

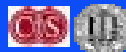
## What I Did on my (Summer) Holiday: International Clinical Decision Support Standards

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Cedars-Sinai Medical Center

University of California, Los Angeles USA  
Co-Chair, Clinical Decision Support Technical Committee, HL7

16 February 2004



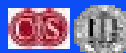
## Overview: Clinical Decision Support Standards

- Part A: Computable Clinical Guidelines
- Part B: Arden Syntax and Related Issues



## Part A: Computable Guidelines

- Rationale for Guidelines: Knowledge dissemination
- HL7: Role of the SDO in KR
- Shareable components of computable guidelines
- Guideline models
- Convergence & the future



## I. Rationale for Guidelines: Evidence of Poor Performance

- 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

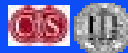
McGlynn EA, Asch SM, Adams J et al. The quality of health care delivered to adults in the United States. *N Engl J Med* 2003;348:2635-2645.

Antman EM, Lau J, Kupchik B et al. A comparison of results of meta-analyses of randomized control trials and recommendations of clinical experts. Treatments for myocardial infarction. *JAMA* 1992;268(2):240-8.



## Rationale for Guidelines: What are they?

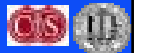
- “Systematically developed statements to assist practitioners and patient decisions about a pppropriate health care for specific clinical circumstances.” (Field MJ, Lohr KN eds. Clinical Practice Guidelines: Directions for a New Program. IOM, Washington,DC: NAP,1990)
- **Guideline:** Multi-step plan that unfolds over time
  - Incorporate the latest (scientific) evidence
  - Identify a standard of care
  - Distribute to caregivers



## Rationale for Guidelines: Guideline Types

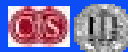
- Screening and prevention
- Diagnosis and prediagnosis management of patients
- Indications for use of surgical procedures
- Appropriate use of specific technologies and tests as part of clinical care
- Care of specific clinical conditions

Field MJ, Lohr KN eds. Guidelines for Clinical Practice: From Development to Use. Washington,DC: NAP,1992.



## Rationale for Guidelines: Addressing Knowledge Dissemination

- **Challenge:** (Paper) guidelines are not used
  - Unavailable, inconvenient at the point of care
  - Lack of educational effect
  - Lack of knowledge of existence of guideline
  - Forgetting to apply guideline in specific circumstances
- **Challenge:** Volume of publication
  - 2M+ articles/y in 20K journals



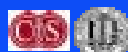
## Improving Guidelines: Incorporate in CDSS

- Use in context of systems for providing patient care
  - CPOE
  - EMR
- Use at the time decisions are being made
- Ample success for limited alerts/reminders
  - Medication prescribing practices
  - Preventive care: screening tests, immunizations
- Less demonstrated success for complex guidelines



## Challenges in Implementing Guidelines in CDSS

- Availability of data
- Identification of data: structured, controlled vocabularies
- Clinical data repositories: Data model
- Shareable knowledge representation

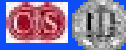


## Benefits of Shareable Guidelines

- Avoid duplication of effort when using common guidelines in many institutions
- Rapid dissemination of modifications
- Encourage development of tools for retrieving and using guideline information
- Encourage future guideline authors to be more rigorous (decreased ambiguity)

Ohno-Machado L, Gennari JH, Murphy SN et al. The GuideLine Interchange Format: a model for representing guidelines. J Am Med Inform Assoc 1998;5:357-372.





## II. Work on KR: HL7

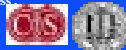
- Growing international organization
  - 20+ international affiliates
  - participation by wide range of stakeholders: academia, vendors, government, consultants
- Moving beyond the core messaging standard
  - CDA, CCOW, Arden Syntax
- Key characteristics
  - All-volunteer organization
  - Refereed consensus process



## Improving KR of Guidelines: Focus on HL7

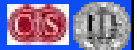
- Main focus: Clinical Decision Support TC
  - SIGs: Arden Syntax, Clinical Guidelines, Electronic Health Records
- Related tasks elsewhere in organization
  - Modeling and Methodology TC: HDF
  - RIM
- Other groups: Guideline International Network (Medinfo panel)

Jenders RA, Sallors RM. Convergence on a standard for representing clinical guidelines: work in Health Level Seven. Proc Medinfo 2004; in press.



