# Clinical Decision Support

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**CTSI Biomedical Informatics Module**

**4 June 2015**

**http://jenders.bol.ucla.edu**

# Learning Objectives

- **Understand key drivers of CDS, including availability of structured data for personalized medicine**
- **Learn the definition and scope of CDS**
  - **CDS = Applying knowledge to data**
- **Describe the details of standards and how they are used to implement CDS**

# Theme: Using Standards to Improve Knowledge Sharing in CDS

- CDS technology exists but is not being used optimally
  - Need to improve knowledge sharing (transfer, reuse, service-mediated access): Reduce the cost, improve the reliability of knowledge engineering, increase the likelihood of CDS use
- Approach: Standards
  - Standards: Not enough; too many!
    - Fill in current gaps + convergence
  - Make it easier
    - Better knowledge transfer
    - Better knowledge access: Standard interfaces instead of standard KR
    - Provide guidance on how to use CDS

# Driver of CDS: Meeting Information Needs

- **Systematic review: N = 72 studies of needs of physicians, medical residents, physician assistants, nurse practitioners, nurses, dentists and care managers**
- **Frequency of clinician questions (mean)**
  - **0.57 questions/patient seen**
  - **Clinicians pursued 51%**
  - **Clinician need met in 78% of these**
- **Domain of questions**
  - **Drug tx: 34%**
  - **Cause of symptom, finding, test result: 24%**

Del Fiol G, Workman TE, Gorman PN. Clinical questions raised by clinicians at the point of care: a systematic review. JAMA Intern Med. 2014 May 1;174(5):710-8.

# Need/Challenge for CDS: Changing Behavior

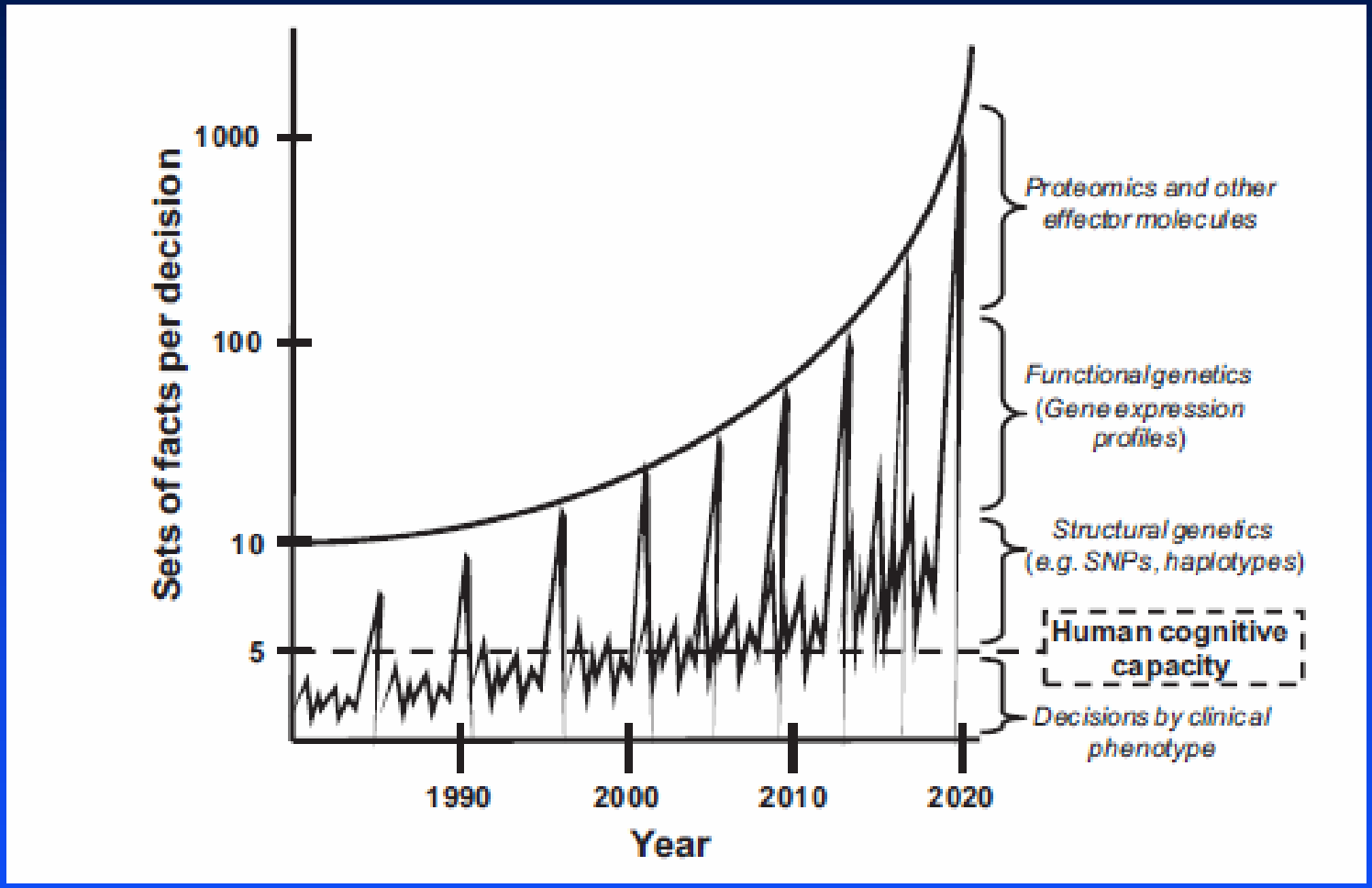
- **USA: Only 54.9% of adults receive recommended care for typical conditions**
  - **community-acquired pneumonia: 39%**
  - **asthma: 53.5%**
  - **hypertension: 64.9%**

  **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.**

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

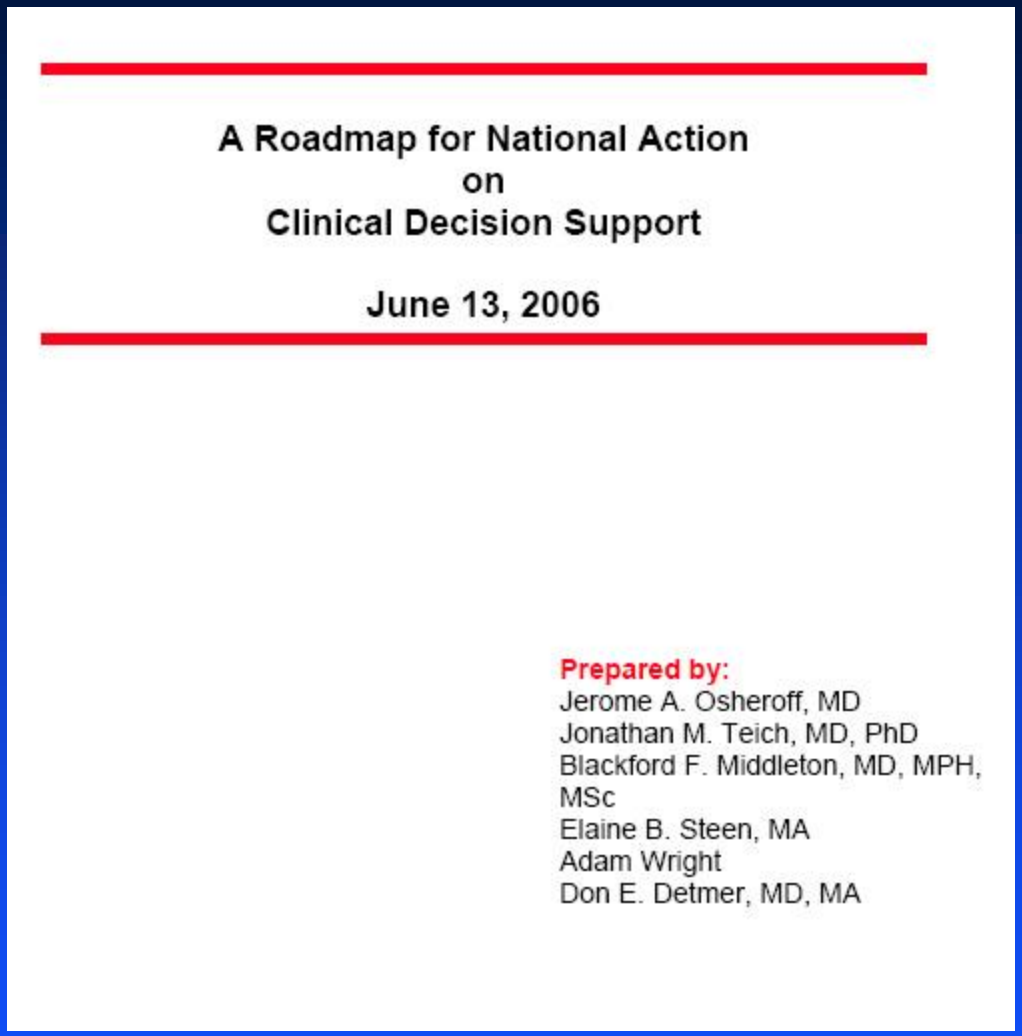
**Antman EM, Lau J, Kupelnick B et al. A comparison of results of meta-analyses of randomized control trials and recommendations of clinical experts. Treatments for myocardial infarction. JAMA 1992;268(2):240-8.**

# Challenge for CDS: Explosion in Data + Knowledge




Stead WW, Searle JR, Fessler HE et al. Biomedical informatics: changing what physicians need to know and how they learn. Acad Med 2011Apr;86(4):429-434.

# A Rationale for Standardization: CDS



A Roadmap for National Action
on
Clinical Decision Support

June 13, 2006

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

Osheroff JA, Teich JM, Middleton B et al. A roadmap for national action on clinical decision support. J Am Med Inform Assoc. 2007 Mar-Apr;14(2):141-5.

# CDS National Roadmap: Three Pillars

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

Jenders RA, Morgan M, Barnett GO. Use of open standards to implement health maintenance guidelines in a clinical workstation. Comput Biol Med 1994;24:385-390.

