Welcome to Workshop 4

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
  Professor, Department of Medicine
  Cedars-Sinai Medical Center
  University of California, Los Angeles
  **Co-Chair, HL7 Clinical Decision Support Work Group**
  **Co-Chair, Arden Syntax Work Group**
  **Discussant, Arden Syntax + GELLO**
Discussants

• **Guilherme Del Fiol, MD, PhD**
  Assistant Professor, Division of Clinical Informatics
  Department of Community and Family Medicine
  Duke University Health System, Durham, North Carolina
  *Developer, Infobutton Standard*

• **Kensaku Kawamoto, MD, PhD**
  Assistant Professor, Division of Clinical Informatics
  Department of Community and Family Medicine
  Duke University Health System, Durham, North Carolina
  *Co-Chair, HL7 Clinical Decision Support Work Group*
  *Developer, Decision Support Service standard*
Overview of Workshop

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

- **Part 2**: Proposed standards
  - vMR project
  - Order Set project
  - HQMF project

- **Part 3**: Current standards
  - Arden Syntax (Jenders)
  - GELLO (Jenders)
  - Infobutton (Del Fiol)
  - DSS (Kawamoto)

- **Part 4**: Your input
HL7 Structure: Clinical Decision Support

- Consensus-based, ANSI-accredited SDO
  - 20+ international affiliates
  - Meetings (3/year): 400 participants

- Clinical Decision Support Work Group (Jenders, Greenes, Kawamoto, Parker)
  - Contribute to RIM, inform CDS aspects of other HL7 work, develop overall decision support system model
  - Related to Arden Syntax Work Group
HL7 Structure: Clinical Decision Support

- Interactions with other groups: EHR Work Group, Patient Care Work Group, etc

- Coordination via the Technical Steering Committee:
  - Structure and Semantic Design
  - Foundation and Technology
  - Domain Experts
  - Technical and Support Services
HL7 CDS: External Relationships

- **HITSP**
  - Coordinate development of work products that fulfill HITSP use cases
  - Examples: Order set standard, Infobutton standard, guideline formalism

- **OMG**
  - DSS

- **ONC**
  - CDS Collaboratory
HL7 CDS: External Relationships

- **Morningside Initiative**
  - Initiated 8/2007
  - Goal: Interoperable delivery of CDS at POC
  - Multiple participants: AMIA (umbrella), Partners, Intermountain, ASU, etc

- **Artifacts**
  - Knowledge module repository
  - Editing, management tools

- **Current status:** Draft bylaws written; committees organized; initial knowledge acquisition related to diabetes guidelines. KR formalism not yet selected.
HL7 Contacts

- [http://www.hl7.org](http://www.hl7.org)
  - Co-chair names/contact information
  - Mission statements
  - Meeting minutes
  - Official standards
Aspects of Standardization

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

- **Messaging**: Format, terminology
  - Enable interoperability

- **Function**: Services
Work Product: Proposed Virtual Medical Record (vMR) Standard

- **Definition:** Data model and implementation guide, based on the HL7 v3 RIM format, for representing clinical information *inputs* and *outputs* to/from clinical decision support services
  - Initial focus: Support POC chronic disease management

- **Functionality:** Clinical information systems use a standard model to represent data communicated with a clinical decision support system

- **Status:** Work started on creation of UML model = HL7 Domain Analysis Model in September, 2009
Work Product:
Proposed 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.
  – Order sets have a purpose.
  – Order sets may contain conditional logic.
  – Some items in an order set may be fully specified, others may have more optionality.
  – Order sets may be part of a larger care plan.
Order Sets

• **In Scope**
  – Create a structural and functional model to communicate order set content between content authors and those who will use the content.