## III. Shareable Guideline Components: Challenges to Agreeing a Standard Guideline Model

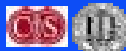
- Many models: GEODE-CM, GLIF, Arden Syntax, EON, DILEMMA, PROforma, Asbru, GEM, GUIDE, PRODIGY, ...
- Many stakeholders: government, vendors, academics, professional organizations, etc
- Many types of guidelines
- Many types of (paper) guideline formats: narrative text, tables, flowcharts, graphs, maps, lists, critical pathways, if-then statements, etc



## Standardizing Guidelines: COGS

- Proposal: a standard for reporting CPGs
- Checklist: 18 elements
  - *Key for implementation*: recommendation/rationale; algorithm; implementation considerations
  - *Others*: Overview, focus, goal, users/setting, target population, developer, sponsor, evidence collection, grading criteria, method for synthesizing evidence, prerelease review, update plan, definitions, potential benefits/harms, patient preferences
- Next step: "Action Palette"

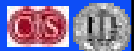
Shiffman RN, Shekelle P, Overhage JM et al. Standardizing reporting of clinical practice guidelines: a proposal from the conference on guideline standardization. Ann Intern Med 2003;139:493-498.



## Design Principles for CIGs: InterMed

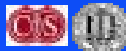
- Expressiveness
- Guideline comprehension
- Sharing: Local specification
  - Delivery platform, mode of user interaction, practice environment, resources, local policies, differences in physical environment, differences in patient population
  - GLIF3: Subguidelines (nesting)
- Other elements: data model, vocabulary, abstractions, validation

Peleg M, Boxwala AA, Tu S et al. The InterMed approach to shareable computer-interpretable guidelines: a review. J Am Med Inform Assoc 2004;11:1-10.



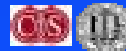
## Shareable Guideline Components: De composing the Problem

- Agreement on an overall standard formalism is challenging.
- Instead, first focus on shareable components:
  - Data model
  - Expression language
- Future: One or more widely implemented models with shared components
  - Shared components = ease the process of database mapping, etc



## Shareable Guideline Components: Standard Data Models

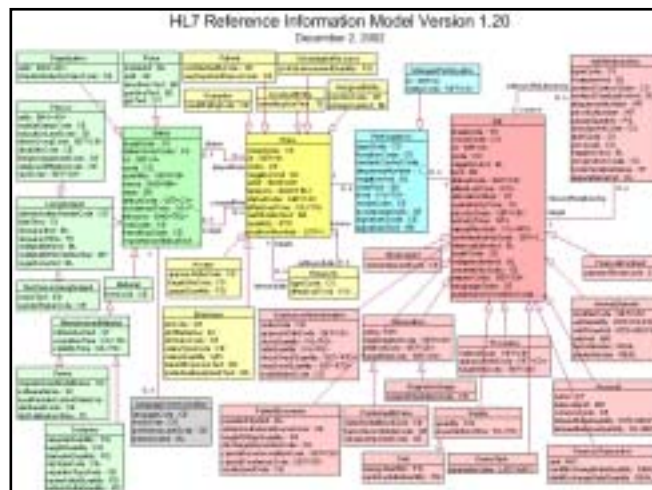
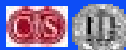
- Candidates
  - RIM = HL7 Reference Information Model
  - vMR = Virtual Medical Record
- Purpose: Standardize references to patient data
  - Promote knowledge transfer: One-time mapping between standard and local model, followed by automated translation at the time of transfer/execution
  - Goal: Avoid manual rewriting of data references



## Standard Data Models: HL7 RIM

- High-level, abstract model of all exchangeable data
  - Concepts are objects: Act (e.g., observations), Living Subject, etc
  - Object attributes
  - Relationship among objects
- Common reference for all HL7 v3 standards

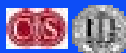
Schadow G, Russell DC, Mead CN, McDonald CJ. Integrating medical information and knowledge in the HL7 RIM. Proc AMIA Symp 2000;:764-768.

