CDA Introduction

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HL7 Germany / Netherlands
• Interoperability
• Clinical Document Architecture
• Header
• Body: Section and Entry
• Entry Inspection: The Module Principle
• Templates
Interoperability and the Clinical Document Architecture
Interoperability

- Human
  - The "paper world" with documents, forms...
  - "Simple text"
- Application
  - Storage, management of clinical data
  - Context driven analysis
  - Reusability
Implementing Interoperability: Clinical Document Architecture

HL7’s answer since 2005
Implementing Interoperability: Clinical Document Architecture

- Clinical Document Architecture (CDA)
- An approved standard way to exchange dictated, scanned, or electronic reports on a patient between various health information technology systems and platforms
- Release 2 since 2005
Structure of a CDA Document

• **Form**
  – A header providing the context:
    • To facilitate the exchanges and the management of the documents, their compilation in the patient record
  – A body
    • clinical information, ordered into sections, paragraphs, lists, tables, ...

• **Encoding in XML**
  – Comprehensive for the human...
  – ... and for the computers
  – can be validated by a schema
Structure of a CDA Document

- Header
- Body

Clinical Document

- Patient
- Provider

Body Structures (textual section)

Entries (Clinical Statements)
- Observation
- Procedure
- Encounter
- Medication
- ...
"Human interoperability guaranteed"
CDA Header
The Header: context of the document

- Identification of the document (ID, category/type, title, date, version)
- Confidentiality, language
- “Manager” of the document
- Patient
- Author
- Responsible Parties
- ...

(Topics covered: context, identification, confidentiality, language, management, patients, authors, responsible parties, etc.)
ClinicalDocument

- Identification
- Classification
- Dates
- Language
- Versioning
- Relationships
- Participations
ClinicalDocument

- **id**
  - unique identification
  - OID concept

- **code**
  - Type of document
  - Specifies content
  - CE CWE [1..1]
  - Usually: LOINC codes

```xml
<code
code="34105-7"
codeSystem="2.16.840.1.113883.6.1"
displayName="Discharge Summarization Note"/>
```
<table>
<thead>
<tr>
<th>Code</th>
<th>Document-Type</th>
<th>Authoring Provider</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>34133-9</td>
<td>Summarization of Episode Note</td>
<td>Practitioner</td>
<td></td>
</tr>
<tr>
<td>18842-5</td>
<td>Discharge summarization note</td>
<td>Provider</td>
<td></td>
</tr>
<tr>
<td>11490-0</td>
<td>Discharge summarization note</td>
<td>Physician</td>
<td></td>
</tr>
<tr>
<td>34745-0</td>
<td>Discharge summarization note</td>
<td>Nurse</td>
<td></td>
</tr>
<tr>
<td>34105-7</td>
<td>Discharge summarization note</td>
<td>Provider</td>
<td>Hospital</td>
</tr>
<tr>
<td>34106-5</td>
<td>Discharge summarization note</td>
<td>Physician</td>
<td>Hospital</td>
</tr>
<tr>
<td>18761-7</td>
<td>Transfer summarization note</td>
<td>Provider</td>
<td></td>
</tr>
<tr>
<td>28616-1</td>
<td>Transfer summarization note</td>
<td>Physician</td>
<td></td>
</tr>
<tr>
<td>28651-8</td>
<td>Transfer summarization note</td>
<td>Nurse</td>
<td></td>
</tr>
<tr>
<td>18733-6</td>
<td>Ambulatory visit note</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18742-7</td>
<td>Arthroscopy report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18743-5</td>
<td>Autopsy report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18745-0</td>
<td>Cardiac catheterization report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11488-4</td>
<td>Consultation note</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18747-6</td>
<td>CT report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11520-4</td>
<td>Echocardiogram report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15507-7</td>
<td>Emergency visit note</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11492-6</td>
<td>History and physical note</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ClinicalDocument

- title
- additional information
  - <title>Patient Summary as of 24. October 2014</title>
- effectiveTime
  - <effectiveTime value="200601171415" />
- LanguageCode
  - ISO 639-1
  - <languageCode code="de-DE"/>
Clinical Documents: involved Parties

- **recordTarget**: Patient
- **author**: who has written the document
- **custodian**: organisation

- **informationRecipient**: intended receivers (as known at the time of creation of the document)
- **legalAuthenticator**: who has signed this document
- **authenticator**: other signing persons
- **dataEnterer**: transcriptionist
- **participant**: other assigned persons
“Patient”