# Rationale: "Meaningful Use"

- **Monetary incentive program created by ARRA HITECH (2009): Payments by CMS for participation**
- **<u>Key ingredients</u>: Use CEHRT "meaningfully" (eRx), health data exchange, reporting quality measures**
- **<u>Phases</u>**
  - **Stage I (2011-2012): Hospitals report 20/24 quality measures**
  - **Stage II (2013): Electronic data exchange (structured lab data, immunization registries), listing patients by condition, etc**
  - **Stage III (2017+): 2015 NPRM just closed for public comment (29 May)**

**http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html**

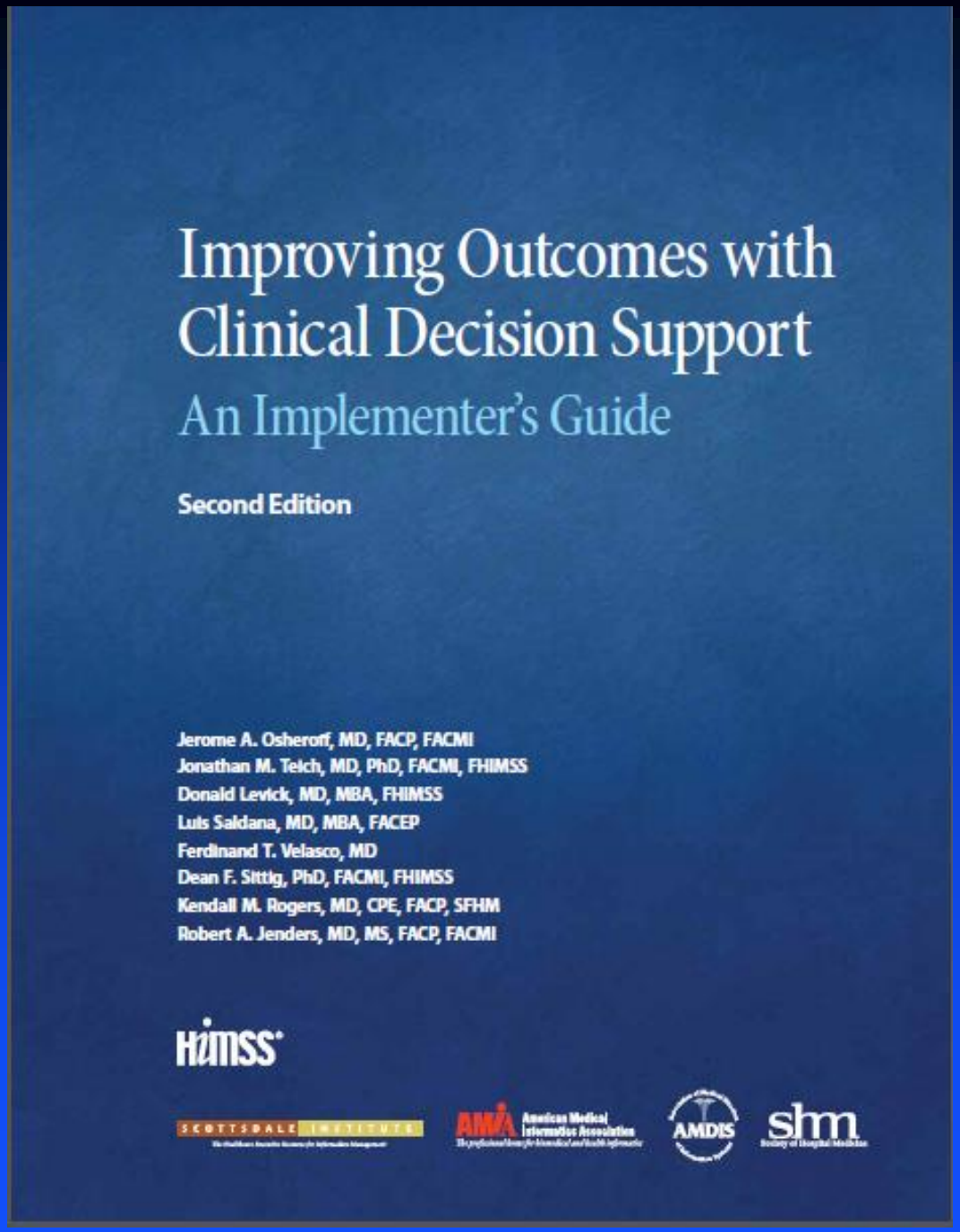
# CDS: Definitions

- **Foundational: Key origin of field of Biomedical Informatics**
  - **AIM == Artificial Intelligence in Medicine**
  - **Computer-based diagnosis in the heyday of AI**

- **Now: Intelligent assistant**
  - **Support / assist human decision-makers, not supplant them**

- **Core: Applying knowledge to data**

**Miller RA. Medical diagnostic decision support systems—past, present and future: a threaded bibliography and brief commentary. J Am Med Inform Assoc 1994;1:8-27.**


Improving Outcomes with Clinical Decision Support
An Implementer's Guide
Second Edition
Jerome A. Osheroff, MD, FACP, FACMI
Jonathan M. Teich, MD, PhD, FACMI, FHIMSS
Donald Levick, MD, MBA, FHIMSS
Luis Saldana, MD, MBA, FACEP
Ferdinand T. Velasco, MD
Dean F. Sittig, PhD, FACMI, FHIMSS
Kendall M. Rogers, MD, CPE, FACP, SFHM
Robert A. Jenders, MD, MS, FACP, FACMI
HIMSS
SCOTTSDALE INSTITUTE
AMIA American Medical Informatics Association
AMDIS
shm

# Improving Outcomes with Clinical Decision Support: An Implementer's Guide

- First edition (2005) = Product of HIMSS Patient Safety Task Force
- Second edition (2012): Sponsored by AHRQ
- Goal: Provide practical advice to health care organizations
  - Choosing decision support goals
  - Choosing technology to advance those goals
  - Developing a deployment strategy

Jenders RA, Osheroff JA, Sittig DF, Pifer EA, Teich JM. Lessons in clinical decision support deployment: synthesis of a roundtable of medical directors of information systems. AMIA Annu Symp Proc. 2007 Oct 11:359-63.

# CDS Interventions

- Computer-based (though not necessary)
- Typical examples: Consulting a colleague, reading a text book, alert/reminder, data forms, order sets, clinical practice guidelines
- Possible ingredients: Trigger, logic, notification, data presentation, action items
- Knowledge management: Key program in leveraging CDS
  - Comprehensive process for acquiring, adapting and monitoring information for use in CDS
  - Keeps information up to date with clinical evidence, expert consensus and local conditions

# CDS: What is it?

- **Definition: "Clinical Decision Support is a process for enhancing health-related decisions and actions with pertinent, organized clinical knowledge and patient information to improve health and healthcare delivery."**
- **Recipients: Patients, clinicians, administrators—anyone involved in care**
- **Information: General knowledge, intelligently processed patient data**
- **Delivery formats: Numerous = Data/order entry facilitators, filtered data displays, reference information, alerts, etc**

# CDS: Five Rights

- Framework for approaching & configuring CDS interventions
- "Rights"
  - Right information delivered to the
  - Right person in the
  - Right intervention format through the
  - Right channel at the
  - Right point in workflow

# CLINICAL DECISION SUPPORT

*The Road to Broad Adoption*

2ND EDITION

Edited by **Robert A. Greenes**

AP

# CDS: What (Else) Is It?

- **Computer-based CDS: The use of information and communication technologies to bring relevant knowledge to bear on the health care and well-being of a patient.**
- **Key aspects**
  - **Aim: Make data apparent or easier to access or foster decision-making**
  - **Provided to a user: Clinician, patient, caregiver, technician**
  - **Function: Select or group knowledge**
  - **Process: Inferencing**
  - **Result: Take some action (includes information presentation) [open loop vs closed loop]**
- **Core: Applying information to data**

# Standards Pertinent to CDS

- **HL7**
  - **v2.x, v3 messaging**
  - **CDA: Structured documents**
  - **SPL: Structured product labels**
  - **CCOW: Desktop interoperability**
  - **EHR Functional Model & Specification**
- **Others**
  - **Terminology: SNOMED, LOINC, ICD, etc**
  - **KR: Arden Syntax, others**

U.S. National Library of Medicine

# Newborn Screening Coding and Terminology Guide

Data Standards for Electronic Reporting



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

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

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

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

- **Views**: Generate customized Web views from the tables of conditions and analytes/measurements maintained by the U.S. National Library of Medicine (NLM®).
  - **Conditions** — Conditions that are targeted by newborn screening
  - **Analytes/Measurements** — Tests that are used as markers for newborn screening conditions
  - **Tailored Views** — Specify subsets, or see relationships between conditions and analytes/measurements
- **Downloads**: Download the tables of newborn screening conditions, of markers for these conditions and/or of mappings between conditions and their markers.
- **Resources**: Find additional information about newborn screening and related codes and data standards, including the Newborn Screening Draft Detailed Use Case that was developed by the Office of the National Coordinator for Health Information Technology (ONC).
- **Code and Terminology Standards**: View terms of use and other information about codes and terminologies listed and referenced on this Web site,

# CDEs

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

**Jenders RA, McDonald CJ, Rubinstein Y, Groft S. Applying standards to public health: an information model for a global rare diseases registry. AMIA Annu Symp Proc 2011;1819.**

My Family Health Portrait

A tool from the Surgeon General

Home | My Family Health History | Copy for Family Member | View Diagram & Table | Get Help

# My Family Health History

## *Create A New Family History*

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

Create My History

| Name | Relationship to Me | Add History | Update History | Remove Relative |
|---|---|---|---|---|
| My Family | | | | |
| | Self | | | |

Welcome to the NLM Personal Health Record (PHR) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

nih.gov https://phr.nlm.nih.gov/

Most Visited Getting Started Latest Headlines

Welcome to the NLM Personal Health...


