Clinical Decision Support Tools for Public Health

2017 Netsmart Public Health Summit
Overland Park, KS
August 3, 2017

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Definitions

Clinical Decision Support (CDS) tools important to support surveillance:

“Computer-based clinical decision support (CDS) can be defined as ‘the use of information and communication technologies to bring relevant knowledge to bear on the health care and well-being of a patient.’”

A Common Foundation

- Three use cases described here – all use common framework and underlying CDS foundation and products
  - OpenCDS (http://www.opencds.org/)
  - HLN CDS Technical Framework (http://www.cdsframework.org)
  - CDS Administration Tool (CAT) for:
    - Rule authoring
    - Testing
    - Terminology maintenance
CAT Software Characteristics

- Framework for developing middle tier services and web-based front ends
- Plugin architecture for adding/removing features
  - Core module ➔ administrative functions
    - User management, security, auditing, etc.
  - CDS module ➔ clinical decision support features
  - Custom modules ➔
    - A means to add additional functionality, if desired
    - May be built on top of/supplement CDS module, or exclude it
    - Example custom modules: ICE, RCKMS Authoring Tool, HL7 QA Tool, Patient Administration
Overview of CAT CDS Functionality

- Value Set Editor → importing, managing value sets
- Concepts Editor → entering concepts and mapping to codes
- Data Model Editor → configure knowledge authoring data model
- List Editor → Context-specific values and dropdowns
- Rule Editor → authoring & deployment of rules
- Test Manager → Validate logic and create/execute test cases
Three Use Cases
Three Software Systems Using CAT/OpenCDS

1. Immunization Calculation Engine (ICE)
2. Reportable Condition Knowledge Management System (RCKMS)
3. Decision Support for Data Segmentation (DS2)
Use Case 1: Immunization Calculation Engine (ICE)

- Service-oriented, standards-based immunization forecasting software system
- Evaluates a patient’s immunization history and generates the appropriate immunization recommendations
- Can be deployed in diverse technical environments, centrally or distributed
- Designed to easily integrate with registries, surveillance systems, clinical systems (EHRs, PHRs)
Sample ICE Deployment

ICE Web Service

OpenCDS

IMMUNIZATION REGISTRY

EHR-S

SCHOOL HEALTH SYSTEM

ICE SOFTWARE SYSTEM

HL7/OMG CDSS Web Service Interface

CDS Admin Tool (CAT)
- Code System Editor
- Vaccine Editor
- Series Editor
- Rule Editor
- Test Editor

Provider

Provider

Provider

Subject Matter Experts
**ICE Client – Sample Screen**

### Patient Info

- **Name:** John Smith
- **DOB:** 20140801
- **Gender:** M
- **Evaluation Date:** 20140904
- **Age @Evaluation:** 0y 1m 3d

### Patient Output Grid

<table>
<thead>
<tr>
<th>Vaccine Group</th>
<th>Recommendations</th>
<th>Evaluations</th>
</tr>
</thead>
<tbody>
<tr>
<td>HepB</td>
<td>Date: 20141001 Status: FUTURE_RECOMMENDED Message: DUE_IN_FUTURE Vaccine Group: HepB</td>
<td>Date: 20140802 Age: 0y 0m 1d Valid: true Vaccine: Hep B, adolescent/high risk infant (42)</td>
</tr>
</tbody>
</table>
Test Case Summary (ICE custom module)

Test Reference View:

Test #: 125

Names: Minimum interval minus one day (51 days) between Dose 2 and Dose 3.

Test Execution Date: 10/21/2011

Patient DOB: 04/01/2011

Age @ Execution Date: 6 months 20 days (203 days)

<table>
<thead>
<tr>
<th>ID</th>
<th>Admin Vaccine Code</th>
<th>Comp Vaccine Code</th>
<th>Admin Date</th>
<th>Age @ Admin Date</th>
<th>Evaluation</th>
<th>Reason(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>263</td>
<td>HepB peds &lt; 20yrs (CVX 08)</td>
<td>HepB peds &lt; 20yrs (CVX 08)</td>
<td>04/29/2011</td>
<td>28 days (28 days)</td>
<td>VALID</td>
<td></td>
</tr>
<tr>
<td>264</td>
<td>HepB peds &lt; 20yrs (CVX 08)</td>
<td>HepB peds &lt; 20yrs (CVX 08)</td>
<td>07/23/2011</td>
<td>3 months 22 days (113 days)</td>
<td>VALID</td>
<td></td>
</tr>
<tr>
<td>265</td>
<td>HepB peds &lt; 20yrs (CVX 08)</td>
<td>HepB peds &lt; 20yrs (CVX 08)</td>
<td>09/12/2011</td>
<td>5 months 11 days (164 days)</td>
<td>INVALID</td>
<td>Below Minimum Interval</td>
</tr>
</tbody>
</table>