**RecordTarget**

- **Patient**
  - **Organization**
    - **PatientRole**
      - **recordTarget**
        - **typeCode**: RCT
        - **contextControlCode**: CNE
  - **Patient**
    - **classCode**: PSN
    - **determinerCode**: INSTANCE
    - **id**: II(0..1)
    - **name**: SET<PBb(0..1)
    - **administrativeGenderCode**: CE CWE [0..1]
    - **birthTime**: TS [0..1]
    - **maritalStatusCode**: CE CWE [0..1]
    - **religionCode**: CE CWE [0..1]
    - **ethnicity**: CE CWE [0..1]
recordTarget (the real thing)
<recordTarget>
    <!---- Patient Data -->
    <patientRole>
        <id extension="6245" root="2.16.840.1.113883.19.3.933"/>
        <id extension="1543627549" root="1.2.276.0.76.4.1"/>
        <addr>
            <streetAddressLine>54 Main street</streetAddressLine>
            <postalCode>51371</postalCode>
            <city>Alphaville</city>
        </addr>
        <telecom value="tel:0221.444.5678"/>
        <patient>
            <name>
                <given>Paul</given>
                <family>Peterson</family>
            </name>
            <administrativeGenderCode code="M" codeSystem="2.16.840.1.113883.5.1"/>
            <birthTime value="19551217"/>
        </patient>
        <providerOrganization>
            <telecom use="WP" value="tel:02412127070"/>
            <telecom use="WP" value="fax:0241212707122"/>
            <addr>
                <streetAddressLine>12 Hospital street</streetAddressLine>
                <postalCode>51371</postalCode>
                <city>Alphaville</city>
            </addr>
        </providerOrganization>
    </patientRole>
</recordTarget>
• **Author**: person or device
• Custodian

**Custodian**

- **AssignedCustodian**
  - classCode*: <= ASSIGNED

- **custodian**
  - typeCode*: <= CST

- **CustodianOrganization**
  - classCode*: <= ORG
  - determinerCode*: <= INSTANCE
  - id*: SET<II> [1..*]
  - name: ON [0..1]
  - telecom: TEL [0..1]
  - addr: AD [0..1]
Visit Information

- Encompassing Encounter
CDA Body
Body Overview

- Header
- Body
  - Section
    - Entry
    - Entry
    - Section
  - Entry
  - Section

CDA Document
- Header
- Header
- Header
- Section
- Entry

Human readable
Machine processable
The Body: Component Model

- iterative definition
- .title = heading
- .text = paragraph

Section 1.

Section 2.

Section 2.1

Section 2.2
Section, mandatory parts

- title
- text
  - section
  - paragraphs
  - headings
  - tables
  - lists
  - revision marks (insert, delete)
  - ...

narrative block
• Section.text choice of
  • content
  • paragraph
  • linkHtml
  • sub / sup
  • br
  • footnote / footnoteRef
  • list
  • table

• table sequence of
  • caption
  • col / colgroup
  • thead
    • tr
      • th
  • tfoot
    • tr
      • td
      • ...
  • tbody
    • tr
      • td
**Example Table**

- rendered with XSLT

<table>
<thead>
<tr>
<th>Col 1</th>
<th>Col 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>aa</td>
</tr>
<tr>
<td>2</td>
<td>bb</td>
</tr>
</tbody>
</table>

```html
<text>
<table>
<thead>
<tr>
<th>Col 1</th>
<th>Col 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>aa</td>
</tr>
<tr>
<td>2</td>
<td>bb</td>
</tr>
</tbody>
</table>
</text>
```
## Sections: "Levels"

<table>
<thead>
<tr>
<th>CDA Release 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CDA Level 1</strong></td>
<td>The unconstrained CDA specification.</td>
</tr>
<tr>
<td><strong>CDA Level 2</strong></td>
<td>The CDA specification with section-level templates applied.</td>
</tr>
<tr>
<td></td>
<td>“My discharge letter has the following structure”</td>
</tr>
<tr>
<td><strong>CDA Level 3</strong></td>
<td>The CDA specification with section-level (and optionally entry-level) templates</td>
</tr>
<tr>
<td></td>
<td>“My discharge letter contains the following granular data”</td>
</tr>
</tbody>
</table>

**Human interoperability**

**Application interoperability**
Onset of asthma in his teens. He was hospitalized twice last year, and already twice this year.
• e.g. when transformed to HTML:

Human interoperability guaranteed
**Section.code**

- **LOINC**
- **coding strength: CWE**

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anamnese</td>
<td>11348-0</td>
<td>History of past illness</td>
</tr>
<tr>
<td>Allergy</td>
<td>10155-0</td>
<td>History of Allergies</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>29548-0</td>
<td>Diagnosis (Text; NAR)</td>
</tr>
<tr>
<td>Medication</td>
<td>10160-0</td>
<td>History of Medication Use</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Body Overview

- Header
- Body
  - Section
    - Entry
    - Entry
  - Section

CDA Document

- Header
- Header
- Header
- Section
- Entry

Human readable

Machine processable
Entries: Computable Representations of Clinical Concepts

- Observation
- Procedure
- Substance Administration
- Supply
- Encounter
- Act
- Organizer

Observation
Region of Interest
Observation Media
Substance Administration
Supply
Procedure
Encounter
Organizer
Act
Entries

- Clinical context
- “Clinical Statement Pattern”
CDA sections: Level 3

- Level 3
- Classes from the HL7 model (clinical statements)

```xml
<component>
  <section>
    <code code="10164-2" codeSystemName="LOINC"
           codeSystem="2.16.840.1.113883.6.1" />
    <title>29.08.2005: History</title>
    <text>
      ...
    </text>
    <entry typeCode="COMP">
      <observation>
        <code code="195967001"
              codeSystem="2.16.840.1.113883.6.96"
              codeSystemName="SNOMED CT"
              displayName="Asthma">  
          </code>
        </observation>
      </entry>
  </section>
</component>
```
Referencing Entries
The entry relationship is defaulted to **COMP** (component)
  - The narrative is the original authenticated content
  - The CDA entries are created by various techniques (e.g., natural language processing, a human coder, a structured data entry tool that outputs both entries and a text report)

The entry relationship **DRIV** (is derived from) can be used in the special case where the narrative is fully derived from CDA Entries
Derivation of text from a Level 3 entry (DRIV)

**Database**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>systolicBP</td>
<td>int</td>
</tr>
<tr>
<td>diastolicBP</td>
<td>int</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Observation**

Systolic BP: 120 mm[Hg]
Diastolic BP: 80 mm[Hg]

Blood pressure 120/80 mmHg

narrative is fully derived from the CDA entries
Family History: Patient with onset of asthma in his teens

<table>
<thead>
<tr>
<th>Database</th>
<th>...</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>familyHistory</td>
<td>text</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Derivation of text from a Level 3 entry (COMP)

<nsection>
  <ntext>
    Patient with onset of asthma in his teens.
  </ntext>
  <nentry typeCode="COMP">
    Observation
    asthma
  </nentry>
</nsection>

narrative is the original authenticated content
Entry Inspection: The Module Principle
CDA Entries (Clinical Statements)

- Choice of Acts (from HL7’s Reference Information Model)
- Relationships between Activities (Classes)
- Participations
Clinical Statement Pattern

- Observation
- Procedure
- Substance Administration
- Supply
- Encounter

- Act
- Organizer
Clinical Statement Types

- **Observation**
  - A Finding, Result, Diagnosis etc.
  - Includes requesting, recommending, promising, refusing or setting a goal
Clinical Statement Types

- Organizer relationships

```
Organizer
classCode*: <= ActClassDocumentEntryOrganizer
moodCode*: <= EVN
id: SET<> [0..*]
code: CD CWE [0..1] <= ActCode
statusCode*: CS CNE [1..1] <= ActStatus
effectiveTime: IVL<TS> [0..1]
```

Has components

- Observation
- Observation
- Observation
Clinical Statement Types

• **Statement Relationship**
  • A link between two or more Clinical Statements
  • Allows a relationship to be stated independently of the related Clinical Statements
• Rash (skin) as a *manifestation* of an allergy
• An appendectomy (procedure) because of the (diagnosis) acute appendicitis
A Patient is given a medication because his blood pressure is found to be 180/120 mm[Hg].
- Model deliberately broad and encompassing
- It would be possible to represent a particular statement in more than one way
- Therefore: constrain the Clinical Statement model!
- **Clinical Statement pattern**
  - Template
  - re-usable block

**Blood Pressure (Organizer)**

- Systolic BP (Observation) 180 mm HG
- Diastolic BP (Observation) 120 mm HG
Example 1: APGAR score

• Apgar score
• was devised in 1952 by Dr. Virginia Apgar as a simple and repeatable method to quickly and summarily assess the health of newborn children immediately after childbirth
**Example 1: APGAR score**

- Five criteria
- ... Simple, on a scale from 0 to 2
- summing up the five values = sum score

