Sharing Clinical Decision Support Rules Using openEHR Archetypes and SNOMED CT

IHTSDO Showcase 2012

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Chief Medical Informatics Officer
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Outline

- **Background**
  - Who, why, how
- **Guide Definition Language (GDL)**
  - Scope, aims, design
- **Implementation of GDL**
  - GDL Editor, some examples
- **SNOMED CT related implementation issues**
- **Live** Demo of GDL Editor
- **Summary & Questions**
Cambio Healthcare Systems

• Founded in 1993
  – 330 staff across the globe
  – Private and Venture funded

• The leading provider of Regional EHR solutions in Scandinavia - presence in Sweden, Denmark, UK, others to follow

• COSMIC is an international standard product

• Close to 95 000 staff users when current projects are fully implemented

• Our solutions are open, scalable and flexible based on industry standards

• Cambio invests 150 000 hours annually in COSMIC

• ISO 9001 certification and CE Marked EHR
One Patient – One Record – Anytime – Anywhere

County of Kronoberg
7% of the working people in Kronoberg are COSMIC users.

Cambio COSMIC:
• Main application and platform for process support
• Common repository for all healthcare information

Integrated with:
• Clinical care support system
• Medical equipment
• Digital archives and PACS
• Decision support

• Wireless Network in hospitals
• VPN over Mobile network
• VPN over Internet
• Network of Municipalities
• National Network for Healthcare in Sweden
• 95% of the population in Kronoberg have an EHR in COSMIC
Background

- **Computerized Clinical Decision Support (CDS)**
  - Evidenced-based medicine, improved efficacy
  - Improved patient safety

- **Update-to-date CDS content is critical**
  - Fully computerized
  - Terminology bound
  - Based on common EHR models

- **Sharing of CDS Rules**
  - Sharing within our customer group
  - Sharing with external clinical groups
  - Medical knowledge is open, and should be shared !!
Stroke Prevention in Atrial Fibrillation

- **20% of strokes** caused by atrial fibrillation
Scope & Aims

- A formal language to express CDS rules
- Natural language independent
  - Easy to add translations
- Terminology independent
  - Easy to add term bindings
- EHR model independent
  - Reuse of common EHR models both for input and output
- Rules for single decision making
  - Process handling not in scope
- Coherent and reusable
  - Encapsulated and possible to chain the rules
- Technical platform independent
Guide Definition Language (GDL) Design

A minimum language to glue together archetypes, terminologies and rules

Three Pillars

- Bindings between archetype elements and variables in the rules

- Rule expressions easily converted to industry rule engine languages

- Bindings between local concepts used in the rules and concepts from reference terminologies
1st Pillar: Bindings between archetype elements and rule variables

Each rule variable is unique identified by a gt code and mapped to a Archetype ID and a path to access an element.

The same gt code is used to represent the variable in all rules in the same guide.

Then the gt code is translated into terms in different natural languages (English, Swedish..)
2\textsuperscript{nd} Pillar: Rule expressions easily converted to industry rule engine languages

```xml
["gt0012"] = (RULE) <
  when = \\
  then = "gt0011.magnitude=((1.23*(140-gt0002.magnitude))\times gt005.magnitude)
  priority = <2>
>
```

- **when** & **then** statements are commonly supported by rule languages

- **Expressions** used in these statements are based on common design (similar to assertions in openEHR Archetype Definition Language)
3rd Pillar: Bindings between local term used in the rules and concepts from reference terminologies

```xml
["gt0017"] = (RULE) <
  when = "<"$gt0003|diagnosis| is a local::gt0100|Heart failure|",...>
  then = "<"$gt0012=1|local::at0028|Present|",...
  priority = <10>
>
term_bindings = <
  ["SNOMEDCT"] = (TERM_BINDING) <
    bindings = <
      ["gt0100"] = (BINDING) <
        codes =<"SNOMEDCT::84114007",...>
    >
  >
>
  ["ICD10"] = (TERM_BINDING) <
    bindings = <
      ["gt0100"] = (BINDING) <
        codes =<"ICD10::I50",...>
    >
  >
>
  ["ICD9"] = (TERM_BINDING) <
    bindings = <
      ["ICD9"] = (BINDING) <
        codes =<"ICD9::428.0",...>
    >
  >
>
```

- A local term is used as a proxy to externally defined concepts in reference terminologies.
- A local term can be bound to a list of concepts or a refset in different target reference terminologies.
Guide Definition Language (GDL) Design Cont.