Shot Component Intervals

<table>
<thead>
<tr>
<th>Interval Between...</th>
<th>Interval...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shot 1 (Group HepB/CVX 08) and Shot 2 (Group HepB/CVX 08)</td>
<td>2 months 24 days (85 days)</td>
</tr>
<tr>
<td>Shot 1 (Group HepB/CVX 08) and Shot 3 (Group HepB/CVX 08)</td>
<td>4 months 14 days (136 days)</td>
</tr>
<tr>
<td>Shot 2 (Group HepB/CVX 08) and Shot 3 (Group HepB/CVX 08)</td>
<td>1 month 20 days (51 days)</td>
</tr>
</tbody>
</table>

Proof of Immunity/Documented Disease

<table>
<thead>
<tr>
<th>Antigen</th>
<th>Immunity Date</th>
<th>Age @ Imm Date</th>
<th>Immunity Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>No records found.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recommendations

<table>
<thead>
<tr>
<th>Recommended Vaccine/Group</th>
<th>Date Due</th>
<th>Age @ Rec Date</th>
<th>Recommendation</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>HepB</td>
<td>11/07/2011</td>
<td>7 months 6 days (220 days)</td>
<td>Future Recommendation</td>
<td>Due in Future</td>
</tr>
</tbody>
</table>
Test Suite “Run” (ICE custom module)

### Suite Test Results

#### Suite Test Results for: HepB Tests

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Duration (ms)</th>
<th>Eval. Passed?</th>
<th>Rec. Passed?</th>
<th>Passed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>Minimum interval minus one day (23 days) between Dose 1 and Dose 2.</td>
<td>97</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>73</td>
<td>Minimum interval (24 days) between Dose 1 and Dose 2.</td>
<td>115.39</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>74</td>
<td>Minimum interval plus one day (25 days) between Dose 1 and Dose 2.</td>
<td>93.18</td>
<td>✔️</td>
<td>🔴</td>
<td>🔴</td>
</tr>
</tbody>
</table>

#### Differences

- Recommendation Date: Due date values do not match: **ICE=10/01/2011; EXPECTED=10/10/2011**

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Duration (ms)</th>
<th>Eval. Passed?</th>
<th>Rec. Passed?</th>
<th>Passed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>Minimum interval minus one day (51 days) between Dose 2 and Dose 3.</td>
<td>96.92</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>
Use Case 2: Reportable Condition Knowledge Management System (RCKMS)

- Service-oriented, standards-based which allows EHR systems to submit initial electronic case reports to public health based on “triggering” event
- Evaluates conditions for reportability to a state/local jurisdiction and returns decision and instructions
- Expected to be deployed nationally on a shared platform with authoring tool for local jurisdictions to configure their rules
eCR Process Flow

1. Public health agency loads its case reporting criteria into Decision Support Intermediary

2. Decision Support Intermediary provides Health Care Providers with nationally consistent criteria for triggering potential case reports.

3. Potential cases detected using nationally consistent trigger criteria optimized for sensitivity.

4. False positive cases filtered out by jurisdiction-specific public health reporting criteria optimized for specificity.

Jurisdiction-specific reporting criteria (input)

Nationally consistent trigger criteria (input)

Public health case reports (true positives)

Public health case reports (true positives & false positives)
eCR Data Flow

AIMS Platform

Routing and Validation Services

Decision Support Service

Repository of PH Reporting Criteria

RCKMS Tool

Reported

Public Health Agency
<table>
<thead>
<tr>
<th>Nationally Notifiable?</th>
<th>Condition Name</th>
<th>Category</th>
<th>Status</th>
<th>Assigned To</th>
<th>Created By</th>
<th>Last Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Chlamydia</td>
<td>Sexually Transmitted Infections</td>
<td>Not Published</td>
<td>daryl</td>
<td>06/03/2017 10:13 AM</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Gonorrhea</td>
<td>Sexually Transmitted Infections</td>
<td>Not Published</td>
<td>daryl</td>
<td>06/03/2017 10:15 AM</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Pertussis</td>
<td>Vaccine Preventable Conditions</td>
<td>Not Published</td>
<td>daryl</td>
<td>06/03/2017 10:10 AM</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Salmonellosis</td>
<td>Enteric Diseases</td>
<td>Not Published</td>
<td>daryl</td>
<td>06/03/2017 10:15 AM</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Zika</td>
<td>Zoonotic and Vectorborne Diseases</td>
<td>Not Published</td>
<td>janet.hui</td>
<td>06/03/2017 10:17 AM</td>
<td></td>
</tr>
</tbody>
</table>
# Reusable Criteria Templates (set up by Administrator)