• **Out of Scope**
  – The result of this project will NOT be a standard for messaging orders at the point of care.
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
  - Use Cases
  - Authorship Milestones
  - Context for Use
Order Sets: Status

- **September, 2008:** Passed DSTU ballot
  - Had previously failed ballots because of disputes over the data model

- **Current status:** Regrouping to resume work on proposed standard
Ancillary Work Product:
Proposed HQMF

• Increasing mandates for clinical performance measurement
  – Pay for performance
  – CMS: No payment for hospital-acquired conditions
  – Competitive measurement: hospitalcompare.gov

• Implementation of quality indicators (QIs) can be costly
  – Need to translate published QI to computable form
  – Need to collect digital data in structured format
  – Otherwise, paper-based collection is time- and resource-intensive
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 an ambulatory vulnerable elder has an osteoporotic fracture diagnosed, THEN physical therapy or an exercise program should be offered within 3 months.

- IF a vulnerable elder is taking warfarin for atrial fibrillation, THEN an INR should be checked at least every 6 weeks.
• No standard formalism for knowledge representation

• Standardization efforts underway
  – AMA Collaborative for Performance Measure Integration with EHR Systems
  – HL7: Healthcare Quality Measure Format (HQMF) being developed as a draft standard for trial use (DSTU) = v3 RIM-based XML

• Clinical guideline standards exist but may not be applicable
  – QIs are population-based, but guideline formalisms are applied to individual patients
HQMF: Status

- Passed DSTU ballot September, 2009
- Extensive reconciliation undertaken
- Publication efforts underway
Extant Standards

• Arden Syntax

• GELLO

• Infobutton

• DSS
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: 2.7
MLM Format

• Three categories and a terminator

• Categories
  – maintenance:
  – library:
  – knowledge:
  – resources: (new in v2.6)

• Terminator
  – end:
MLM Example

maintenance:

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);;
specialist: Alan Simon, MD (ads5@columbia.edu);;
date: 1996-01-24;;
validation: research;;

library:

purpose: To notify investigators of the admission of a patient whose admission diagnosis suggests acute coronary artery disease. IRB number 7205;;
explanation: ;;
keywords: ;;
citations: ;;
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', 'CAD',
  'ANGINA PECTORIS NOS', 'CHR ISCHEMIC HRT DIS NEC',
  'RULE OUT MI', 'R/O MYOCARDIAL INFARCTION', 'ACUTE MI',
  'SUBENDO INFARCT', 'UNSTABLE ANGINA/MI',
  'ANGINA PECTORIS', 'CORONARY ARTERY DISEASE');
mrn := read last {'pcodes'='now mrn '};
patient_name := read last {'dam'='GYDAPMP'; 'HPBASIC'; 'HNAME'};
location := read last {'dam'='GYDAPMP'; 'HLOC'; 'HLOCNURS'};
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 ||
    "\nMRN: " || mrn ||
    "\nLocation: " || location ||
    "\nAdmission Diagnosis: " || diagnosis_text ||
    "\n\n\n" || patient_name || " " || mrn || " " || location
at email_dest;
;;
end:
System Vendors

• Eclipsys
• McKesson
• Siemens
• Medexeter
Resources

- Official Archive: www.hl7.org

- *HL7 Library or Book Store* to obtain authoritative copy of standard

- *Work Groups / Arden Syntax* for committee’s homepage
Arden Syntax v2.8

- **Timeline:** Normative ballot 1/2011

- **2 key advances**
  - **Fuzzy logic:** Represent linguistic variables + operators to manipulate these
    - “moderately severe”; “potentially associated”
  - **XML (“Arden ML”):** Refine present non-normative XML version of Arden
    - Stepwise refinement of different levels of markup: MLM -> category -> slot -> statement -> operator
Arden Syntax v3.0

• **Timeline**: Indefinite future
• **Potential ingredients**
  – Further elaborate structured WRITE statement (i.e., expansion of the Action slot)
  – vMR
  – Support for complex guidelines, e.g., “master MLMs” that document packages of MLMs and their dependencies
  – Additional logics: Other methods for addressing uncertainty (e.g., probability constructs)
  – Workflow constructs, in part to enable an authoring/development environment
Potential ingredients (continued)

- Reference implementation + conformance model (in part as verification of particular implementations)
- Authoring/maintenance environment syntactical constructs
- Support for terminology references + a data model
- Support for quality measure implementation
- Support for data interface (e.g., expansion of the READ statement; ask now vs later directed at synchronous users)
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
  – Based on OMG OCL

