Overview of Tools for Detailed Clinical Models

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R4C Results 4 Care B.V.
Purpose

This presentation focuses on the tools that are necessary and available to analyze a clinical domain in order to model this for development of information technology in health care.

And where different types of information technology can work together and exchange information (being interoperable)

It will be presented based on the example of detailed clinical modeling.

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Semantic interoperability

- Functional interoperability – the ability of two or more systems to exchange information (so that it is human readable by the receiver),

- Semantic interoperability – the ability for information shared by systems to be understood at the level of formally defined domain concepts (so that information is computer processable by the receiving system).

ISO 20514: 2005
Tools for DCM?

- Tools for DCM can be considered a set of software programs that facilitate one or more steps in the DCM development or use.
- Most important: concept representations in different formats
- Tools should work together, or allow moving smoothly from one step to the other, ending with testing of working systems
# DCM Tool overview

<table>
<thead>
<tr>
<th>Phase in DCM</th>
<th>Activity</th>
<th>Tool</th>
</tr>
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<tbody>
<tr>
<td>Project</td>
<td>Business Modeling</td>
<td>UML</td>
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<tr>
<td>Clinical Content</td>
<td>Information analysis &amp; requirements</td>
<td>Mind map, Office</td>
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<tr>
<td>Formalization</td>
<td>Structure and sort clinical content</td>
<td>DCM pattern in Enterprise Architect</td>
</tr>
<tr>
<td>Verification</td>
<td>Professionals review and improve content</td>
<td>CKM, Clinical Templates tool Scotland.</td>
</tr>
<tr>
<td>Modeling</td>
<td>Model the structured and verified content</td>
<td>EA DCM pattern, ADL tools, HL7 R-MIM designer, XML editor</td>
</tr>
<tr>
<td>Re-use</td>
<td>Transform</td>
<td>Medical Objects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EA DCM pattern exports</td>
</tr>
<tr>
<td>Functional Design</td>
<td>Compile EHR, message, HIT</td>
<td>EA, Ocean template</td>
</tr>
<tr>
<td>Quality and testing</td>
<td>Check quality of models &amp; transforms</td>
<td>HL7 schematron! ADL? EA DCM? Prorec?</td>
</tr>
<tr>
<td>Repository</td>
<td>Store and retrieve models etc.</td>
<td>CKM, Clinical Templates tool Scotland</td>
</tr>
</tbody>
</table>
Modeling Maturity

- No specifications
- Textual
- Text with models
- Models with text
- Precise models
- Models only

Business modeling

- Purpose: to identify and model the business with respect to
  - Organization
  - Stakeholders
  - Purpose
  - Context
- Tools: usually word processing and general drawing tools
Information analysis

- Analyze data, information, knowledge and represent this in computer files

- Brainstorm and overview:
  - Mindmapping Tools
    - Mindjet Mindmanager Pro
    - RDF

- Data specification tool
  - Mapping table (Basic or Core or Minimal Data Sets)
    - Spreadsheet format (e.g. Excel)

- DCM outline document format
  - Word processor format (e.g. Word)

- Existing forms, questionnaires and assessments

- Existing applications
  - Reverse engineering: several variants

- More?

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Mind map

- Gezondheidsbeleving en instandhouding
- Activiteitenpatroon
- Slaap-rustpatroon
- Cognitie en waarnemingspatroon
- Zelfbelevingspatroon
- Rol-relatiepatroon
- Seksualiteit- en voortplantingspatroon
- Stressverwerkingspatroon
- Waarden- en levensovertuigingspatroon
- Uitscheidingspatroon
- Voedings- en stofwisselingspatroon

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Terminology binding

- Map data and definitions to coding systems
  - Mapping
  - Mapping methoden (face, expert, dissection)
    - GALEN
    - Others?

- Terminology toolkits (multiple!)
  - ETS (enterprise terminology server)
  - Apelon
  - CliniClue Browser -> SNOMED CT
  - Relma -> LOINC
  - ICD-9 of WHO via www.who.int
  - Lexgrid
  - ICD-10 WHO web
  - ICPC
  - Local terminology: data dictionaries

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Zich wassen

Note
- Wassen en afdrogen van het gehele lichaam, of lichaamsdelen, met gebruik van water en geschikte was- en droogmaterialen of methoden, zoals baden, douchen, wassen van handen en voeten, gezicht en haar, en met een handdoek drogen.