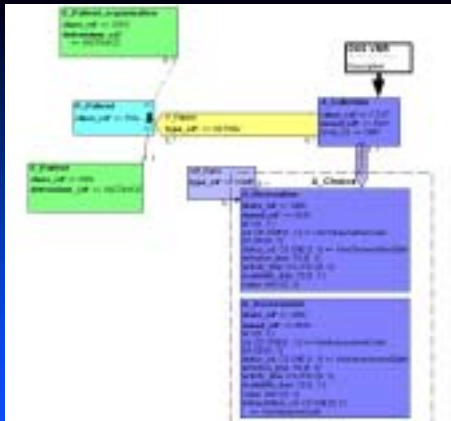


## Standard Data Model: vMR

- Problem with RIM: Too abstract
- Potential solution: Tailored version of RIM specifically for decision support
- Current work: Virtual Medical Record (SCHIN)
  - Establish distinct objects that in RIM might be high-level classes (with mood and other attributes)
- Key classes: patient, plan, procedure, medication, appointment, referral, goal and assessment

Johnson PD, Tu SW, Musen MA, Purves I. A virtual medical record for guideline e-based decision support. Proc AMIA Symp 2001;:294-298.





## Standard Data Model: Not Enough

- Need standard vocabularies
- Agreement is difficult
  - Solution: Format for referring to a standard vocabulary in data references
  - Examples: SNOMED-CT, ICD-9, LOINC, CPT, etc
  - Implementation: One-time mapping between local and standard vocabularies
- Facilitation: Free licensing of SNOMED in USA as part of UMLS

## Shareable Guideline Components: Expression Language

- Purposes
  - Query data (READ)
  - Logically manipulate data (IF-THEN, etc)
- Current work: GELLO (BWH) = Guideline Expression Language

Ogunyemi O, Zeng Q, Boxwala A. Object-oriented guideline expression language (GELLO) specification: Brigham and Women's Hospital, Harvard Medical School 2002. Decision Systems Group Technical Report DSG-TR-2002-001.

## Expression Language: GELLO

- Original goal (InterMed): Procedural component for high-level guideline format (GLIF)
- Subsequent goal: Provide similar functionality for current HL7 KR standard (Arden Syntax)
- Emphasis: Shareability of queries and expressions
- Mechanism: Reference data in OO fashion

## GELLO (continued)

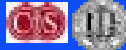
- Provides basic data types
- Allows reference to underlying standard data model (vMR)
- Based on the Object Constraint Language (UML)
- Current goal: Ballot as a separate HL7 standard during the coming 12 months

## 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

## IV. Guideline Models

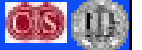
- Workproceeds in parallel with shareable components
- Process: HL7 HDF
  - story board modeling process
  - workfrom use cases
- Candidate models
  - Arden Syntax
  - GLIF
  - GEM
  - CPGA



## Guideline Models: Arden Syntax

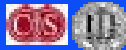
- ASTM v1 1992, HL7 v2 1999, v2.1 (ANSI) 2002
- Formalism for procedural medical knowledge
- Unit of representation = Medical Logic Module (MLM)
  - Enough logic + data to make a single decision
  - Generate alerts/reminders
- Adopted by several major vendors

Jenders RA, Dasgupta B. Challenges in implementing a knowledge editor for the Arden Syntax: knowledge base maintenance and standardization of database linkages. Proc AMIA Symp 2002;:355-359.