# Welcome to the NLM Personal Health Record (PHR)

With the NLM PHR you can

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

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

## Login

Account ID: jenders

Password:

Sign in

Forgot your User ID? Click Here

Forgot your password? Click Here

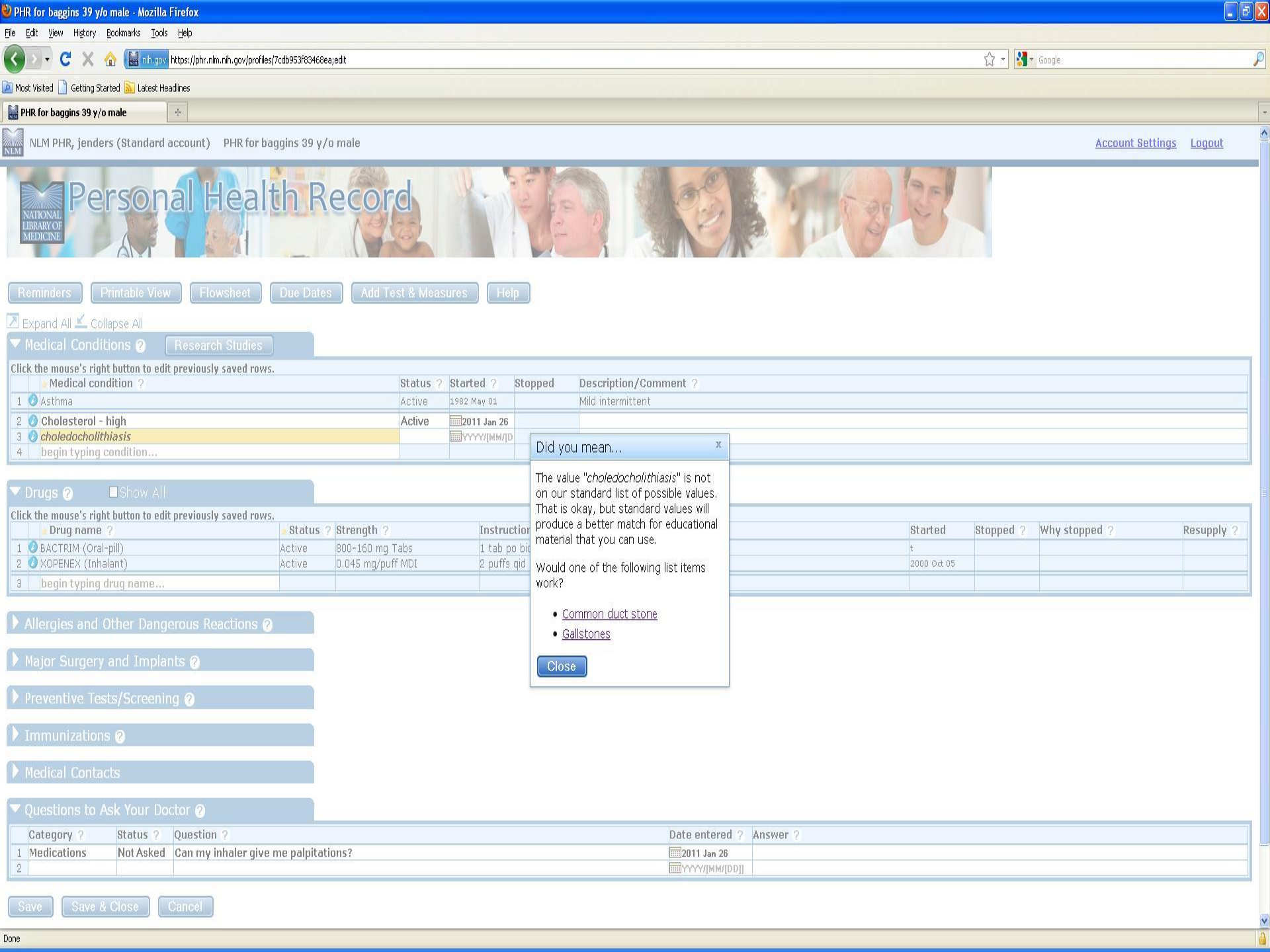
If you forgot both your User ID and password, first recover your User ID and then your password following the links above.

### New User?

To create a new NLM PHR account Click Here

Learn More: •User Agreement •Privacy Policy •FAQ •NLM Home

Done


PHR for baggins 39 y/o male - Mozilla Firefox
File Edit View History Bookmarks Tools Help
https://phr.nlm.nih.gov/profiles/7cdb953f83468ea;edit
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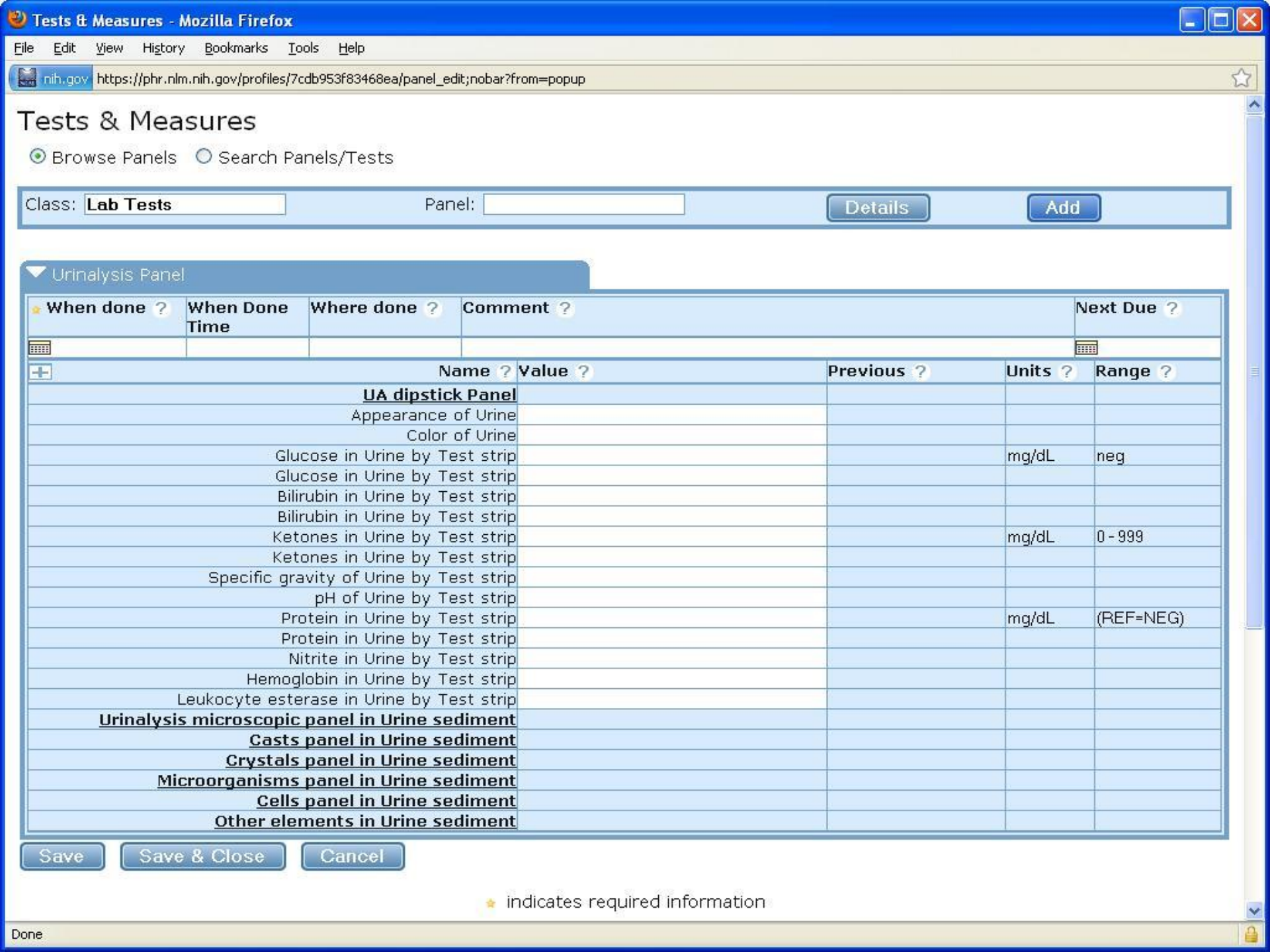
PHR for baggins 39 y/o male
NLM PHR, jenders (Standard account) PHR for baggins 39 y/o male
Account Settings Logout
Personal Health Record
NATIONAL LIBRARY OF MEDICINE
Reminders Printable View Flowsheet Due Dates Add Test & Measures Help
Expand All Collapse All
Medical Conditions
Research Studies
Click the mouse's right button to edit previously saved rows.
Medical condition ? Status ? Started ? Stopped Description/Comment ?
1 Asthma Active 1982 May 01 Mild intermittent
2 Cholesterol - high Active 2011 Jan 26
3 choledocholithiasis YYYY/[MM/[D
4 begin typing condition...
Did you mean...
x
The value "choledocholithiasis" is not on our standard list of possible values. That is okay, but standard values will produce a better match for educational material that you can use.
Would one of the following list items work?
Common duct stone
Gallstones
Close
Drugs
Show All
Click the mouse's right button to edit previously saved rows.
Drug name ? Status ? Strength ? Instruction Started Stopped ? Why stopped ? Resupply ?
1 BACTRIM (Oral-pill) Active 800-160 mg Tabs 1 tab po bi
2 XOPENEX (Inhalant) Active 0.045 mg/puff MDI 2 puffs qid 2000 Oct 05
3 begin typing drug name...
Allergies and Other Dangerous Reactions
Major Surgery and Implants
Preventive Tests/Screening
Immunizations
Medical Contacts
Questions to Ask Your Doctor
Category ? Status ? Question ? Date entered ? Answer ?
1 Medications Not Asked Can my inhaler give me palpitations? 2011 Jan 26
2 YYYY/[MM/[DD]]
Save Save & Close Cancel
Done


Tests & Measures - Mozilla Firefox
File Edit View History Bookmarks Tools Help
nih.gov https://phr.nlm.nih.gov/profiles/7cdb953f83468ea/panel_edit;nobar?from=popup
Tests & Measures
Browse Panels
Search Panels/Tests
Class: Lab Tests
Panel:
Details
Add
Urinalysis Panel
When done
When Done Time
Where done
Comment
Next Due
Name
Value
Previous
Units
Range
UA dipstick Panel
Appearance of Urine
Color of Urine
Glucose in Urine by Test strip mg/dL neg
Glucose in Urine by Test strip
Bilirubin in Urine by Test strip
Bilirubin in Urine by Test strip
Ketones in Urine by Test strip mg/dL 0 - 999
Ketones in Urine by Test strip
Specific gravity of Urine by Test strip
pH of Urine by Test strip
Protein in Urine by Test strip mg/dL (REF=NEG)
Protein in Urine by Test strip
Nitrite in Urine by Test strip
Hemoglobin in Urine by Test strip
Leukocyte esterase in Urine by Test strip
Urinalysis microscopic panel in Urine sediment
Casts panel in Urine sediment
Crystals panel in Urine sediment
Microorganisms panel in Urine sediment
Cells panel in Urine sediment
Other elements in Urine sediment
Save
Save & Close
Cancel
indicates required information
Done

# NLM PHR, jenders (Standard account) PHR for baggins 39 y/o male

## Medical Conditions

| Medical condition | Status | Started | Stopped | Description/Commen |
|---|---|---|---|---|
| Asthma | Active | 1982 May 01 | | Mild intermittent |
| Cholesterol - high | Active | 2011 Jan 26 | | |
| Common duct stone | Inactive | 2011 Jan 03 | 2011 Jan 26 | |

## Drugs

| Status | Drug | Instructions | Started | Stopped | Why stopped | Resupply |
|---|---|---|---|---|---|---|
| Active | BACTRIM (Oral-pill) -- 800-160 mg Tabs | 1 tab po bid | t | | | |
| Active | XOPENEX (Inhalant) -- 0.045 mg/puff MDI | 2 puffs qid prn wheezing | 2000 Oct 05 | | | |