• A formal language based on openEHR d-ADL
  – Machine-readable format

• The main object model consists of
  – Header: Id, concept, language, description, translation
  – Archetype binding
  – Guide definition, pre-condition and list of rules
  – Each rule has when and then expressions
  – Term_definitions for language-dependent labels
  – Term_bindings for terminology bindings

• Expressions model

*Extensive reuse of existing openEHR specifications*
GDL Model

Blue: openEHR
Yellow: new
GDL - expressions
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### Table 8: CHA$_2$DS$_2$-VASc score and stroke rate

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestive heart failure/LV dysfunction</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>Age $\geq$ 75</td>
<td>2</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1</td>
</tr>
<tr>
<td>Stroke/TIA/thrombo-embolism</td>
<td>2</td>
</tr>
<tr>
<td>Vascular disease$^6$</td>
<td>1</td>
</tr>
<tr>
<td>Age 65–74</td>
<td>1</td>
</tr>
<tr>
<td>Sex category (i.e., female sex)</td>
<td>1</td>
</tr>
<tr>
<td>Maximum score</td>
<td>9</td>
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</table>

(a) Risk factors for stroke and thrombo-embolism in non-valvular AF

- Previous stroke, TIA, or systemic embolism
- Age $\geq$ 75 years
- Heart failure or moderate to severe LV systolic dysfunction (e.g., LV EF $\leq$ 40%)
- Hypertension - Diabetes mellitus
- Female sex - Age 65–74 years
- Vascular disease$^6$

(b) Risk factor-based approach expressed as a point based scoring system, with the acronym CHA$_2$DS$_2$-VASc

(Note: maximum score is 9 since age may contribute 0, 1, or 2 points)
GDL Guide for calculating CHA$_2$DS$_2$-VASc score

The CHA$_2$DS$_2$-VASc score archetype servers both as intermediate results place holder and final output from CDS
Rule for Checking Congestive Heart Failure

If patient has any diagnosis that is kind of congestive heart failure?

If so, set the congestive heart failure sub-component to ‘present (1)’.
Simulation of CHA₂DS₂-VASc Guide

**Table 8** CHA₂DS₂-VASc score and stroke rate

(a) Risk factors for stroke and thrombo-embolism in non-valvular AF

<table>
<thead>
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<th>'Major' risk factors</th>
<th>'Clinically relevant non-major' risk factors</th>
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(b) Risk factor-based approach expressed as a point based scoring system, with the acronym CHA₂DS₂-VASc

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Support for Natural Languages - Header

English

Swedish

Chinese
Support for Natural Languages - Expressions

English

Expression editor

Expression viewer

(((1.23 * (140 - $gt0002.magnitude)) * $gt0005.magnitude) / $gt0009.magnitude)

unchanged

Swedish

Expression editor

Expression viewer

(((1.23 * (140 - $gt0002.magnitude)) * $gt0005.magnitude) / $gt0009.magnitude)

Chinese

Expression editor

Expression viewer

(((1.23 * (140 - 年龄) * 体重) / 肌酐)

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2012-10-31
SCT Related Implementation

• Use cases
  – Subsumption relationship: IS_A
  – Semantic equivalence check: post-coordination expressions

• OWL representation of SNOMED CT content
  – Converted by Perl scripts included in the release

• Protégé OWL editor v4.1
  – OWL Module Extraction by DL Query Plugin

• Runtime terminology service (experimental)
  – SCT Concept ID => OWL identifier
  – OWL API v3.3, reasoner: Hermit 1.3.6
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Summary

- Guide Definition Language (GDL) is a way to share CDS rules using openEHR archetypes and reference terminologies, e.g. SNOMED CT

- GDL rules are natural language, terminology and technical platform independence

- open specification, open source reference implementation of tools will be available

- GDL design is still evolving, and will improve through more CDS rules modeling in different domains
Acknowledgements

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