• GELLO expressions:
  – Extract and manipulate data
  – Construct decision criteria, abstractions, formulae
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

- **Initial version:** ANSI standard release 1 = May, 2005

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 exceeds a threshold signifying osteodystrophy
    
    renal_failure and calcium_phosphate_product > threshold_for_osteodystrophy
GELLO: Status

• 2006
  – Tool release by Medical Objects (Australia)
  – Demonstration project: e-Prescribing prior authorization rules
GELLO: Status

- **2007**
  - Authoring tool release by InferMed (UK).
  - **Demonstration projects**
    - Possible: Clinical trial
    - Australia (Medical Objects + Haematology Society + Leukaemia Society of Australia): Guideline representation in a GLIF context
  - Result of demonstration projects
    - BNF revision
    - Work on vMR as a RIM-derived data model for decision support
GELLO: Status

- **2008**: Two work products
  - v 1.0: Revision of BNF to fix errors
  - v 2.0: Expand in light of prior testbed projects

- **2009**: Further refinement
  - v 2.0: Passed initial normative ballot 9/2009
Moving right along…

- **Arden Syntax**
- **GELLO**
- **Infobutton**
- **DSS**
Discussion Questions

• **Overall**
  – How do I get involved?
  – Need for shared knowledge repository?

• **Infobutton**
  – Where can I get them?
  – How should the standard be improved?

• **DSS**
  – What types of knowledge modules are useful?
  – Would you use a DSS provider?
  – Do we need a guideline representation formalism?
Discussion Questions

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

• **HQMF**
  – How will organizations use this?

• **Order Set**
  – Will an HL7 standard matter in the setting of a de facto standard?
The End

jenders@ucla.edu

guilherme.delfiol@duke.edu

kawam001@mc.duke.edu

Thanks!
Context-aware Knowledge Retrieval (Infobutton) Standard

Guilherme Del Fiol, MD, PhD

Assistant Professor
Division of Clinical Informatics
Department of Community and Family Medicine
Duke University
guilherme.delfiol@duke.edu
Point-of-care information needs

2 questions out of every 3 patients seen (Covell, 1985)

> 50% of questions left unanswered (Ely, 2005)
Electronic Health Record

Infobutton Manager

Resources & topics

Adult Dose
Azithromycin
Female
81 years

User: MD
Order entry

Overview
✓ Adult Dose
Pediatric Dose
Contraindications
Adverse Effects

Choose a resource:
✓ Micromedex
UpToDate
MDConsult
Medline Plus

Micromedex
Adult Dose
Azithromycin
Female
81 years
Why did we need a standard?

- Lack of a common understanding of "context"
  - Information model
  - Terminologies
- Numerous resources available
  - Answers not likely to be found in one single resource
  - Not designed for infobutton integration
  - Non-scalable integration
    - Implementations linking to a single resource
No standard in place

Electronic Health Record

Infobutton Manager

Resource 1

Resource 2

Resource 3

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


http://resource3.com/searchConcept = 3333 ^ azithromycin filter = 11 ^ dosage
Overview of the Standard

• Standard mechanism to express and communicate EHR “context”

• HL7 v3 standard
  – Messages
    ▪ Infobutton request
    ▪ Infobutton response (under development)
  – Implementations
    ▪ XML and URL-based
    ▪ SOA (under development)

• Standard terminologies
  – RxNorm, LOINC, SNOMED-CT, MeSH
  – “Free-text” is an option to allow faster adoption
Participants

• Health care & academic institutions
  – Duke University, Intermountain Healthcare, NIH Clinical Center, Columbia University, Partners Healthcare, VA, Cedars-Sinai, Kaiser Permanente

• Content providers
  – Wolters Kluwer Health, Thomson Reuters, NLM, UpToDate, Ebsco, Healthwise, ACP, Elsevier, Lexicomp

• EHR vendors
  – GE, Epic, Eclipsys, Siemens
Example

• The user is looking at a problem list of a female, 97 years-old patient with Heart Failure. The user clicks on an infobutton that presents a series of questions. The user selects “How do I treat Heart Failure?”
URL-based Implementation