## Questions to Ask Your Doctor

| Category | Status | Question | Date entered | Answer |
|---|---|---|---|---|
| Medications | Not Asked | Can my inhaler give me palpitations? | 2011 Jan 26 | |

Close

# Further Data Aggregation: HIEs, Registries

- **Information Exchanges**
  - Locate and move data among partners
  - Clinical data: HIEs (e.g., Indiana)
  - Research data: PBRNs, other (RTRN)
  - Ultimate realization: NHIN
    - Promising mechanism for implementation: Direct Project
- **Registries**: Pool exchanged data
  - Cancer and immunization = most common
  - Ultimately connect via HIEs

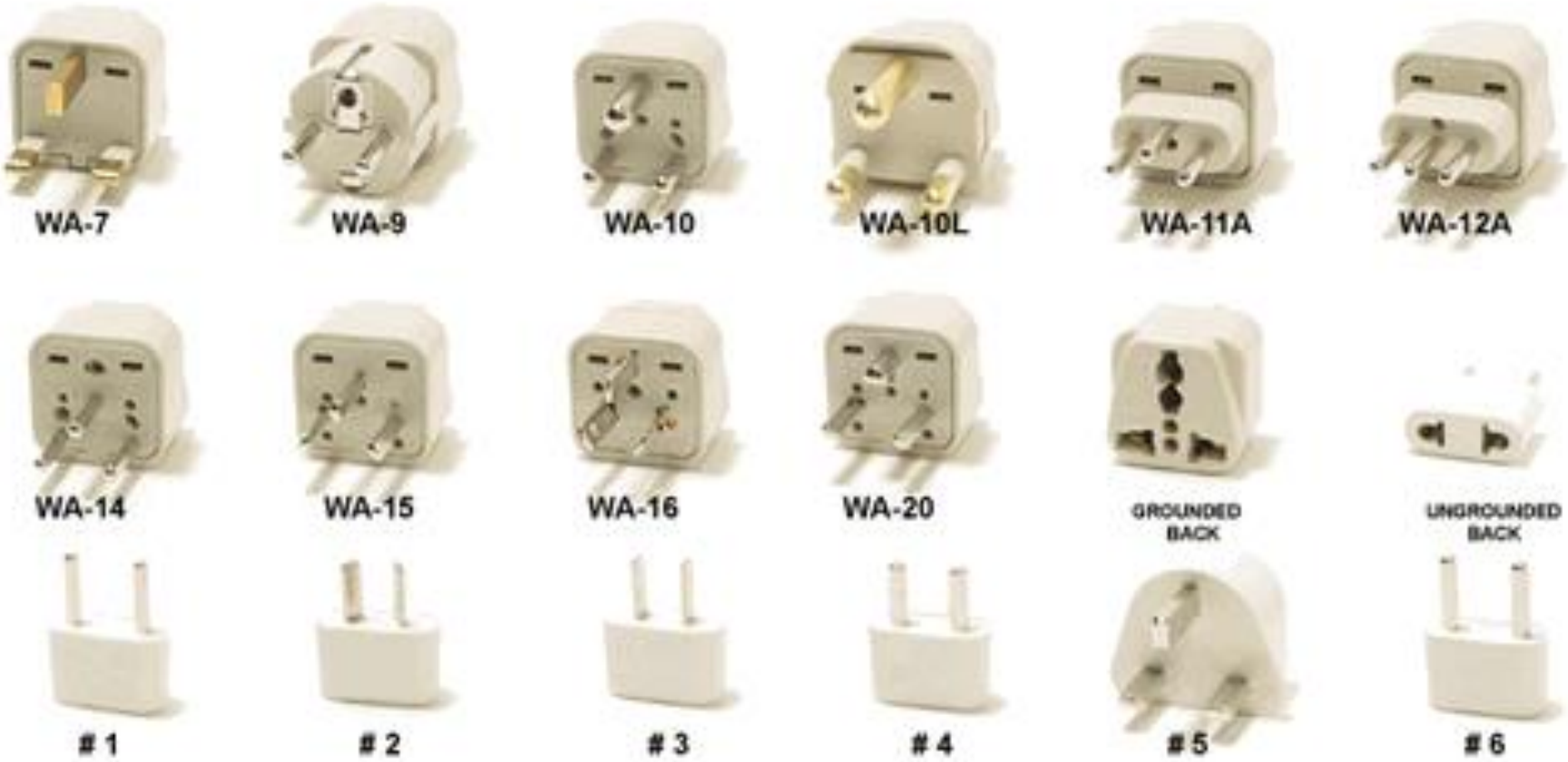
Jenders RA, Dasgupta B, Mercedes D, Clayton PD. Design and implementation of a multi-institution immunization registry. Medinfo 1998;9 Pt 1:45-49.

# Putting CDS Standards Together to Deliver Decision Support

- **Knowledge Transfer**
  - **Procedural/Executable: Arden Syntax,**
  - **Declarative: HQMF, Order Set, CDS Knowledge Artifact Specification, (CQL)**
- **Knowledge Access**
  - **Infobutton, Decision Support Services**
- **Infrastructure**
  - **vMR, (QUICK)**

# “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 ARRA HITECH ONC


WA-7
WA-9
WA-10
WA-10L
WA-11A
WA-12A
WA-14
WA-15
WA-16
WA-20
GROUNDED BACK
UNGROUNDED BACK
#1
#2
#3
#4
#5
#6

# SDO Process:
# Health Level Seven International

- North America with 20+ international affiliates
  - JIC: Coordinate with other SDOs (e.g., CEN TC251)
- Subdivided into work groups that create/maintain different standards
- Mostly volunteer workers
- Heavily consensus-based, multilayer voting approval process
- Certification of adherence to process by external authority that charters SDOs (ANSI)
- Effect: Achieved through implementation/use

# HL7 CDS Standards

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

- **Implementation Guide**
  - **CDS Knowledge Artifact Specification ( = order sets + event-condition-action rules)**

# 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) = enough data + knowledge to make a single decision
- Explicit definitions for data elements
- HL7 / ANSI / ISO Standard
- Current version: 2.10 (final approval in progress)

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.

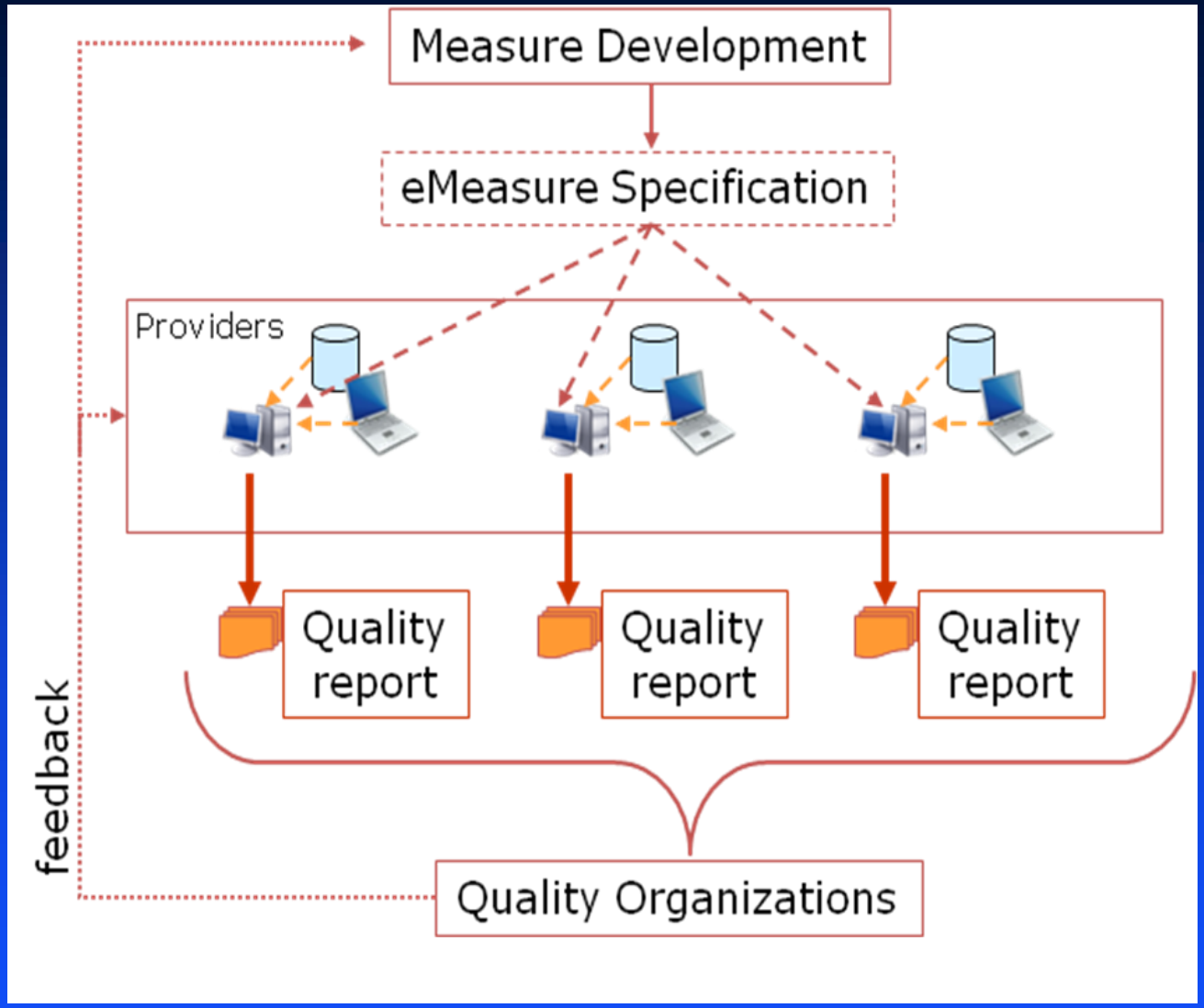
# Arden Syntax: Evolving with User Demand

- Moving away from relatively simple, clinician-friendly expressions to more powerful computability
- v2.7: Complex objects
- v2.8 (2011): Switch statement, complex list operators
- v2.9 (2012): Fuzzy logic
- v2.10 (2014): Complete XML representation format
- Active implementations
  - Fuzzy logic in infection control (U Vienna)
  - VA: Prototype implementation of health maintenance reminders via remote KB with GELLO to access data via "curly braces"

# Healthcare Quality Measure Format (HQMF)

- **Increasing mandates for clinical performance measurement**
- **Implementation of quality indicators (QIs) can be costly**
  - **Need to translate published QI to computable form**
  - **Need to collect digital data in structured format**
- **Solution: HQMF (2009) -> R2.1 (2014)**
- **Active use: eMeasures for CLABSIs (CDC); retooling quality measures into HQMF (AHRQ); implementation guide.**