Inclusion
- wassen van lichaamsdelen; wassen van gehele lichaam; zich afdrogen

Exclusion
- verzorgen van lichaamsdelen (d520): zorgdragen voor toilettang (d530)

Modifier: Uitvoering en vermogen
- xxx.0 GEEN beperking/participatieprobleem (geen, afwezig, verwaarloosbaar) 0-4%
- xxx.1 LICHT beperking/participatieprobleem (gering, laag) 5-24%
- xxx.2 MATIGE beperking/participatieprobleem (gemiddeld) 25-49%
- xxx.3 ERNSTIGE beperking/participatieprobleem (hoog, sterk, aanzienlijk) 50-95%
Information modeling

- Dynamic aspects: information management
  - Methods such as the Health Level 7 Development Framework
  - UML model examples activity diagram, interaction diagram, sequence diagram and so on

- Tools:
  - Enterprise Architect
  - Poseidon
  - MS Visio
  - Etc.
Client kan het niet meer aanvragen indicatie

Indicatie Organen

Keuze Intramuraal

Probleem

client Extramurale zorg

medew. Indicatie Orgaan

Zorgkantoor

Zorgaanbieder

positief besluit

Overdracht Dossier

negatief besluit

Regelen van zorg

Ontvangt Elektronisch Dossier Bericht

Start Zorg
Information modeling

- Structural aspects of data
  - UML
    - Method: Object Orientation / Static Modeling
    - Domain Analysis Model
    - Detailed Clinical Model
  - Tools:
    - Enterprise Architect
    - Open Health Tools SMD (static model designer)
    - IBM Eclipse UML
Verification by care professionals

**Methods:**
- Consensus methods / Delphi method

**Tools:**
- Web based questionnaires
- Voting systems

**Collaborative work methods**

**Tools:**
- OpenEHR Clinical Knowledge Manager
- Wiki
- Groove / Sharepoint / Google office
- Results 4 Care DCM development site 2010
Formalisms

- Necessary, but unavailable?
- Holy Grail?
- Need to have a formalism that allows capturing clinical knowledge and supports different technological developments.
OWL (web ontology language)

- Ontology to structure knowledge
- To combine requirements on concept representations from different techniques to enforce consistency and prevent inconsistencies and errors

Tools:
- Protégé
- Semantic Web
HL7 interoperability paradigm

- HL7 v2
- HL7 v3 & CDA & services
  - Method: constraining models from reference model via domain model to message model:
  - Tools RIM – D-MIM – R-MIM modeling:
    - Visio R-MIM designer
    - XML exports and editors
    - MIF editor & OCL (object constraint language)
    - XMI
    - XSLT
  - (RIM – DIM – CIM – LIM if message independent)

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Zorgketen

Zorgverlener A:
- REPC_AR002030UV

Verwijzing: REPC_RM_002000

Acceptatie / Weigering: REPC_RM_003000

Vraag (query): QUPC_RM_040000

Dossier (samenvatting): REPC_RM_004000

Zorgverlener B:
- REPC_AR002040UV
- REPC_AR002020UV

Verwijzing: REPC_RM_002000

Acceptatie / Weigering: REPC_RM_003000

Vraag (query): QUPC_RM_040000

Dossier (samenvatting): REPC_RM_004000

Zorgverlener C:
- REPC_AR002040UV
- REPC_AR002020UV
HL7 application RIMBAA

- HL7 v3 en CDA inspiration source
  - Purpose: to develop a Context Information Model for Service Oriented Architecture SOA (all of health care context included)
  - Tools: RIM – DIM – CIM – LIM if message independent
    - Visio R-MIM designer
    - XML weergave
    - MIF editor & OCL (object constraint language)
    - XMI
    - XSLT

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OpenEHR/ ISO/CEN 13606

- Develop clinical content against a reference information model, using archetypes

- Tools:
  - Archetype editor for small items
    - ADL output (Archetype Definition Language)
    - XML output

- Develop forms using archetypes
  - Template editor for complete forms
  - Archetype workbench

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Technical validation

- **Purpose:** to check if the models work properly in the information technology

- **Tools:**
  - Validation of XML exchange between systems
    - Schematron
  - Transformations between standards
    - NHS tool XSLT for archetype to HL7 v3 formats vice versa.
User interface

To develop example screens for the user in which the clinical data are presented and can be used

Tools:
- Archetype editor
- Template editor
- MS Infopath
- MS Excel
- Rapid Prototyping software
- Etc.
User Interface DCM based

Allergy Widget

Patient Identification (minimal PatientBanner)

<table>
<thead>
<tr>
<th>period</th>
<th>causative agent</th>
<th>reaction</th>
<th>severity</th>
<th>who</th>
<th>when</th>
<th>edit</th>
<th>deactivate</th>
</tr>
</thead>
</table>

Allergy Entry Form will appear “in-place”, replacing and expanding the line were the edit button is pressed.