• More compatible with current EHR underlying infrastructures
  – Faster adoption

• Rules for automated conversion
  – URL can be automatically derived from XML message
<mainSearchCriteria code="428" codeSystem="2.16.840.1.113883.6.103" displayName="Heart Failure"/>

http://www.e-resource.com/api?
mainSearchCriteria.c=428
&mainSearchCriteria.cs=2.16.840.1.113883.6.103
&mainSearchCriteria.dn=Heart Failure
## Clinical significance

- **Management** depends on severity of hypokalemia.
  - **Severe hypokalemia requires immediate management.**
    - Risk of ventricular fibrillation if $<2.5 \text{ mEq/L} (<2.5 \text{ mmol/L})$.  

<table>
<thead>
<tr>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 3.0 mEq/L (&lt;3.0 mmol/L)</strong></td>
</tr>
<tr>
<td><strong>WITH</strong></td>
</tr>
<tr>
<td>premature ventricular complexes in setting of myocardial ischemia or digoxin toxicity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 3.0 mEq/L (&lt;3.0 mmol/L)</strong></td>
</tr>
<tr>
<td><strong>WITH</strong></td>
</tr>
<tr>
<td>premature atrial complexes but no or infrequent premature ventricular complexes and no digoxin toxicity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mild</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.1-3.5 mEq/L (3.1-3.5 mmol/L)</strong></td>
</tr>
<tr>
<td><strong>WITH</strong></td>
</tr>
<tr>
<td>no or infrequent premature ventricular complexes and patient asymptomatic</td>
</tr>
</tbody>
</table>
Conjunctivitis, acute infective; neonate

Treatment guidelines

For neonates requiring systemic treatment, the American Academy of Ophthalmology recommends prompt, joint management with a pediatrician and ophthalmologist.

1. Commence pathogen-directed therapy according to results of diagnostic tests.

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlamydial infection</td>
<td><strong>Erythromycin</strong> oral</td>
</tr>
<tr>
<td>Gram-positive organisms</td>
<td><strong>Erythromycin</strong> topical</td>
</tr>
<tr>
<td>Gram-negative organisms (other than suspected gonococcus)$^a$</td>
<td>Use either:</td>
</tr>
<tr>
<td></td>
<td>• <strong>Gentamicin</strong> topical</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>• <strong>Tobramycin</strong> topical</td>
</tr>
</tbody>
</table>
Current Status

• Infobutton **knowledge request**
  – Draft Standard for Trial Use (**DSTU**)  
  – HITSP  
    ▪ T81 - Retrieve Medical Knowledge  
    ▪ One of the EHR capabilities (**CAP 122**)  
  – URL-based implementations  
    ▪ 15+ large scale implementations  
    ▪ Working demonstration at AMIA 2007  
    ▪ Several ongoing development efforts
Ongoing Work

• Infobutton DSS
  – Services Oriented Architecture (SOA)
  – Supports enhanced integration
    ▪ Standardized knowledge response
  – Leverages existing standards
    ▪ HL7/OMG Decision Support Services Standard
    ▪ Atom (IETF)
  – Ballot for comments – Sep 2009
Infobutton SOA

Knowledge Retrieval Metadata

EHR

Infobutton Manager

Infobutton request (DSTU)

Drug KB

HL7

Diseases

Patient education
<xml version="1.0" encoding="utf-8"?><!-- contents of the evaluation request -->

<kmRequests>
  <clientTimeZoneOffset>-05:00</clientTimeZoneOffset>
  <driData>
    <DataRequirementItemData>
    </DataRequirementItemData>
  </driData>
</kmRequests>
</EvaluationRequest>
</evaluate>
</soap:Body>
</soap:Envelope>
<kmRequests>
  <KMEvaluationRequest>
    <kmId>
      <scopingEntityId>com.KnowledgeResource</scopingEntityId>
      <businessId>InfobuttonKnowledgeModule</businessId>
      <version>1.0.0</version>
      <!-- major.minor.revision -->
    </kmId>
  </KMEvaluationRequest>
</kmRequests>
Infobutton DSS Request