# HQMF


Measure Development
eMeasure Specification
Providers
Quality report
Quality report
Quality report
feedback
Quality Organizations

# Order Set Standard

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

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

- Solution: Standardized format (published 2012) that are interoperable: Shareable and importable in CPOE

# Health eDecisions

- **Part of US Realm ONC Standards & Interoperability Framework, 2012 – 2014**

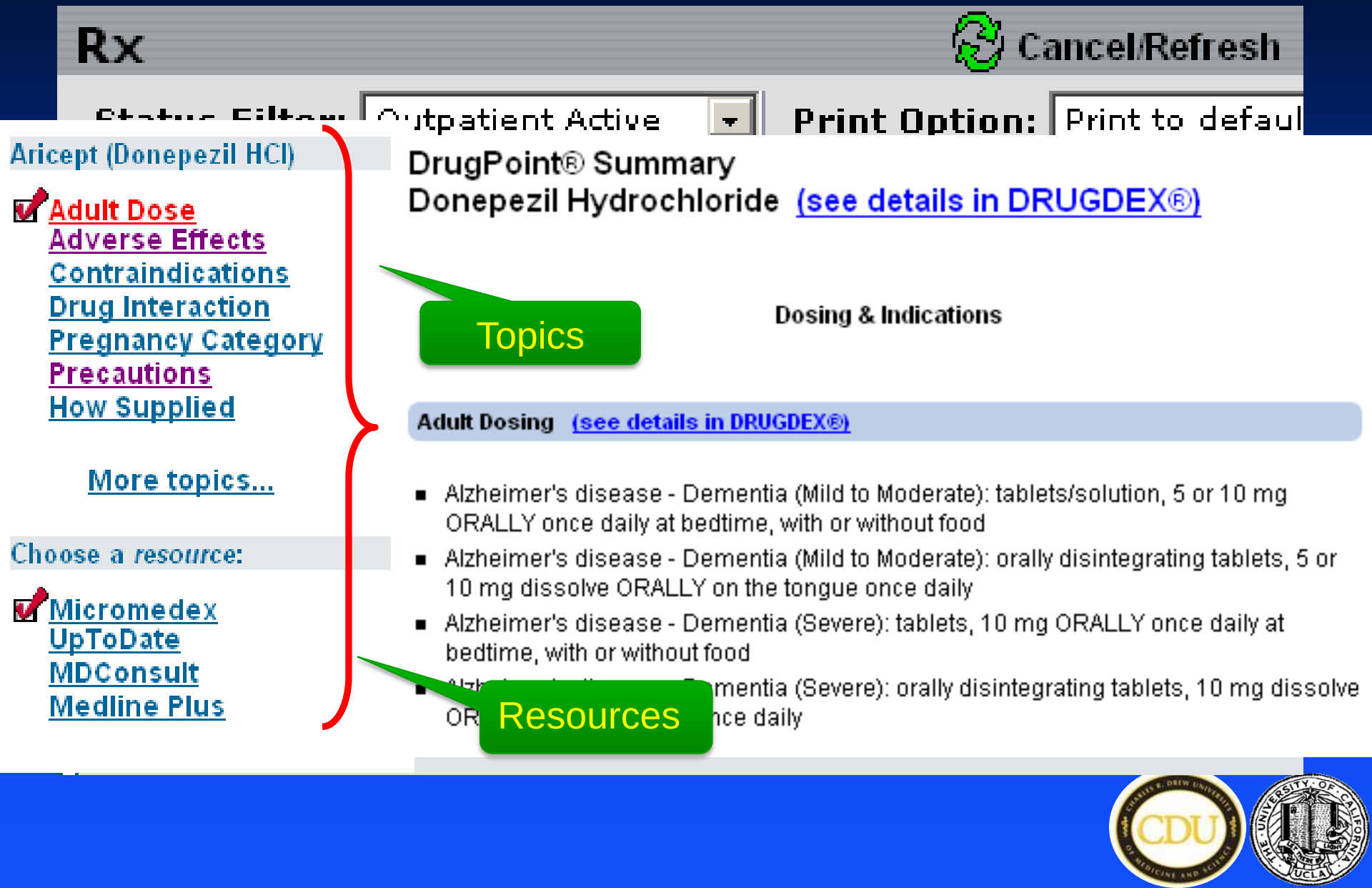
- **<u>Two key use cases</u>**
  - **CDS Guidance Service (send patient data, receive advice) = equivalent of HL7 DSS standard**
  - **Sharing knowledge artifacts (order sets, event-condition-action rules, document templates) = Replaces HL7 order set standard, possibly others**

- **<u>Focus</u>: Incorporate CDS standards into Meaningful Use regulation (NPRM 2015)**

# HeD -> Quality Improvement

- **US ONC Unified Clinical Quality Improvement Framework (aka CQF)**
- **Attempt to converge CDS and QI knowledge formalisms**
- **<u>Artifacts under development</u>**
  - **QUality Information and Clinical Knowledge (QUICK): Data model that harmonizes NQF QDM + HL7 vMR**
  - **Clinical Quality Language (CQL)**

# Infobutton


Rx
Cancel/Refresh
Outpatient Active
Print Option:
Print to defaul
Aricept (Donepezil HCl)
Adult Dose
Adverse Effects
Contraindications
Drug Interaction
Pregnancy Category
Precautions
How Supplied
More topics...
Choose a resource:
Micromedex
UpToDate
MDConsult
Medline Plus
DrugPoint® Summary
Donepezil Hydrochloride (see details in DRUGDEX®)
Dosing & Indications
Adult Dosing (see details in DRUGDEX®)
Alzheimer's disease - Dementia (Mild to Moderate): tablets/solution, 5 or 10 mg ORALLY once daily at bedtime, with or without food
Alzheimer's disease - Dementia (Mild to Moderate): orally disintegrating tablets, 5 or 10 mg dissolve ORALLY on the tongue once daily
Alzheimer's disease - Dementia (Severe): tablets, 10 mg ORALLY once daily at bedtime, with or without food
Topics
Resources

CSMC Web/VS - Results - Netscape

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop http://cscdrweb.csmc.edu/cdr/result.asp?mrn=021105897&case=&ptid=275084&ptype= Search Print

Mail Home Radio Search Bookmarks Instant Message RealPlayer

Merriam-Webster Online | CDR and Web/VS Project Information | Weather Underground: San Antonio Inte... | Diccionarios.com | CSMC Web/VS - Results

Web/VS

[redacted]

**Clinical Results**

Reported Collected

04 24 03 thru

04 30 04 Go

**Flow Sheets**

Blood Bank Go

**Reports**

All Reports Go

**Find Any Test**

Go

Another Pt | QuickLook

PPL Del | Subscribe

MD Feedback

PBS Ticket

Help | Log Off



## Results reported from 4/24/03 through 4/30/04

[redacted]

4/30/04 18:05 JENDERSR

| Collection Date/Time | Result Date/Time |
|---|---|
| 4/13/04 00:00 | 4/13/04 15:29 |
| 10/13/03 14:33 | 10/16/03 16:35 |
| 10/13/03 14:10 | 10/16/03 08:17 |
| 10/10/03 10:54 | 10/10/03 11:32 |
| 9/16/03 00:00 | 9/16/03 14:39 |
| 7/6/03 01:36 | 7/6/03 04:07 |
| 7/5/03 23:23 | 7/6/03 06:28 |
| 7/5/03 23:21 | 7/5/03 23:41 |
| 7/5/03 23:21 | 7/5/03 23:41 |

Clin-eguide - Netscape

Back Forward Reload Stop Print

Clin-eguide

DISEASE | DRUG | LABORATORY | PERFORMANCE | Contact Us | Help | Disclaime

THIS PAGE LOCATION: erythrocyte distribution width > high

SELECT CONTENT

- Reference range
- Clinical significance
- Causes
- Further tests
- Full references

OVID MEDLINE®

### Clinical significance

- NOT helpful for diagnosis in patients without anemia.
  - Red cell size distribution width should be used in conjunction with other diagnostic tests.
- Useful in the early classification of some anemias.
  - Red cell size distribution width often becomes abnormal earlier than other red cell parameters.
  - More sensitive in microcytic conditions than macrocytic.
  - Most useful to distinguish early iron deficiency from:
    - anemia of chronic disease
    - thalassemia minor.
  - Useful to improve detection of early iron, vitamin $B_{12}$ or folate deficiency.
- Usually interpreted in conjunction with the mean cell volume (MCV).

| Indices | Red cell size distribution width elevated | Red cell size distribution width normal |
|---|---|---|
| MCV low | • Anemia of chronic disease (occasionally) | • Anemia of chronic disease (occasionally) |

| | | Ref. Range |
|---|---|---|
| | | 4-11 1000/UL |
| | | 4.5-6.0 MILL/UL |
| | | 14-18 G/DL |
| | | 42-53 % |
| | | 80-100 FL |
| | | 27-33 PG |
| | | 32-36 % |
| | | 11.5-14.5 % |
| | | 150000-450000 /UL |
| | | 7.4-10.4 FL |
| | | % |
| | | % |
| | | % |
| | | % |
| | | % |
| | | 1.8-8.0 1000/UL |
| ABS LYMPHS | 5.1 | 1.0-4.5 1000/UL |
| ABS MONOS | 0.6 | <0.8 1000/UL |
| ABS EOS | 0.3 | <0.4 1000/UL |
| ABS BASOS | 0.1 | <0.2 1000/UL |
| RBC MORPHOLOGY | ABNORMAL | |

Document: Done (0.42 secs)

