root="2.16.840.1.113883.10.20.1.27"/>
    <!-- Problem act template -->
    <id root="6a2fa88d-4174-4909-aece-db44b60a3abb"/>
    <code nullFlavor="NA"/>
    <entryRelationship typeCode="SUBJ">
      <observation classCode="OBS" moodCode="EVN">
        <templateld root="2.16.840.1.113883.10.20.1.28"/>
      </observation>
    </entryRelationship>
  </act>
</entry>

<problem>
  <id root="6a2fa88d-4174-4909-aece-db44b60a3abb"/>
  <problemCode codeSystem="2.16.840.1.113883.6.96" code="195967001" displayName="Asthma"/>
  <problemEffectiveTime low="1950"/>
  <diagnosticEventTime low="20110825" high="20110825"/>
  <problemStatus codeSystem="2.16.840.1.113883.6.96" code="55561003" displayName="Active"/>
</problem>

<templateld root="2.16.840.1.113883.10.20.1.50"/>
  <!-- Problem status observation template -->
  <code code="33999-4" codeSystem="2.16.840.1.113883.6.1" displayName="Status"/>
  <statusCode code="completed"/>
  <value xsi:type="CE" code="55561003" codeSystem="2.16.840.1.113883.6.96" displayName="Active"/>
</observation>
</entryRelationship>
</observation>
</entryRelationship>
</act>
</entry>
```
### CDS Guidance

**Service – Example**

- **Decision Support Service**
  - **EHR System**
  - **vMR**
  - **Eval. Result**

#### Summary: DM | No Known Drug Allergies

<table>
<thead>
<tr>
<th>Report Type</th>
<th>Date/Time</th>
<th>Status</th>
<th>Fac.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive Clinic Note</td>
<td>07/06/2007 00:00</td>
<td>DUMI</td>
<td></td>
</tr>
<tr>
<td>GLYCATED HEMOGLOBIN (HBA1C)</td>
<td>03/22/2007 15:01</td>
<td>DUMI</td>
<td></td>
</tr>
<tr>
<td>CHOLESTEROL, TOTAL</td>
<td>03/22/2007 15:01</td>
<td>DUMI</td>
<td></td>
</tr>
<tr>
<td>LDL-CHOLESTEROL (DIRECT)</td>
<td>03/22/2007 15:00</td>
<td>DUMI</td>
<td></td>
</tr>
<tr>
<td>FAM Endocrinology Follow Up</td>
<td>03/22/2007 00:00</td>
<td>DUMI</td>
<td></td>
</tr>
<tr>
<td>MICROALBUMIN/Creatinine Ratio</td>
<td>07/13/2006 16:54</td>
<td>DUMI</td>
<td></td>
</tr>
<tr>
<td>GENLAB Chemistry: Final</td>
<td>03/22/2007 15:01</td>
<td>DUMI</td>
<td></td>
</tr>
</tbody>
</table>

**Problem**

- **id root**: d11275e7-67ae-11db-bd13-0800200c9a66
- **problemCode codeSystem**: 2.16.840.1.113883.6.96
- **problemEffectiveTime low**: 1950
- **diagnosticEventTime low**: 20110825
- **problemStatus codeSystem**: 2.16.840.1.113883.6.96
- **codeName**: Diabetes mellitus
- **displayName**: Diabetes mellitus

**Problem**

- **id root**: 670ddd2-53e
- **observationFocus code**: 2.16.840.1.113883.6.96
- **observationEventTime**: 20110825
- **observationValue xsi:type**: String

**Problem**

- **id root**: 55661003
- **problemCode codeSystem**: 2.16.840.1.113883.6.96
- **codeName**: Active
- **displayName**: Active

---

**Decision Support Service**

- **EHR System**
  - **vMR**
  - **Eval. Result**
OpenCDS

• Reference implementation of HL7 DSS and vMR standards
• Uses JBoss Drools rules engine
• Freely available under Apache 2 open-source license
OpenCDS – Architectural Overview

Standard Interface:
HL7 Decision Support Service Standard
(http://hssp-dss.wikispaces.com)

Standard Data Models:
HL7 Virtual Medical Record (vMR) Standard
NQF Measure 31 for Meaningful Use

- **Initial Patient Population**
  - AND: "Patient characteristic: birth date" >= 41 year(s) and <= 68 year(s) starts before start of "Measurement period"
  - AND: "Patient characteristic: Gender Female"

- **Denominator**
  - AND: "Initial Patient Population"
  - AND: "Encounter: encounter outpatient" <= 2 year(s) starts before or during "Measurement end date"
  - AND NOT:
    - AND:
      - OR: "Procedure performed: bilateral mastectomy"
      - OR:
        - AND: "Procedure performed: unilateral mastectomy CPT"
        - AND: "Procedure performed: bilateral mastectomy modifier"
      - OR:
        - AND: > 1 count(s) of
          - AND: "Procedure performed: unilateral mastectomy"
          - AND:
            - AND NOT: FIRST:"Procedure performed: unilateral mastectomy" concurrent with SECOND :"Procedure performed: unilateral mastectomy"
          - starts before or during "Measurement end date"

- **Numerator**
  - AND: "Diagnostic study performed: breast cancer screening" <= 2 year(s) starts before or during "Measurement end date"

- **Exclusions**
  - None
OpenCDS Implementation – Denom.