## Arden Syntax (continued)

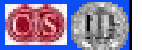
- Has been used to encode guidelines (as hierarchy of MLMs)
- Consensus: Not ideally suited for guidelines
  - Entry points and eligibility criteria (not triggers)
  - Flow of steps (not procedures)
- Ongoing work
  - Arden as a separate standard for simple alerts
  - Examine other models for guidelines



## Guideline Model: GLIF

- Guideline Interchange Format
- Origin: Study collaboration in medical informatics
- Now: GLIF3
  - Very limited implementation
- Guideline = Flowchart of temporally ordered steps
  - Decision & action steps
  - Concurrency: Branch & synchronization steps

Peleg M, Ogunyemi O, Tu S et al. Using features of Arden Syntax with object-oriented medical data models for guideline modeling. Proc AMIA Symp 2001;:523-527.



## GLIF (continued): Levels of Abstraction

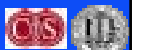
- Conceptual: Flowchart
- Computable: Patient data, algorithm flow, clinical actions specified
- Implementable: Executable instructions with mappings to local data



## Guideline Model: GEM

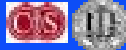
- Guideline Elements Model = Current ASTM standard
- Markup of a narrative guideline into structured format using XML
  - Not procedural programming
  - Tool = GEM Cutter
- Resulting structure might be used to translate to executable version

Shiffman RN, Agrawal A, Deshpande AM, Gershkovich P. An approach to guideline implementation with GEM. Proc Medinfo 2001;:271-275.



## GEM (continued)

- **Model** = 100+ discrete elements in 9 major branches
  - identity and developer, purpose, intended audience, development method, target population, testing, revision plan and knowledge components
- **Iterative refinement**: Adds elements not present verbatim but needed for execution
- **Customization**: Adding meta-knowledge
  - controlled vocabulary terms, input controls, prompts for data capture



## Guideline Model: CPGA

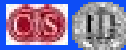
- Clinical Practice Guideline Architecture (SCHIN -> UK NHS)
- Model = Based on HL7 CDA (XML)
  - Not a programming language
  - Represents the structure of a guideline

Sponsored by Centre for Health Informatics at Newcastle. Clinical practice guideline architecture, version 0.797.  
<http://www.schin.ncl.ac.uk/cpga> Web site accessed 24 April, 2003.



## CPGA (continued)

- Guideline = Hierarchy of elements
  - Header
    - Title, developer, etc
  - Body
    - Basis of evidence, recommendation, etc
- Elements can be refined into more atomic elements
  - Action recommendation -> recommendation ID, author, evidence, prose recommendation and structured recommendation



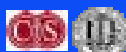
## V. Convergence and The Future

- **Ongoing work**: Use HDF to broker consensus on a computable guideline formalism
  - Proceed from real-world use cases
  - Use storyboard techniques
  - Resulting formalism may include elements of Arden, GLIF, GEM and CPGA



## Convergence (continued)

- **Opposing view**: A single formalism may not be possible or desirable
  - Complexity of guidelines and their purposes
  - Result: A small number of “niche” formalisms
    - Arden for simple alerts/reminders
    - Others for complex guidelines
  - A small group of formalisms would share common components (data model, vocabulary, expression language)



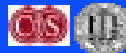
## The Future: Parallel Tracks

- HDF process for a guideline model
- Shareable components of a guideline model
  - Work on these components may promote consensus on an overall guideline model



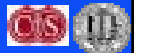
## The Future: Other Key Points

- Shareable KR = Only 1 part of a CDS milieu
  - Electronic data acquisition, repositories, messaging/communication, EMRs, controlled vocabularies
- Computable knowledge transfer must address data mapping
  - Query language, data model, vocabulary



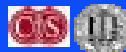
## Part A: Summary

- Clinical performance is not ideal + knowledge is exploding
  - Guidelines can help
- Paper guidelines not used ideally
  - Need computable guidelines
- Knowledge sharing is fostered by standards
  - Components: Expression language, data model
  - Guideline formalism: Arden, GLIF, GEM, CPGA, etc



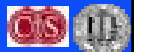
## Part B: Arden Syntax and Guideline Issues