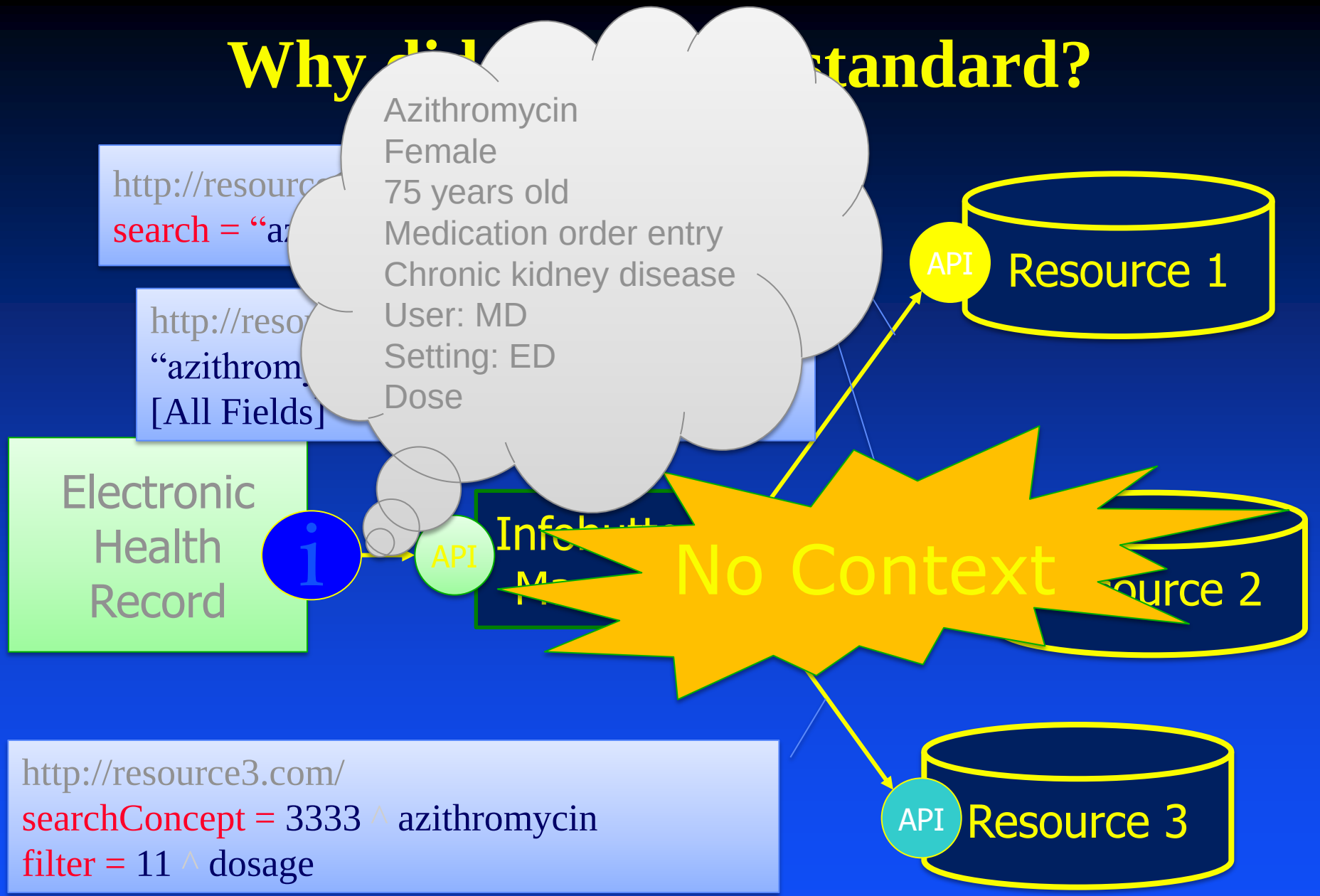
Start | Pal... | Re... | CS... | In... | C:... | Ad... | Cli... | 18:09

# Impact of Infobuttons

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

Maviglia et al. J Am Med Inf Assoc, 2006.
Cimino JJ. AMIA Ann Fall Symp. 2008.
Del Fiol et al. J Am Med Inf Assoc, 2008.

# Why did ... standard?



# Context Dimensions

## Patient

- **Concept of interest**
- **Gender / age**
- **Vital signs / renal function**
- **Problems / medications**

## User

- **Patient vs. provider**
- **Discipline / specialty**

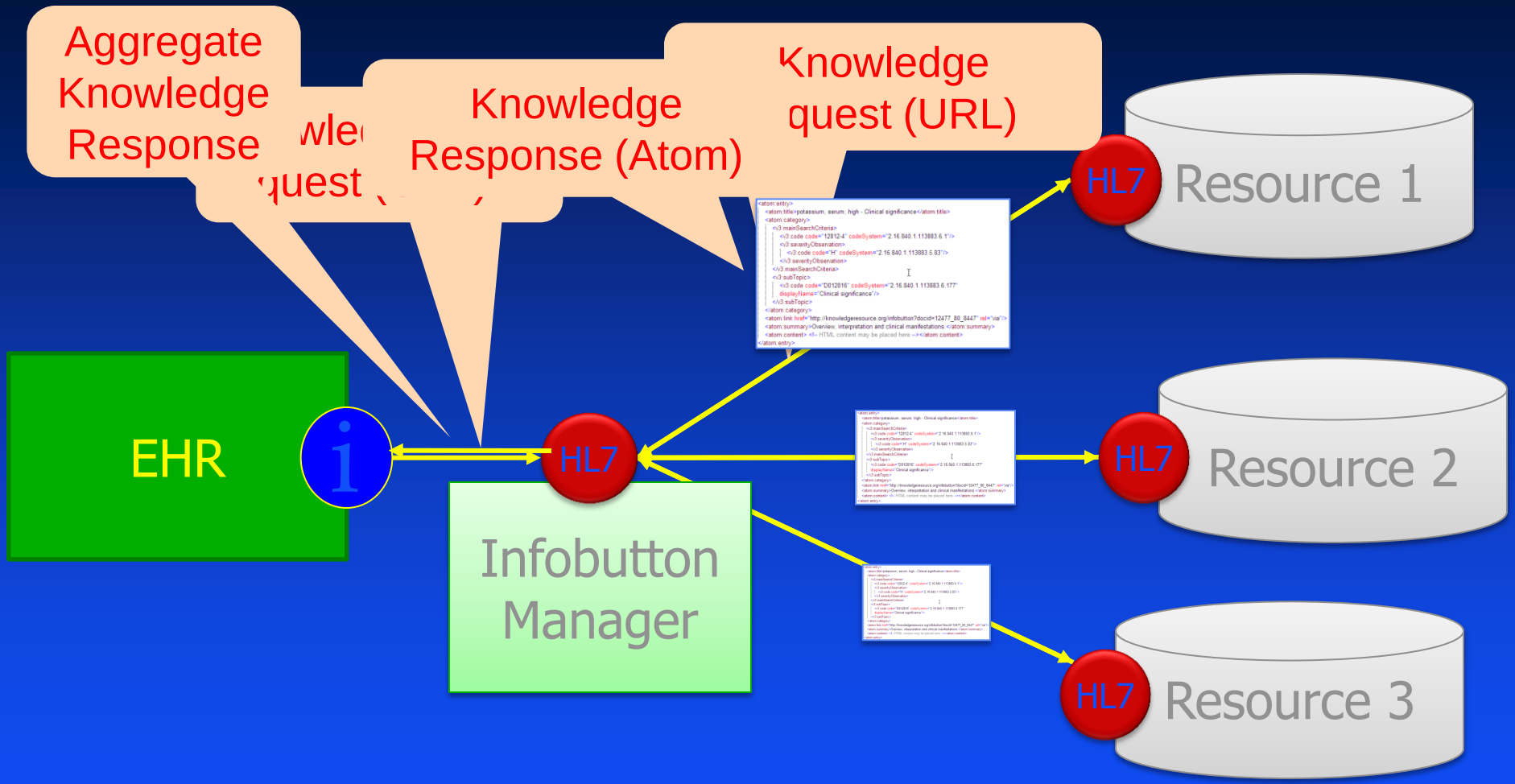
## EHR Task

- E.g., order entry, problem list entry, lab results review

## Organization

- Care setting
- Service delivery location
- Location of interest

# Standards-Based Approach



# Clin-eguide Guideline: conjunctivitis, acute infective; neonate

Updated: Jun 18, 2010



## Treatment guidelines

For neonates requiring systemic treatment, prompt joint management with a pediatrician and ophthalmologist is recommended by the A
Ophthalmology.

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

| Pathogen | Therapy |
|---|---|
| Chlamydial infection | • Erythromycin oral B1 REF |
| Gram-positive organisms | • Erythromycin topical B1 REF |
| Gram-negative organisms (other than suspected gonococcus)[a] | Use either:<br>• Gentamicin topical<br>OR<br>• Tobramycin topical B1 REF |
| Gonococcal neonatal conjunctivitis | • Ceftriaxone IV/IM B1 REF |
| Gonococcal disseminated infection | Use either:<br>• Ceftriaxone IV/IM B1 REF<br>OR<br>• Cefotaxime IV/IM |
| HSV conjunctivitis, blepharoconjunctivitis, or superficial keratoconjunctivitis | • Acyclovir IV<br>• The use of concomitant topical antivirals is controversial<br>▪ The American Academy of Pediatrics recommends use of<br>▪ Considered unnecessary by other experts (because IV ac levels in tears) |

# Interviews with HL7 Infobutton Implementers

## Strengths:

- Simplicity
- Built over widely adopted standards

## Challenges:

- Access to documentation & quick start guidance
- Competing priorities

## Benefits:

- Adds business value
- Simple mechanism to support decision-making

## Adoption:

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

Del Fiol et al. J Biomed Inform, 2012.