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 an Outpatient encounter
   1 or more times in the past
   2 year(s)

6. not ( )
7. Pt.Proc.Past - Patient has had a Bilateral mastectomy
   or
9. Pt.Proc.Past.Lat - Patient has had a Mastectomy with a laterality of Bilateral
   or
    2 or more times in the past
    200 year(s)

THEN
1. Assert that NQF 0031 denominator criteria met
OpenCDS Implementation – Numerator

WHEN
1. Initialize - Note that all criteria below must be met for the rule to fire.
2. Pt.Proc.Past - Patient has had a Breast cancer screening
3. - in the past 2 year(s)

THEN
1. Assert that NQF 0031 numerator criteria met
rule "DenomCriteriaMet"

dialect "java"

lock-on-active true

when

(EvalTime($evalTime = evalTimeValue) and FocalPersonId($focalPersonId : id)) //DslUsed==InitializeVariablesDsl

($PatientAgeLowDsl_focalPerson : Person(isFocalPerson == true) and PersonAgeAtEvalTime(personId == $PatientAgeLowDsl_focalPerson.id,
ageUnit == "year", age >= 42)) //DslUsed==PatientAgeLowDsl||n==42

($PatientAgeHighDsl_focalPerson : Person(isFocalPerson == true) and PersonAgeAtEvalTime(personId == $PatientAgeHighDsl_focalPerson.id,
ageUnit == "year", age <= 69)) //DslUsed==PatientAgeHighDsl||n==69

($PatientGenderDsl_focalPerson : Person(isFocalPerson == true) and GenderConcept(conceptTargetId == $PatientGenderDsl_focalPerson.id,
openCdsConceptCode == "C31")) //DslUsed==PatientGenderDsl||X==C31

($PatientEncounterEventCountDsl_encounterTypeConcepts_C44 : java.util.List (size >= 1) from collect (EncounterTypeConcept(openCdsConceptCode == "C44")) and $PatientEncounterEventCountDsl_encounters_C44 : java.util.List (size >= 1) from collect (EncounterEvent(subjectIsFocalPerson == true, subjectEffectiveTimeEnd <= $evalTime, id memberOf

(eval($LogicHelperUtility.getInstance().timeDifferenceLessThanOrEqualTo($evalTime, subjectEffectiveTimeBegin, 1, 2))) and (eval($PatientEncounterEventCountDsl_encounters_C44.size() >= 1))))

//DslUsed==PatientEncounterEventCountDsl||X==C44||n1==1||n2==2||timeUnits==1

not (

($PatientProcedureEventDsl_procedureConcept_C46 : ProcedureConcept(openCdsConceptCode == "C46") and ProcedureEvent(id ==

$PatientProcedureEventDsl_procedureConcept_C46.conceptTargetId, subjectIsFocalPerson == true, subjectEffectiveTimeEnd <= $evalTime))

//DslUsed==PatientProcedureEventDsl||X==C46

or

($PatientProcedureEventLateralityDsl_procedureConcept_C49 : ProcedureConcept(openCdsConceptCode == "C49") and

$PatientProcedureEventLateralityDsl_bodySite_C49 : BodySite (clinicalStatementId ==

$PatientProcedureEventLateralityDsl_procedureConcept_C49.conceptTargetId) and LateralityConcept(openCdsConceptCode == "C51",
conceptTargetId == $PatientProcedureEventLateralityDsl_bodySite_C49.id) and ProcedureEvent(id ==

$PatientProcedureEventLateralityDsl_procedureConcept_C49.conceptTargetId, subjectIsFocalPerson == true, subjectEffectiveTimeEnd <=

$evalTime)) //DslUsed==PatientProcedureEventLateralityDsl||X==C49||y1==1||y2==1 || x1 || y2==1 || z1 || z2==1 || z3


### OpenCDS Implementation – Decision Table

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<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>
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</table>
Web-Based Authoring – Flow Control
Current Status

• Infobutton
  – Normative HL7 standard
  – Required for US EHR certification

• Decision Support Service (DSS)
  – V1 – Normative Standard
  – V2 - under ballot

• Virtual Medical Record (vMR)
  – DSTU

• vMR and DSS will be required for US EHR certification (Stage 3)
  – Pilot tests in the Fall of 2013
Thank you