## Reporting Specification

### Edit Reporting Specification

<table>
<thead>
<tr>
<th>Reporting Specifications</th>
<th>Lab Reporting (Lab2)</th>
<th>Provider/Facility Reporting (CLIN+EPI)</th>
<th>Provider/Facility Reporting (DX)</th>
<th>Provider/Facility Reporting (Lab)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reporting Timeframe</td>
<td>1 day(s)</td>
<td>1 day(s)</td>
<td>1 day(s)</td>
<td>1 day(s)</td>
</tr>
<tr>
<td>Clinical</td>
<td></td>
<td>Necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmonellosis (Diagnosis or active problem)</td>
<td></td>
<td></td>
<td>Sufficient</td>
<td></td>
</tr>
<tr>
<td>Laboratory</td>
<td>Sufficient</td>
<td></td>
<td></td>
<td>Sufficient</td>
</tr>
<tr>
<td>Detection of Salmonella (except S. typhi and S. paratyphi) nucleic acid by any method in a clinical specimen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identification of Salmonella (except S. typhi and S. paratyphi) by culture method in a clinical specimen, including identification tests performed on an isolate</td>
<td>Sufficient</td>
<td></td>
<td></td>
<td>Sufficient</td>
</tr>
<tr>
<td>Epidemiologic</td>
<td></td>
<td>Optional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact of a person with Salmonellosis (Not Yet Implemented)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Use Case 3: Decision Support for Data Segmentation (DS2)

- Part of ONC HITECH SHARP research project in a state-level HIE environment
- Uses OpenCDS to identify and redact selected sensitive conditions from clinical summary documents
- Includes a web-based "inference analyzer" for visualizing the effectiveness and the impact of probabilistic redaction
- Includes a suite of related tools for creating, importing, and editing Continuity of Care (CCD) documents; testing redacted CCDs
DS2 Research Objectives

- Analyze (de-identified) patient problem lists to determine which conditions that may reveal information deemed “sensitive” (e.g. - STDs, mental health conditions, substance abuse)
- For HIV: explored ways to remove as little data as possible to not reveal sensitive condition while retaining as much of the medical record as possible
  - Deterministic “Level 1” predicates written using Drools
  - Probabilistic “Level 2” and “Level 3” predicates incorporated using Weka machine learning toolkit
  - By combining a classifier with established deterministic rules, the system could “learn” how “guessable” a condition might be after redacting specific medical data from the patient’s record
## DS2: Sample Output from Predicate/Reducer

### Predicate Reducer

**Select ILHIE classifications to disclose:** (leave blank to redact all classifications)

- HIV (ILHIE_HIV)
- Mental Health (ILHIE_MentalHealth)
- Substance Abuse (ILHIE_SubstanceAbuse)

**Upload file for reducing:**

### Summary of key clinical facts from selected parts of the Virtual Medical Record (vMR)

#### Problems

1. Human immunodeficiency virus [HIV] disease (SNOMED-CT 86406008) **HIV**
2. Candidiasis of lung (SNOMED-CT 3487004) **HIV**
3. Other specified bacterial infections in conditions classified elsewhere and of unspecified site, mycoplasma (SNOMED-CT 95889002)
4. Acute maxillary sinusitis (SNOMED-CT 50272006)

#### Substance Administration

1. clindamycin (RxNorm 192254) **HIV**
2. novir (RxNorm 196479) **HIV**
3. procit (RxNorm 227303)
4. azithromycin (RxNorm 18831)
5. fluconazole (RxNorm 4450)

#### Encounters

1. Laparoscopic appendectomy (SNOMED-CT 470.1)

### Version 1.0
Resources

- HLN CDS Framework (ICE, CAT, SHARPS)
  https://www.cdsframework.org/
- OpenCDS
  http://www.opencds.org
- RCKMS
  http://www.cste.org/group/RCKMS
Contact Information

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@noamarzt