- I. Context: KR in clinical decision support
- II. Work in HL7
  - Improving Shareability: Component Development
  - Arden Syntax
- III. Issues regarding clinical guidelines: Immunization information systems (IIS) as case example



## What is Clinical Decision Support? *Different Levels*

- Organization of Data: the CIS
  - “checklist effect”
- Stand-Alone Expert Systems
  - often require redundant data entry
- Data Repository: Mining
- CDSS Integrated into Workflow
  - push information to the clinician at the point of care
  - examples: EMR, CPOE

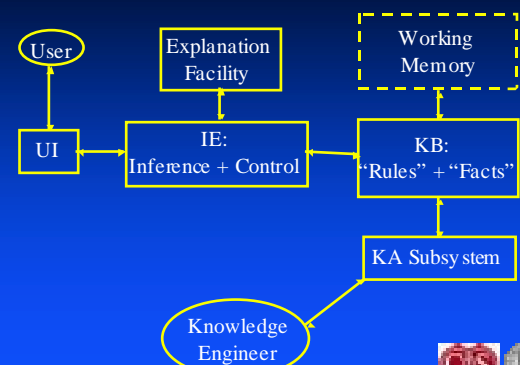


## Key Architectural Elements


- Data capture/display/storage
  - EMR
  - central data repository
- Controlled, structured vocabulary
- Knowledge representation
- Knowledge acquisition
- Clinical event monitor: integrate the pieces for many different uses (clinical, research, administrative)

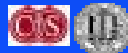


## KR: Role in CDSS Architecture



## Forms of Knowledge Representation

- Bayesian/probabilistic = Decision Analysis
  - Guideline Models: GEM, GLIF, etc
  - Case-based reasoning
  - Ontologies
  - Decision Tables
  - Artificial Neural Networks
  - Bayesian Belief Networks
  - Procedural
  - Production rules
- Arden Syntax
- 



## II. Work in HL7: Arden Syntax

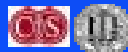
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## Support for Arden Syntax

### Institutions

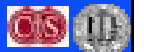
- Cedars-Sinai Medical Center

### Software Vendors

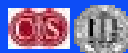
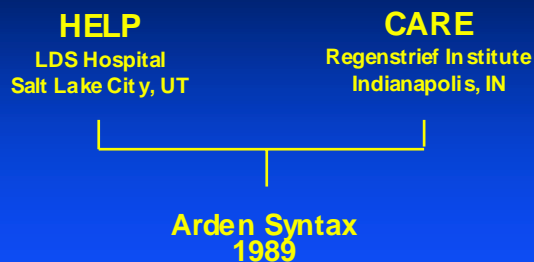
- Eclipsys/Healthvision
- McKesson
- Siemens

### Knowledge Vendors

- Micromedex



## Arden Syntax - History



## Arden Syntax - Rationale

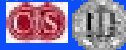
*Arden Syntax arose from the need to make medical knowledge available for decision making at the point of care.*

- Allow knowledge sharing within and between institutions
- Make medical knowledge and logic explicit
- Standardize the way medical knowledge is integrated into hospital information systems



## Medical Logic Module

- MLM = an independent unit in a health knowledge base
- MLM: Makes a single health decision
  - maintenance information
  - links to other sources of knowledge/data
  - logic
- MLM = a stream of text stored in an ASCII file in statements called slots
- Purpose: Standard format so that knowledge can be shared



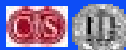
## MLM - Structure

```
maintenance:
  slotname: slot-body;;
  slotname: slot-body;;
  ...
library:
  slotname: slot-body;;
  ...
knowledge:
  slotname: slot-body;;
  ...
end:
```



## Maintenance Category - Example

```
maintenance:
title: Contrast CT study in patient with renal failure;;
mlmname: ct_contr.mlm;;
arden: Version 2;;
version: 1.00;;
institution: Arden Medical Center;;
author: John Doe, MD;;
specialist: Jane Doe, MD;;
date: 1995-09-11;;
validation: testing;;
```