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <soap:Body>
    <evaluate>
      <EvaluationRequest>
        <!-- contents of the evaluation request -->
        <kmRequests>
          <clientTimeZoneOffset>-05:00</clientTimeZoneOffset>
        </kmRequests>
        <driData>
          <DataRequirementItemData>
          </driData>
        </driData>
      </EvaluationRequest>
    </evaluate>
  </soap:Body>
</soap:Envelope>
<DataRequirementItemData>
  <drild>
    <containingEntityId>
      <scopingEntityId>com.KnowledgeResource</scopingEntityId>
      <businessId>InfobuttonKnowledgeModule</businessId>
    </containingEntityId>
    <itemId>InfobuttonRequestPayload</itemId>
  </drild>
  <informationModelSSId>
    <scopingEntityId>org.hl7</scopingEntityId>
    <businessId>REDS_RM010001UV</businessId>
  </informationModelSSId>
  <data>
    <v3:infobuttonEventNotification xmlns="urn:hl7-org:v3">
    </v3:infobuttonEventNotification>
  </data>
</DataRequirementItemData>
Request Payload

```
<v3:infobuttonEventNotification xmlns="urn:hl7-org:v3">
  <v3:administrativeGenderCode code="C10173" codeSystem="2.16.840.1.113883.5.1" codeSystemName="AdministrativeGender" displayName="Male"/>
  <v3:age>
    <v3:code code="30525-0" codeSystem="2.16.840.1.113883.6.1" codeSystemName="LN" displayName="AGE"/>
    <v3:value value="77" unit="a"/>
  </v3:age>
  <v3:taskContext>
    <v3:code code="LABRREV" codeSystem="HL7-TaskContext" displayName="Laboratory Results Review"/>
  </v3:taskContext>
  <v3:mainSearchCriteria>
    <v3:code code="12812-4" codeSystem="2.16.840.1.113883.6.1" displayName="serum potassium"/>
    <v3:severityObservation>
      <v3:interpretationCode code="H" codeSystem="2.16.840.1.113883.5.83"/>
    </v3:severityObservation>
  </v3:mainSearchCriteria>
</v3:infobuttonEventNotification>
```
Response Payload

```xml
<data>
  <atom:feed xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
            xmlns="http://www.w3.org/2005/Atom" xmlns:v3="urn:hl7-org:v3">
    <atom:author>
      <atom:name>Knowledge resource publisher</atom:name>
    </atom:author>
    <atom:entry>
    </atom:entry>
    <atom:entry>
    </atom:entry>
    <atom:entry>
    </atom:entry>
  </atom:feed>
</data>
```
<atom:entry>
  <atom:title>potassium, serum; high - Clinical significance</atom:title>
  <atom:category>
    <v3:mainSearchCriteria>
      <v3:code code="12812-4" codeSystem="2.16.840.1.113883.6.1"/>
      <v3:severityObservation>
        <v3:code code="H" codeSystem="2.16.840.1.113883.5.83"/>
      </v3:severityObservation>
    </v3:mainSearchCriteria>
    <v3:subTopic>
      <v3:code code="D012816" codeSystem="2.16.840.1.113883.6.177" displayName="Clinical significance"/>
    </v3:subTopic>
  </atom:category>
  <atom:link href="http://knowledgeresource.org/infobutton?docid=12477_80_8447" rel="via"/>
  <atom:summary>Overview, interpretation and clinical manifestations.</atom:summary>
  <atom:content> <!-- HTML content may be placed here --> </atom:content>
</atom:entry>
Timeline

- **Infobutton Request (DSTU)**: Jan 2008
- **Infobutton DSS (For comments)**: Sep 2009
- **Infobutton Request (Normative)**: Jan 2010
- **Infobutton DSS (DSTU)**: May 2010
Lessons Learned

• Make it simple
• Make it easy to understand and implement
• Target quick adoption
  – Make it compatible with implementers’ current infrastructure
• Provide plenty of examples
• Validate with real implementations
HL7-OMG Healthcare Services Specification Project (HSSP) and HSSP Decision Support Service Standard – Current Status and Future Directions