Allergy Entry Form

- start date
- end date
- causative agent filter
- causative agent filter
- reaction
- severity

new

«navigate»
Database Design

To develop a database that can hold the required clinical data elements, their coding, metadata and others

Tools:
- Enterprise Architect
- HL7 RIMBAA
- SQL ER (entity relationship)
- Many others
class DatabaseSimple

- Patient (1..*)
- CareProvision (1..*)
- CareStatements (0..*)
- AuthorRoles (1..*)
- Author (1..*)
- TypesRoles
  - receiver (1..*)
  - sender (1..*)
Publication tools

Purpose: to document the standard and examples

Tools:
- Assigning Artifact id and numbering
- Assigning index terms
- Storing in repository
- Allowing to combine text, tables, graphs etc.
- Example: HL7 publishing tool
- OpenEHR repository
Repository / Library

Purpose: to store, retrieve, manage, maintain and distribute DCM

- Storing tools, eg database, webforms
- Indexing to find
- Apply Version management
- Use and reuse supporting technology
- Search engine

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## Accessing archetypes

**14 Archetype(s) found**

You can now narrow or broaden your search result or start a new search.

<table>
<thead>
<tr>
<th>Search</th>
<th>Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search 1</td>
<td>Any term = 'blood'</td>
</tr>
</tbody>
</table>

### Blood glucose

<table>
<thead>
<tr>
<th>Archetype ID</th>
<th>openEHR-EHR-OBSERVATION.laboratory-glucose.v1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The concentration of glucose in the blood</td>
</tr>
<tr>
<td>EHR class</td>
<td>Observation</td>
</tr>
<tr>
<td>Health Area</td>
<td>Patient recording</td>
</tr>
<tr>
<td>Purpose</td>
<td>Biochemical investigation</td>
</tr>
<tr>
<td>Language</td>
<td>German, English</td>
</tr>
<tr>
<td>Data source</td>
<td>Pathology episode</td>
</tr>
<tr>
<td>Country</td>
<td>Australia</td>
</tr>
</tbody>
</table>

**Links**

- **Parent Archetype**: openEHR-EHR-OBSERVATION.laboratory.v1
- **HTML**: openEHR-EHR-OBSERVATION.laboratory-glucose.v1.html
- **ADL**: openEHR-EHR-OBSERVATION.laboratory-glucose.v1.adl
- **Blood gas assessment**: openEHR-EHR-OBSERVATION.blood_gases.v1

The assessment of blood gas concentrations and acid-base balance in blood

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Repositories of repositories: where to find what is out there

Garde S, Workshop on Care Information Models post Medinfo 2007, Brisbane
Test tools

- To test the models and their functioning in systems
- To test the exchange of information: is it really semantic interoperable?
  - Tools:
    - Schematron to some extend
    - To be developed
- ISO standard on test design
Soon...

- Traceable to Functional Models (EHR-S FM)
- UML Profile (MDG Technology)
  - Templates, Patterns, Stereotypes, Datatypes
- Validation of the Models
  - professional, EA using Conformance Statements, and in a running system Schematron
- Manuals / How-to's
- Repository with rtf, xmi, hl7 xml, archetype, etc.
- Wireframes

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Modelling and transforms

Detailed Clinical Model

- Template (Design) Patterns
- DCM Project Template
- HL7 v3 UML (Colorized)
- Eclipse IBM UML
- UML
- TCC data dictionary
- UMCG Template Editor
- Parelsoer
- SQL ER
- Mindmap

- Programming Language
  - Java
  - C#
- Archetype ADL
- eEHR
- Synapses SynOM
- OpenEHR
- *13606
- ISO WG TC251

- Content
  - Clinical Statement pattern = Semantisch Model
  - ISO21090- R2 datatypes
  - Metadata (o.a. auteur)
  - Impliciet & Expliciet
  - Shared Context
  - Standard Operation Procedures (SOP)

- Validatie Modellen
  - Schematron
  - OCL
  - Prog. Language

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Conclusions

- Capturing and Organizing clinical content
- Business modeling
- Information modeling
- Terminology modeling
- Transformations
- Storage and retrieval
- Maintenance
- Testing
- All require tools that can work together
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