## Library Category - Example

```
library:
purpose: To alert the health care provider of new or
worsening serum creatinine level;;
explanation: If the creatinine is at or above a threshold
(1.35 mg/dl), then an alert...;;
keywords: renal insufficiency; renal failure ;;
citations: Proceedings of the Fifteenth Annual Symposium
on Computer Applications in Medical Care; 1991 Nov
17-20; Washington, D.C. New York IEEE Computer
Society Press, 1991.
links: URL "NLM Web Page", http://www.nlm.nih.gov/;;
```



## Knowledge Category - Slots

- . Type
- . Data
- . Priority
- . Evolve
- . Logic
- . Action
- . Urgency



## Data Slot - Example

```
creatinine := read {'dam'='PDQ RES2'};
last_creat := read last {select "OBSRV_VALUE" from "LCR"
where qualifier in ("CREATININE",
"QUERY_OBSRV_ALL")};
```

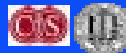


## Evoke Slot

The evoke slot defines what triggers an MLM

### Example triggers

- The occurrence of an event
- Timed execution after an event
- Periodic repetition after an event
- Direct call from another MLM



## Evoke Slot - Example

```
data:
  creatinine_storage := event {'32506','32752'};

evoke:
  creatinine_storage;;
```

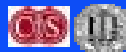


## Evoke Slot - Temporal Manipulation

```
evoke: 3 days after time of creatinine_storage;
```

```
evoke: every 1 day for 7 days starting at time of
creatinine_storage;
```

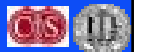
```
evoke: every 1 day starting at time of K_storage until
K>=3;
```



## Logic Slot

- Set of medical criteria
- Logical algorithm
- Ends with a “conclude statement”

```
conclude true;
  or
conclude false;
```



## Logic Slot: IF - THEN

```
if <expr1> then
  <block1>
endif;
```

```
if <expr1> then
  <block1>
else
  <block2>
endif;
```

```
if <expr1> then
  <block1>
elseif <expr2> then
  <block2>
elseif <expr3> then
  <block3>
...
elseif <exprN> then
  <blockN>
else
  <blockE>
endif;
```



## Logic Slot - Iteration

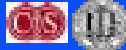
```
while <expr> do
  <block>
enddo;
```

```
for <expr> do
  <block>
enddo;
```



## Logic Slot - Call Statements

```
<var> := call <name>;  
  
<var> := call <name> with <expr>;  
  
(<var>, <var>, ...) := call <name> with <expr>;  
  
<var> := call <name> with <expr>, ..., <expr>;  
  
(<var>, <var>, ...) := call <name> with <expr>, ..., <expr>;
```



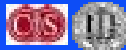
## Call Statements - Examples

```
var1 := call my_mlm with param1, param2;  
  
var1 := call my_event with param1, param2;  
  
var1 := call my_interface_function with param1,  
param2;
```



## Logic Slot - Example

```
logic:  
  if last_creat is not present then  
    alert_text := "No recent creatinine available. Consider  
    ordering creatinine before giving IV contrast."  
    conclude true;  
  elseif last_creat > 1.5 then  
    alert_text := "This patient has an elevated creatinine.  
    Giving IV contrast may worsen renal function."  
    conclude true;  
  else conclude false;  
endif;
```

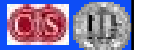


## Action Slot - Example

```
action:  
  write "Last creatinine: " || last_creat || " on: " || time of  
  last_creat;
```

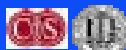
*appears as:*

Last creatinine: 2.36 on: 1997-02-16T06:30:00



## Conclude Statement

- *conclude true;*
  - terminate the rule
  - go to the action slot
- *conclude false;*
  - terminate the rule
  - do not go to the action slot