November 13, 2009

Kensaku Kawamoto, M.D., Ph.D.
Assistant Professor
Division of Clinical Informatics
Department of Community and Family Medicine
Member, Institute for Genome Sciences & Policy
Duke University Medical Center
kawam001@mc.duke.edu
Disclosure

- The research underlying the DSS specification has been funded in part by grants from:
  - The National Library of Medicine
  - The Agency for Healthcare Research and Quality
  - The Health Resources and Services Administration
  - The National Human Genome Research Institute

- Financial disclosures
  - Dr. Kawamoto is a co-owner of Clinica, Inc., which holds IP rights to a CDS technology known as SEBASTIAN. A patent application on the SEBASTIAN technology has been filed.
  - Dr. Kawamoto and Duke University may benefit financially if products utilizing SEBASTIAN are commercially successful.
  - SEBASTIAN represents just one of potentially many approaches for instantiating an HL7 Decision Support Service.
Agenda

- Healthcare Services Specification Project
  - Overview
  - Current Status
  - Future Directions

- HSSP Decision Support Service Standard
  - Overview
  - Current Status
  - Future Directions
  - Discussion Questions
Healthcare Services Specification Project

- Effort to standardize functionality, semantics, and interfaces of services important to health IT

- Initiated in 2005 as joint effort between HL7 and Object Management Group (OMG)
  - OMG: vendor consortium producing enterprise interoperability specifications; specified UML & CORBA

- Described in upcoming JAMIA article
HSSP Process

Identify standardization candidates

Specify Service Functional Model (SFM) [defines functionality, interfaces, and semantics*]

Adopt SFM as HL7 Draft Standard for Trial Use (DSTU)

Issue OMG request for technical specifications

Vendors generate common service interface specification and additional semantic profiles*

Technical service specification adopted as OMG standard

Commercial service implementations available

*Service semantics also specified in separately balloted semantic profiles

HL7 Process (~1.0 - 1.5 yrs)

OMG Process (~1.5 - 2.0 yrs)
## HSSP – Current Status

<table>
<thead>
<tr>
<th>Service</th>
<th>HL7 SFM adopted</th>
<th>OMG spec. adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity Identification Service</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Retrieve, Locate, &amp; Update Service</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Decision Support Service</td>
<td>X</td>
<td>Anticipated 12/09</td>
</tr>
<tr>
<td>Common Terminology Services 2</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Clinical Research Filtered Query Service</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Healthcare, Community Services and Provider Directory, Release 1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Privacy, Access, and Security Services</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© 2009, Kensaku Kawamoto
Division of Clinical Informatics
Dept. of Community and Family Medicine
HSSP – Future Directions

- **Continue development of HL7/OMG standards**
  - Projects actively seeking interested contributors

- **Facilitate adoption and use**
  - E.g., via Open Health Tools (http://www.openhealthtools.org/)
  - Chief Health Informatics Officer of Open Health Tools: Dr. Robert Kolodner, former head of ONCHIT and Veterans Health Administration CIO
HSSP – Further Information

- **HSSP Wiki**
  - http://hssp.wikispaces.com/

- **Current HL7 Service Functional Models**
Decision Support Service (DSS) – Overview

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

- **Functionality:**
  - Evaluates patient data using knowledge modules and returns machine-interpretable conclusions

- **History:**
  - Based on service interface of CDS Web service developed at Duke (SEBASTIAN)
  - Project initiated in 10/05 by HL7 Clinical Decision Support TC in collaboration with HL7 SOA SIG
  - Presenter (K.K.) serving as the project lead and editor
DSS – Architectural Overview

Decision Support Service

Knowledge Modules

Queries for required pt data

Patient Data Sources

Client Decision Support Apps

Institution A

Patient data, knowledge modules to use

Conclusions about patient

Queries for required pt data

Patient Data Sources

Client Decision Support Apps

Institution B

1

2
DSS Knowledge Module (KM) – Components

- **Descriptive traits**
  - E.g., authors, keywords, purpose, explanation

- **Data requirements**
  - E.g., patient’s most recent serum creatinine level, provided using HL7 v3 format

