Clinical Governance, Decision Support and Practical Impacts of Archetype Based EHR Systems

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2013.1.16 Tromsö
Outline

• **Background**
  – Who are we, where are we from
  – Informatics vision, why interoperability matters

• **Case study**
  – stroke prevention in atrial fibrillation

• **Underlying informatics components**
  – openEHR archetypes and CDS rules in GDL

• **Summary & discussions**
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
Guideline-based Stroke Prevention in Atrial Fibrillation
Atrial Fibrillation

• 1-2% of general population, increase with age
  – 4% in North Sweden by Swedish study

• AF patients 5 times more stroke chance, 20% strokes caused by AF, more severe

• **Recent advancement** Stroke prevention is the most important part of AF management

• Recent advancement of knowledge, ESC guidelines on AF management
  – Stroke risk assessment
  – Treatment recommendation given highest level of evidence

• **Estimated 2000 preventable stroke cases in Sweden per year!!** *(independent Swedish study)*
Knowledge of Stroke Prevention in AF


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

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

<table>
<thead>
<tr>
<th>‘Major’ risk factors</th>
<th>‘Clinically relevant non-major’ risk factors</th>
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<tbody>
<tr>
<td>Previous stroke, TIA, or systemic embolism</td>
<td>Heart failure or moderate to severe LV systolic dysfunction (e.g. LV EF ≤ 40%)</td>
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<tr>
<td>Age ≥ 75 years</td>
<td>Hypertension - Diabetes mellitus</td>
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<td></td>
<td>Female sex - Age 65–74 years</td>
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<td>Vascular disease*</td>
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</table>

(b) Risk factor-based approach expressed as a point based scoring system, with the acronym CHA₂DS₂-VASc (Note: maximum score is 9 since age may contribute 0, 1, or 2 points)

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Score</th>
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<tbody>
<tr>
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<td>1</td>
</tr>
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<td>1</td>
</tr>
<tr>
<td>Age ≥75</td>
<td>2</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1</td>
</tr>
<tr>
<td>Stroke/TIA/thrombo-embolism</td>
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</tr>
<tr>
<td>Maximum score</td>
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</table>

**Tromboembolirisk och behandlingsrekommendation vid förmaksflimmer enligt CHA₂DS₂-VASc(1-2)**

<table>
<thead>
<tr>
<th>Riskfactor</th>
<th>Poäng</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Hjärtsvikt (EF ≤40 %)</td>
</tr>
<tr>
<td>H</td>
<td>Hypertoni</td>
</tr>
<tr>
<td>A</td>
<td>Ålder ≥ 75 år</td>
</tr>
<tr>
<td>D</td>
<td>Diabetes</td>
</tr>
<tr>
<td>S</td>
<td>Tidigare stroke/emboli</td>
</tr>
<tr>
<td>V</td>
<td>Aterosklerotisk sjukdom</td>
</tr>
<tr>
<td>Å</td>
<td>Ålder 65–74 år</td>
</tr>
<tr>
<td>AS</td>
<td>Kvinnligt kön*</td>
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</table>

* kvinnor under 65 årsåldar utan andra riskfaktorer har tveksamt nytta av antitrombotisk behandling.

**CHAD₂DS₂-VASc-poäng:**

- 0 = ingen behandling (ev. ASA)
- 1 = warfarin (ev. ASA)
- ≥2 = warfarin
### Table 9  Approach to thromboprophylaxis in patients with AF

<table>
<thead>
<tr>
<th>Risk category</th>
<th>CHA$_2$DS$_2$-VASc score</th>
<th>Recommended antithrombotic therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>One ‘major’ risk factor or $\geq$2 ‘clinically relevant non-major’ risk factors</td>
<td>$\geq$ 2</td>
<td>OAC$^a$</td>
</tr>
<tr>
<td>One ‘clinically relevant non-major’ risk factor</td>
<td>1</td>
<td>Either OAC$^a$ or aspirin 75–325 mg daily. Preferred: OAC rather than aspirin.</td>
</tr>
<tr>
<td>No risk factors</td>
<td>0</td>
<td>Either aspirin 75–325 mg daily or no antithrombotic therapy. Preferred: no antithrombotic therapy rather than aspirin.</td>
</tr>
</tbody>
</table>
Context of stroke prevention project