## II. Improving Arden Shareability: Shareable Guideline Components

- Standard data model
- Expression language
- Controlled terminologies



## Using Shared Components in Arden: Curly Braces Problem

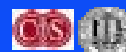
- Site-specific data mappings are not part of the standard
  - Enclosed in { }
- Example  

```
last_creat := read last {select "OBSRV_VALUE" from "LCR"
where qualifier in ("CREATININE", "QUERY_OBSRV_ALL")};
```
- Types of Elements
  - Data queries
  - Events
  - Destinations



## Addressing the Curly Braces Problem: Two Approaches

- Backward-Compatible (transitional)
  - Standard (object-oriented) data model
  - Standard vocabularies
  - Add “dot notation” to make variables more object-like
  - Operator parameters must be simple/current data types
- Backward-Incompatible
  - Fully object-oriented variables
  - Methods
  - Operator parameters may be objects



## Backward-Compatible Approach

- Focus first on data queries (bulk of processing time)
- Elements
  - Query language = SQL
  - Data model = RIM
  - Vocabulary = SNOMED-CT, LOINC, CPT-4, ICD-9, etc
- General form  

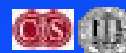
```
<variable> :=
  READ <aggregation> <attribute>
  FROM <RIM object>
  WHERE <constraint>;
```

Jenders RA, Corman R, Dasgupta B. Making the standard more standard: a data and query model for knowledge representation in the Arden Syntax. Proc AMIA Symp 2003;



## Standardized Curly Braces: Examples

- *plasma\_cell\_count := read value from observation where code='24103-4'^'PLASMA CELLS'^'LN'^'2.05' and classCode = 'OBS' and moodCode='EVN';*
- *(name, sex, location) := read name, administrativeGenderCode, addr from person where name = 'Jones';*
- *oral\_meds := read code from substanceAdministration where routeCode = 'PO' and classCode = 'SBADM' and moodCode = 'EVN'.*

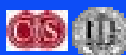


## Arden Syntax: Object-Oriented Model

- Declare an object  

```
<variable> := OBJECT [<attribute-1>,
  <attribute-2>,...]
```
- Instantiate object with a query  

```
<variable> := READ AS <object type>
  <aggregation> (<mapping>) WHERE
  <constraint>;
```



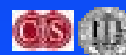
## Arden Syntax: Object-Oriented Example

```
med := OBJECT [code, route];

pt_meds := READ AS med (code,
  routeCode) from substanceAdministration
  where classCode = 'SBADM' and moodCode =
  'EVN';
```

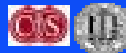
### Variable References

```
med.code
med.routeCode
```



## Backward-Incompatible Approach

- Fully object-oriented on both sides of assignment operator
  - Queries (“curly braces”)
  - Variables
- Current Arden operators would have to be redefined to handle objects as parameters
- Application: GELLO



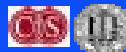
## GELLO: Examples

- 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



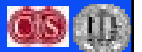
## III. Knowledge Sharing Issues

- Knowledge Libraries: IMKI as an example
- Knowledge Validation: IIS as an example



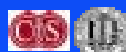
## IMKI

- Institute for Medical Knowledge Implementation = Vendor consortium
- Goals
  - Provide tools for encoding knowledge
  - Provide a library of shareable knowledge (directly executable or automatically translatable)
- Initial effort: Arden Syntax MLMs
- Current status: On hiatus



## Other Knowledge Sharing

- Altruistic individual institutions
  - CPMC ([www.dmi.columbia.edu](http://www.dmi.columbia.edu))
- Among institutions of the same CDSS vendor



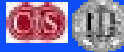
## Knowledge Sharing Issues: IIS as Case Example

- Immunization Information System
  - Population-based registry of immunizations delivered
  - Aggregating data from multiple sources
- Complex guidelines for administration: age-based, disease-based
- Status in USA
  - State and local registries (not a national registry)
  - Work on data exchange