- **Definition of how conclusions will be returned**

- **Semantics requirements fulfilled**
  - Semantic requirement example:
    - *Service must support trait set X;*
    - *Service must draw data requirements from superset Y; &*
    - *Service must return conclusions using semantics A, B, or C*
## DSS KM – Sample Inferences

<table>
<thead>
<tr>
<th>Sample Evaluation Input</th>
<th>Sample Evaluation Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age, gender, past health maintenance procedures</td>
<td>List of health maintenance procedures due or almost due</td>
</tr>
<tr>
<td>Medication identifier, age, gender, weight, serum creatinine level</td>
<td>Recommended maximum and minimum doses for medication given patient's estimated renal function</td>
</tr>
<tr>
<td>Age, gender, co-morbidities, chief complaint</td>
<td>Admission order set in HL7 format</td>
</tr>
<tr>
<td>Insurance provider, data relevant to prescription</td>
<td>Prior authorization to prescribe medication</td>
</tr>
</tbody>
</table>
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. Describe Knowledge Module
   Module of interest
   Description of module

4. Get Data Requirements
   Modules of interest
   Data requirements

Service Client
DSS – Sample Use Case

Context

- Jane Doe is a 64 year old female with diabetes mellitus.
- Doctor David is Jane’s primary care clinician.
- David’s practice utilizes an EHR system which uses DSSs to provide decision support capabilities.

Scenario

- Jane checks into David’s clinic.
- When David opens Jane’s record in the EHR system, he is presented with a patient summary screen that contains patient-specific care recommendations.
- The EHR system uses DSS A to obtain these recommendations.
# Sample Care Recommendation Screen (Duke)

## Health Maintenance

<table>
<thead>
<tr>
<th>Focus</th>
<th>Status</th>
<th>Relevant Data</th>
<th>Last Done</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pap Test</td>
<td>DUE NOW</td>
<td></td>
<td>05/23/05 (3y 5m ago)</td>
<td>18-65yo F: begin 3yrs after first sex or age 21. min q3yr unless hysterectomy, more frequently if high risk</td>
</tr>
<tr>
<td>Mammogram</td>
<td>Not Due</td>
<td></td>
<td>09/09/08 (1m 24d ago)</td>
<td>40-70yo F: min q2yr unless bilateral mastectomy</td>
</tr>
<tr>
<td>Colorectal Cancer Screen</td>
<td>Not Due</td>
<td>FOBT(x3); Flex. Sigmoidoscopy; ACBE; Colonoscopy;</td>
<td>&gt;2y ago; &gt;10y ago; &gt;10y ago; 07/27/06 (2y 3m ago)</td>
<td>50-80yo: FOBT(x3) q1yr, flex. sig. q5yr, ACBE q5yr, or colonoscopy q10yr</td>
</tr>
</tbody>
</table>