• **Swedish County of Östergötland**
  – 400,000 inhabitants
  – One of the earliest COSMIC regional users
  – Linköping University Hospital + regional hospitals and primary care centers

• **Clinical governance of AF in Östergötland**
  – AF responsible cardiologist, Carlos Valladares M.D.
  – Study ESC guidelines & disseminate the knowledge
    • **Documents, workshops, phone consultations**
  – Most of the AF patients meet general practitioners and non-cardiology specialist
  – Suspect undertreatment in general population
    • **But how many of them? Why deviation, for good or bad reasons!**
### CHA₂DS₂-VASc score and stroke rate

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

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#### (b) Risk factor-based approach expressed as a point based scoring system, with the acronym CHA₂DS₂-VASc

(Note: maximum score is 9 since age may contribute 0, 1, or 2 points)

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</tr>
<tr>
<td><strong>Maximum score</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
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#### Example:

- 0: Under 65
- 1: Between 65–74
- 2: Above or equals to 75

*
Create Rules for CHA2DS2-VASc calculation

- Set CHF present
- Set hypertension
- Set diabetes
- Set previous stroke
- Set age below 65
- Set age between 65-74
- Set age above or equals to 75
- Set gender male
- Set gender female
- Calculate total score
- Set default
- Set vascular disease
- Compliant with score 1
- Compliant with score >= 2
- Compliant with Atrial fibrillation guideline
Rule for checking Congestive Heart Failure

Diagnostics codes are verified by the cardiologist.
Compliance Checking Rule
Treatment Compliance Checking
Study Patient Groups

- **Cardiologist group (n=514)**
  - Patients treated by the Cardiologist responsible for AF in the region in 2 years
  - Registered in AF quality register manually

- **General population group (n=8130)**
  - Confirmed AF patients in 2010 in the whole region of Östergötland
  - Directly from the regional EHR
Patient group treated by the Cardiologist

90.7% compliance
All AF patients in Östergötland 2011
62.57% compliance
Preventable stroke per year in LiÖ

<table>
<thead>
<tr>
<th>CHA2DS2-VASc</th>
<th>Cases</th>
<th>Non-compliant</th>
<th>Possible stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>328</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>611</td>
<td>127</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1057</td>
<td>395</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>1549</td>
<td>544</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>1797</td>
<td>726</td>
<td>29</td>
</tr>
<tr>
<td>5</td>
<td>1437</td>
<td>582</td>
<td>38</td>
</tr>
<tr>
<td>6</td>
<td>842</td>
<td>424</td>
<td>41</td>
</tr>
<tr>
<td>7</td>
<td>348</td>
<td>166</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>132</td>
<td>66</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>29</td>
<td>16</td>
<td>2</td>
</tr>
</tbody>
</table>

Total possible stroke/yr: 155
Total preventable stroke/yr: 152

• 152 X 0.7 MSEK = 106.4 Million SEK (initial cost)
• 152 X 7.0 MSEK = 1.064 Billion SEK (long-term cost)
A Stroke Prevention Prototype

Driven by CDS rules

Documentation

CHADVASC score 5.0

CDS Recommendation

Recommended Drug List: Warfarin 2.5 mg

Based on ESC Guideline for Atrial fibrillation management. Telephone: 0123 3454-1123, Dr. Responsible for AF in LiO

Recommended Treatment

Warfarin 2.5 mg Tablett
Generated Documentation and Decision

**Documentation automated generated by CDS application**

**Documentation entered by clinician**
Informatics Underpinning

Archetypes, Rules, Terminologies
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
1\textsuperscript{st} 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..)
2nd Pillar: Rule expressions easily converted to industry rule engine languages

```
"gt0012" = (RULE) <
  when = ""gt0002">=20.0 yr", "$gt0003==#{local::at0005|Male}">
  then = ""gt0011.magnitude=((1.23*(140-"gt0002.magnitude"):gt0005.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)
3\textsuperscript{rd} Pillar: Bindings between local term used in the rules and concepts from reference terminologies

```
["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)

• GDL is a way to **share** CDS rules using **openEHR archetypes** and reference terminologies (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
Summary

• Semantic technology like openEHR archetypes offers huge potentials

• Clinical governance is needed in archetype-based systems; international, national and regional collaboration are necessary

• Scalable Clinical decision support can be facilitated by semantic EHR technology, like openEHR.

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