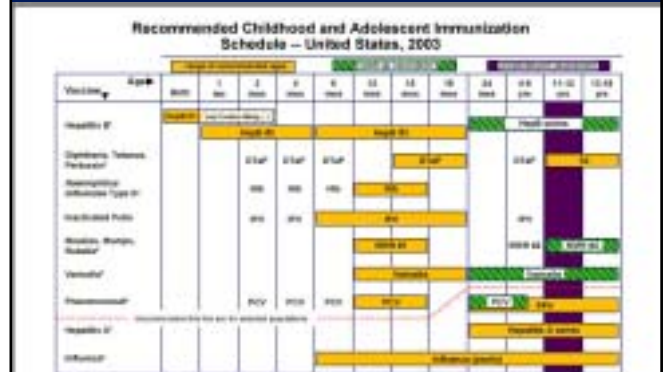


## IIS: Key Knowledge Sharing Issues

- How to represent (executable) guidelines?
- How to validate algorithm?
- How to validate implementation?
- Who does the validation?



## Decision Support Challenge: Schedule Complexity

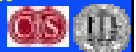


## Decision Support Challenge: Schedule Complexity

1. **Hepatitis B vaccine (HepB).** Infants should receive the first dose of Hepatitis B vaccine soon after birth and receive a second dose...  
 2. **Polio vaccine (IPV).** The fourth dose of IPV may be administered as early as age 12 months...  
 3. **Measles, mumps, and rubella vaccine (MMR).** The second dose of MMR is recommended routinely at age 4-6 years...  
 4. **Varicella vaccine.** Includes vaccine recommended at any age at or after age 12 months...  
 5. **Haemophilus influenzae type b (Hib) vaccine.** The first dose of Hib vaccine is recommended at age 2 months...  
 6. **Diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP).** The fourth dose of DTaP may be administered as early as age 12 months...  
 7. **MMR2 vaccine.** Includes vaccine recommended at children and adolescents in special circumstances...  
 8. **Influenza vaccine.** Influenza vaccine is recommended annually for children age 6 months and older...

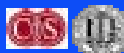
## How to represent guidelines in IIS?

- **Appropriate format?**
  - Original guidelines so sometimes vague and exception-filled
  - ACIP: Text-based algorithms
  - Computable format: What to use? (Arden Syntax, GLIF, etc)
- **Ideal goal:** Publish in both narrative and executable forms
  - Could contribute to shareable library
  - Avoid need for manual translation at each site



## How to validate guidelines in IIS?

- **Assured function:** Test cases
- **Assured knowledge structure:** Central authority creates executable versions
- **Assured system function:** Central authority tests CDSS



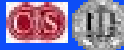
## Who validates guidelines in IIS?

- **Interest in certification** (funding, assured security upon record transfer)
- **Problem:** Who certifies?
  - Private agency: costly
  - Government
  - Professional organizations: AMIA, AAP, etc
- **Standards for certification:** NVAC Functional Standards
  - NIRCC: National Immunization Registry Certifying Committee
  - Pilot certifications now in progress



## Part B: Summary

- Arden Syntax = rule-based / procedural hybrid for KR
- Improving Arden Shareability
  - Standardized “curly braces”
  - Shareable components: Data model, expression language
- HIS illustrate other issues beyond KR that must be addressed
  - Validation: How & who



## Overall Summary

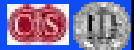
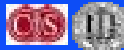
- There is no right answer!
  - Arden Syntax is implemented by major vendors
  - Arden Syntax is used by many clients
  - Arden Syntax may not be ideal for guidelines
  - GEM (and others) lack computability
- Shareability must address data linkages



## Thanks!

- Klaus Veil, Peter MacIsaac and HL7 Australia
- Agency for Healthcare Research and Quality (USA), grant R01-HS10472-01A1
- University of Melbourne

jenders@ucla.edu  
<http://www.boh.ucla.edu/~jenders/>



## Questions/Issues for Workshop

- What form(s) of KR for guidelines?
- Tools?
- Should we wait for HL7 to define a standard?
  - What can/should we do now?
- Practical next steps