## Diabetes

<table>
<thead>
<tr>
<th>Focus</th>
<th>Status</th>
<th>Relevant Data</th>
<th>Last Done</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>Not Due</td>
<td>Height: <strong>163.8cm (64.5in)</strong></td>
<td>07/10/07 (age 54y 7m)</td>
<td>21+yo: once after age 21</td>
</tr>
<tr>
<td>Weight/BMI</td>
<td>DUE NOW</td>
<td>Weight: <strong>97.9kg (215.9lb)</strong> BMI 36.5</td>
<td>08/12/08 (2m 21d ago)</td>
<td>21+yo: q visit. Goal: BMI &lt;25</td>
</tr>
<tr>
<td>Smoking Screen</td>
<td>DUE NOW</td>
<td>Status unknown</td>
<td>not on record</td>
<td>10+yo: check tobacco use yearly unless age 25+ and never smoked</td>
</tr>
<tr>
<td>Alcohol Screen</td>
<td>DUE NOW</td>
<td>Status unknown</td>
<td>not on record</td>
<td>10+yo: check alcohol use yearly (excessive: males &gt;2/d, females &gt;1/d)</td>
</tr>
<tr>
<td>Visual Foot Exam</td>
<td>DUE NOW</td>
<td></td>
<td>&gt;2y ago</td>
<td>q visit</td>
</tr>
<tr>
<td>Foot Monofilament</td>
<td>DUE NOW</td>
<td></td>
<td>&gt;2y ago</td>
<td>annual</td>
</tr>
<tr>
<td>HgbA1C</td>
<td>Due in 10d</td>
<td>HgbA1C: <strong>7.0%</strong></td>
<td>08/12/08 (2m 21d ago)</td>
<td>21+yo: q6mo if &lt;7%, q3mo if &gt;= 7%. Goal: &lt;7%.</td>
</tr>
<tr>
<td>Urine Micro alb/cr</td>
<td>Not Due</td>
<td>alb/cr ratio: <strong>4.3 mg/g</strong></td>
<td>08/12/08 (2m 21d ago)</td>
<td>10+yo: annual</td>
</tr>
<tr>
<td>Total Chol.</td>
<td>Not Due</td>
<td>Total-C: <strong>168 mg/dL</strong></td>
<td>08/12/08 (2m 21d ago)</td>
<td>annual, goal &lt;200</td>
</tr>
<tr>
<td>LDL Chol.</td>
<td>Not Due</td>
<td>LDL-C: <strong>106 mg/dL</strong></td>
<td>08/12/08 (2m 21d ago)</td>
<td>annual, goal &lt;100</td>
</tr>
<tr>
<td>Eye Exam</td>
<td>Not Due</td>
<td>Scheduled: N/A</td>
<td>09/11/08 (1m 22d ago)</td>
<td>10+yo: annual</td>
</tr>
<tr>
<td>Flu Vacc.</td>
<td>CONSIDER</td>
<td></td>
<td>11/03/06 (1y 11m ago)</td>
<td>annual, unless egg allergic</td>
</tr>
<tr>
<td>Pneum. Vacc.</td>
<td>Not due</td>
<td></td>
<td>04/24/06 (6y 6m ago)</td>
<td>once; revacc if &gt;=65 and last 5yrs ago when &lt;65</td>
</tr>
<tr>
<td>ASA (81 mg)</td>
<td>Not Due</td>
<td>Not known to be allergic to aspirin</td>
<td></td>
<td>40+yo: no contraindications</td>
</tr>
<tr>
<td>Education</td>
<td>DUE NOW</td>
<td>Aspirin listed as prescribed</td>
<td>not on record</td>
<td>once; repeat annually if HgbA1C &gt;=7%</td>
</tr>
</tbody>
</table>

## Hypertension

© 2009, Kensaku Kawamoto

Division of Clinical Informatics
Dept. of Community and Family Medicine
Underlying Interaction (Detailed)
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
DSS – Benefits of Standard

- **DSS providers (e.g. knowledge vendors, government)**
  - Expansion of potential client base
  - Scalable deployment architecture
  - Minimal restrictions on how underlying knowledge is represented

- **DSS consumers (e.g. CIS vendors, healthcare institutions)**
  - Ability to easily integrate CDS capabilities into applications
  - Access to multiple knowledge bases through single interface
DSS – Current Status

- DSS SFM approved in 9/06 as HL7 DSTU
- DSS profiles being developed for several domains (Infobutton, immunization CDS, clinical genomics CDS)
- DSS RFP issued by OMG in 3/07
- Five companies responding to RFP
  - 88solutions, Religent/Clinica*, Software Partners, dbMotion* (supporter), InferMed (supporter)
  - * = principal contributors
DSS – Current Status

- OMG/HL7 peer review completed 9/09
- Revised specification completed 11/09
- OMG adoption expected 12/09
DSS – Future Directions

- Complete OMG specification
- Harmonize with HL7 standards
- Facilitate adoption
- Continue effort to specify and standardize semantic profiles for common CDS patterns
  - Critical path: specification of common CDS input/output semantics via HL7 virtual medical record (vMR) effort
DSS – Further Information

- **HSSP DSS Wiki**
  - http://hssp-dss.wikispaces.com/

- **HL7 Decision Support Service Standard**

- **OMG Decision Support Service Specification**