# Meaningful Use Stage 2

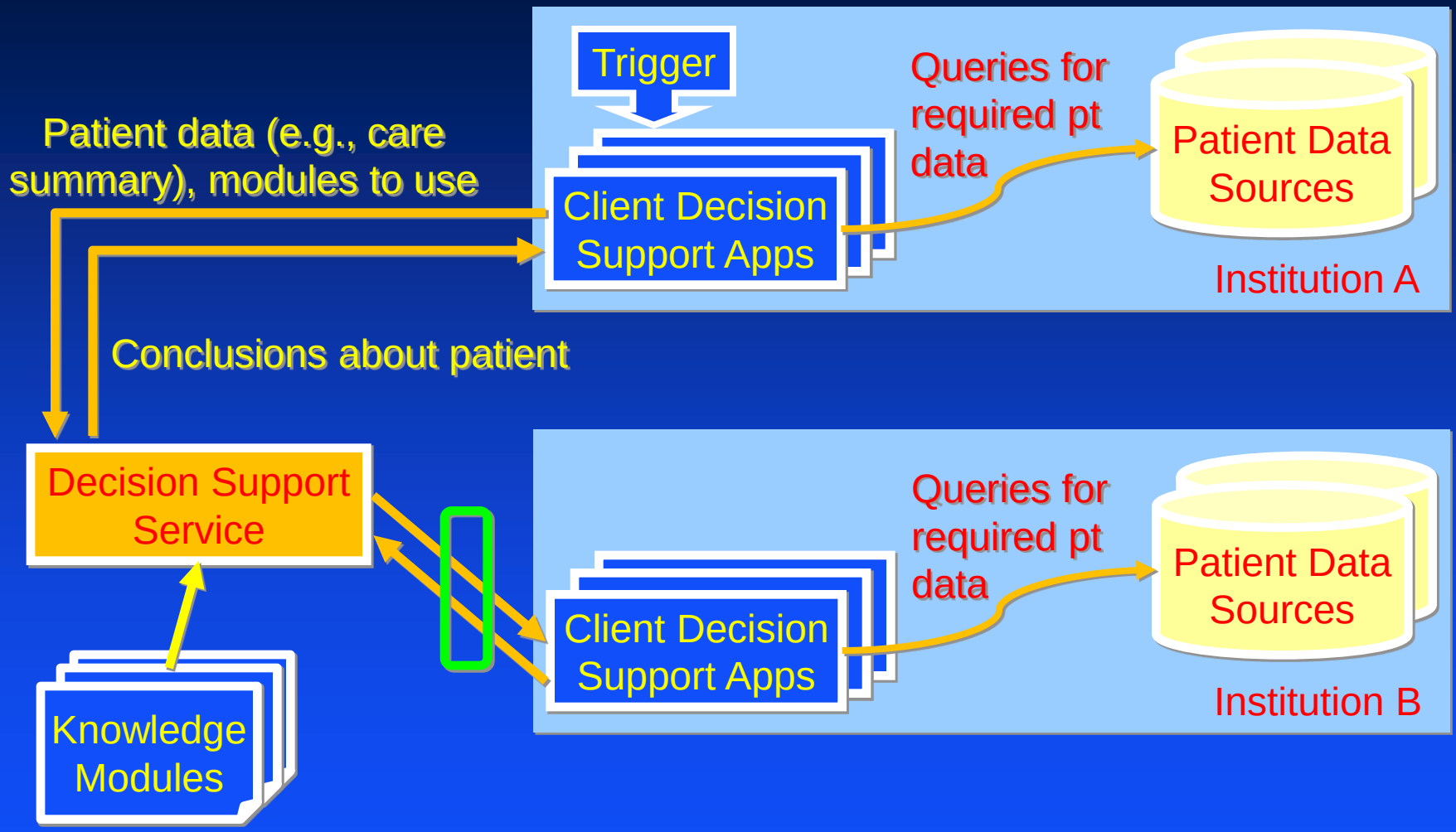
- **Required CDS capability**
  - **MAY use Infobutton Standard for provider reference information**
  - **MUST use Infobutton Standard for patient education**

- **Significant interest increase among EHRs vendors**

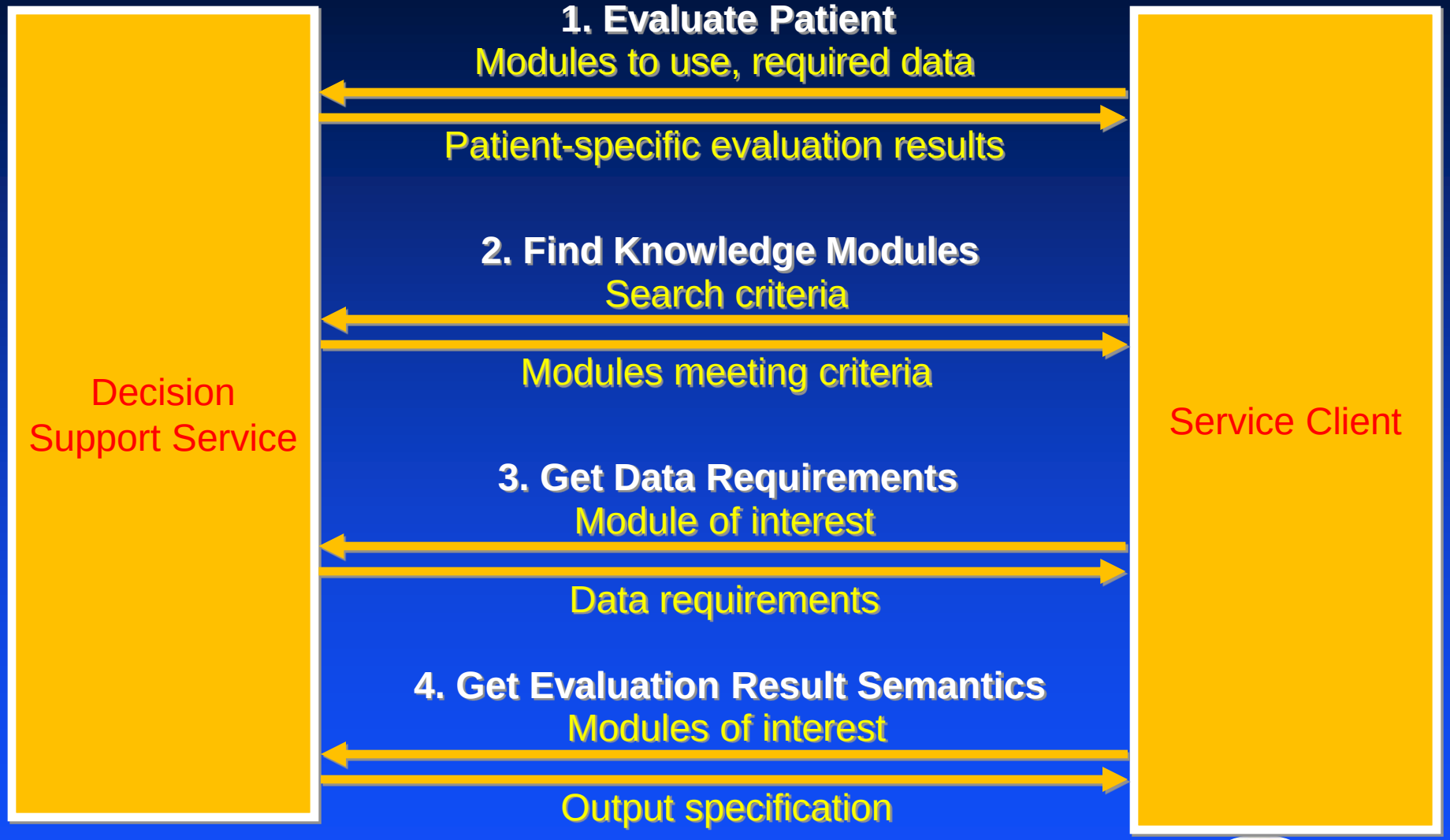
# Decision Support Service (DSS): Overview

- **Function:**
  - **Evaluates patient data (inputs) and returns machine-interpretable conclusions (outputs)**
- **Normative HL7/ANSI standard**

# DSS: Architectural Overview



# DSS – Primary Service Operations



# HL7 DSS – Tools and Use

- **Tools**
  - **OpenCDS: open-source reference implementation**
- **Known users of DSS standard (partial list)**
  - **Alabama Department of Public Health**
  - **CDS Consortium/Partners HealthCare**
  - **eClinicalWorks**
  - **HLN Consulting, LLC**
  - **HP Advanced Federal Healthcare Innovation Lab**
  - **New York City Department of Health & Mental Hygiene**
  - **University of Utah Health Care**
  - **VHA Knowledge Based Systems Office**

# Standard Data Models

- **Candidates**
  - **vMR = Virtual Medical Record**
  - **RIM = HL7 Reference Information Model**
  - **FHIR = Fast Health Interoperable Resources**
  - **CDISC SDTM**
  - **OMOP CDM**
- **Purpose: Promote semantic interoperability**
  - **Data stored, retrieved, interpreted, displayed and analyzed with the same meaning as when first captured**
  - **“Big Data” -> Secondary use of clinical data**
  - **References to data (CDS, research studies, etc) can be shared regardless of vendor or implementation**

# Virtual Medical Record (vMR)

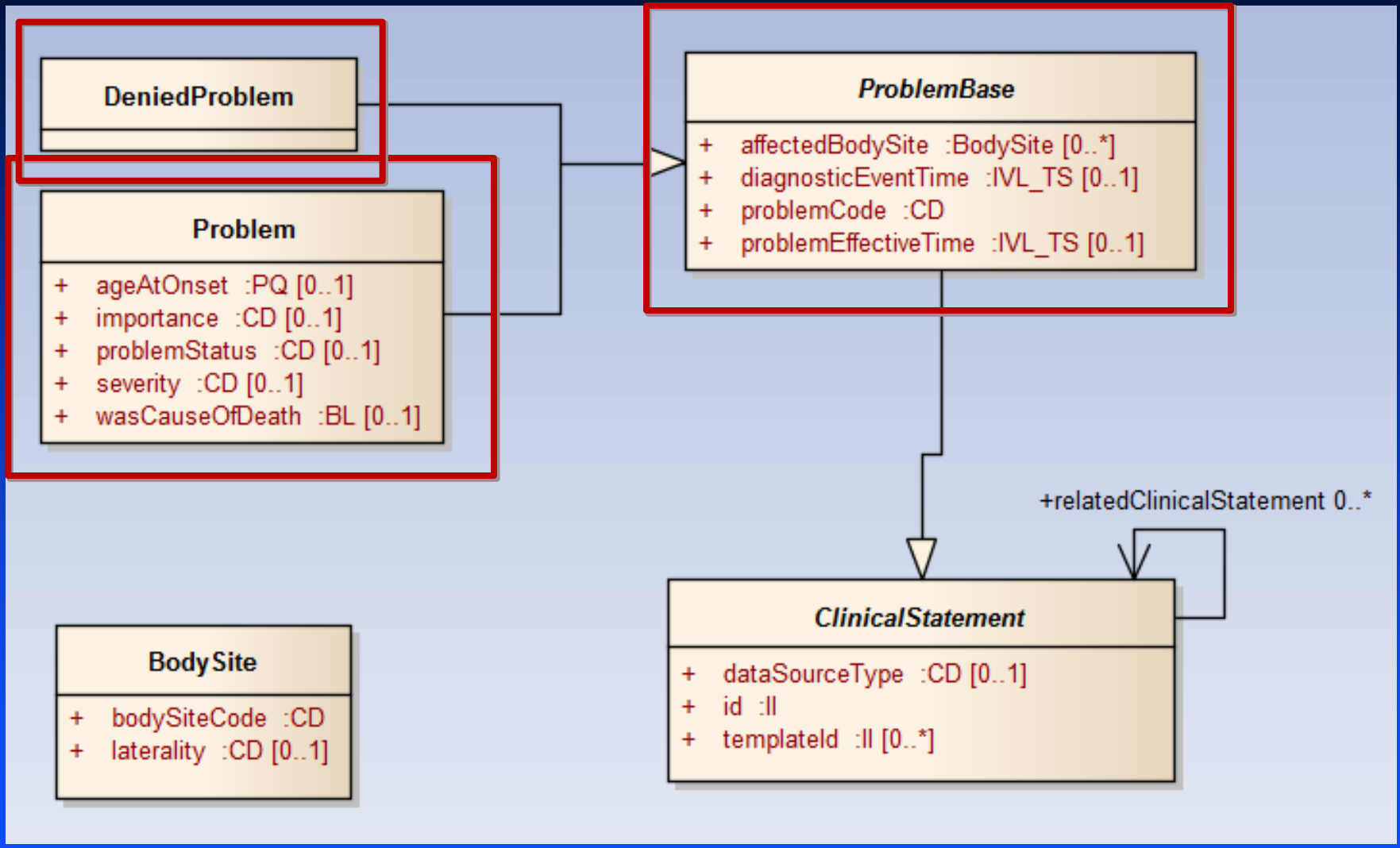
- **Goal: Provide common information model upon which interoperable clinical decision support resources (e.g., rules) can be developed**

- **Linked to the overall HL7 Reference Information Model (RIM)**

# Project History

- **Analysis of data required by 20 CDS systems from 4 countries (Kawamoto *et al.*, AMIA 2010)**
- **Refinement of vMR via implementation within OpenCDS**
- **HL7 R1: 9/2011**
- **HL7 Logical Model R2: 1/2014**

# vMR Problem Model



# HL7 vMR – Tools and Use

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

# OpenCDS

- **Provides a reference implementation of the HL7 DSS and vMR standards**
- **1.1 release freely available under Apache 2 open-source license**

**http://www.opencds.org**

# Featured Collaborators











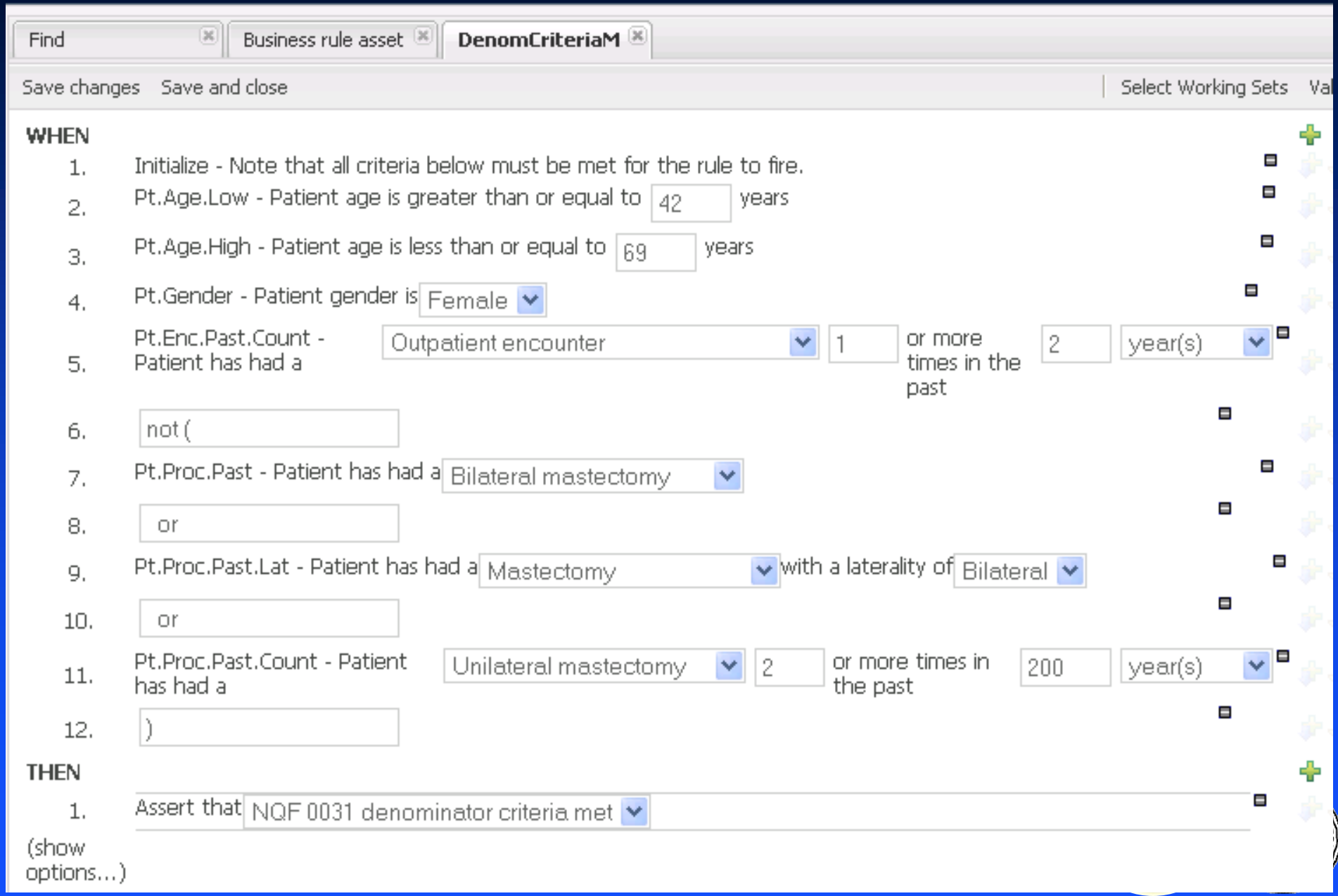








# OpenCDS Knowledge Authoring - Rules

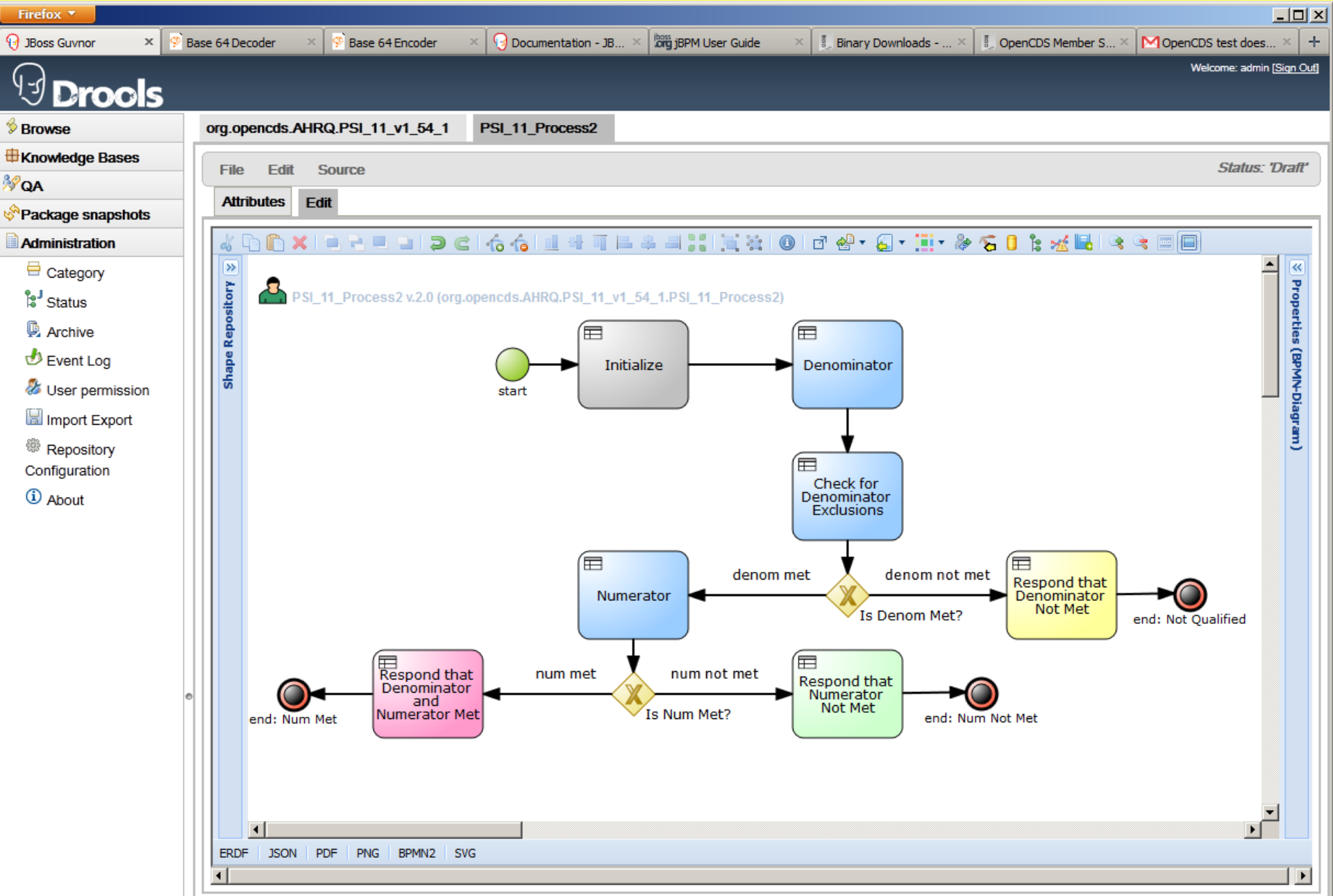


# OpenCDS Knowledge Authoring – Decision Tables

Decision table

| # | Desc | Vaccine | Gender | Dose # | Min Age | Units1 | Max Age | Units2 | Index Dose # | Min Interval | Units3 | Rec Interval | Units4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | HPV | Female | 1 | 9 | Yr | 26 | Yr | | | | | |
| 2 | | | | 2 | | | | | 1 | 24 | Day | 61 | Day |
| 3 | | | | 3 | | | | | 2 | 80 | | 121 | |
| 4 | | | | | | | | | 1 | 164 | | 182 | |
| 5 | | | Male | 1 | 11 | | | | | | | | |
| 6 | | | | 2 | | | | | 1 | 24 | Day | 61 | Day |
| 7 | | | | 3 | | | | | 2 | 80 | | 121 | |
| 8 | | | | | | | | | 1 | 164 | | 182 | |

# Knowledge Authoring: Flow Diagrams



# CDS: Ten Commandments

- Speed is everything
- Anticipate needs & deliver in real time
- Fit into user workflow
- Little things make a big difference (e.g., screen design)
- Recognize that MDs will resist stopping
- Changing direction is easier than stopping (e.g., dosing)
- Simple interventions work best
- Ask for information only if you really need it
- Monitor impact, get feedback and respond
- Manage & maintain your KBS

Bates DW, Kuperman GJ, Wang S et al. Ten commandments for effective clinical decision support: making the practice of evidence-based medicine a reality. J Am Med Inform Assoc 2003;10:523-30.

# Summary

- Explosion in (structured) data plus regulatory & economic environment driving CDS
- Key to CDS:  Delivering information to decision-makers under the Five Rights
- Standards = essential for disseminating knowledge using CDS, but universal agreement lacking
- Two key approaches
  - Knowledge transfer
  - Knowledge access

# Thanks!


- Corey Arnold, PhD & William Hsu, PhD
- Gail Panatier
- NIMHD U54MD007598
- NCATS UL1TR000124



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