- Appearance
- Pulse
- Grimace
- Activity
- Respiration

<table>
<thead>
<tr>
<th>Component of Acronym</th>
<th>Score of 0</th>
<th>Score of 1</th>
<th>Score of 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skin color</strong></td>
<td>blue all over</td>
<td>blue at extremities</td>
<td>no cyanosis</td>
</tr>
<tr>
<td></td>
<td>body pink (acrocyanosis)</td>
<td>body and extremities pink</td>
<td></td>
</tr>
<tr>
<td><strong>Pulse rate</strong></td>
<td>absent</td>
<td>&lt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td><strong>Reflex irritability</strong></td>
<td>no response to stimulation</td>
<td>grimace/feeble cry when stimulated</td>
<td>sneeze/cough/pulls away when stimulated</td>
</tr>
<tr>
<td><strong>Muscle tone</strong></td>
<td>none</td>
<td>some flexion</td>
<td>active movement</td>
</tr>
<tr>
<td><strong>Breathing</strong></td>
<td>absent</td>
<td>weak or irregular</td>
<td>strong</td>
</tr>
</tbody>
</table>
Example 1: APGAR score

- **Method**
  - The test is generally done at one and five minutes after birth
  - may be repeated later if the score is and remains low

- **Interpretation**
  - Scores 3 and below are generally regarded as critically low
  - 4 to 6 fairly low, and
  - 7 to 10 generally normal
Interspersed Exercise 1

- **Prerequisites**
  - Apgar score is scientifically validated
  - indicator of health condition of a newborn
- **Exercise**
  - Use the Clinical Statement model to represent Apgar score
  - Think about how to identify sum score and the five scales
  - Determine the properties of the class attributes
Possible Solution

- Sum Score 0..10
  - Appearance 0..2
  - Pulse 0..2
  - Grimace 0..2
  - Activity 0..2
  - Respiration 0..2
• We just created a template...
• Is this really so easy?
Exercise

- Remember

Mickey Mouse

- Prerequisites
  - Pen and a piece of paper
  - Your memories and your drawing skills
- Exercise: draw the face of Mickey Mouse
Background Story
Mouse Statement

relationship

Mickey Mouse

Choice
Mini Intro and Outro

Templates
...with CDA you aren’t there yet...

Generic models
...need something
...to fill the gap
...to semantic interoperability
Templates
Generic vs specific definitions

- CDA is not a *highly* specified/differentiated model
  - “any” document definition
- Rule: the more general a model is the more you have to bridge the gap towards semantic interoperability
  - “any” document definition → “my” document definition
CDA & Implementation

• Re-usable generic blocks
  • Once you implemented a RecordTarget, re-use it in all document types
  • Choice of RIM favorite acts in it’s finest purity

• Incremental Interoperability
  • allows for a migration phase
  • ‘lowest common denominator’
    = human interoperability
  • Start with a simple CDA
  • Structured data elements are added over time
A template is a set of further constraints on top of an underlying model

Example: patient

Model: the patient shall have one or more identifications (id)

Template: our patients shall have exactly one Dutch national patient identifier

Documentation of “rules” in HL7’s Templates Exchange Format (DSTU)
### Consolidated CDA

**Template (section level)**

<table>
<thead>
<tr>
<th>Item ID</th>
<th>CT</th>
<th>Card</th>
<th>Conf</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cda:section</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cda:templateid</td>
<td>2.1.6.840.1.113883.10.20.22.2.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cda:code</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cda:title</td>
<td>48785-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cda:code</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cda:system</td>
<td>2.1.6.840.1.113883.6.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cda:displayName</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cda:entry</td>
<td>contains: 2.1.6.840.1.113883.10.20.22.4.30, Allergy Problem Act</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This section lists and describes any medication allergies, adverse reactions, idiosyncratic reactions, anaphylaxis/anaphylactoid reactions to food items, and metabolic variations (e.g., latex, indigo, tape adhesives) used to assure the safety of health care delivery. At a minimum, it should list currently active and any relevant historical allergies and adverse reactions.
Sample XML fragment

<observation classCode="OBS" moodCode="EVN">
  <templateId root="2.16.840.1.113883.10.20.22.4.4"/>
  <!-- Problem Observation template -->
  <id root="d11275e7-67ae-11db-bd13-0800200c9a66"/>
  <code code="409586006" codeSystem="2.16.840.1.113883.6.96" displayNonce="Complaint"/>
  <text>
...  
  </text>
  <statusCode code="completed"/>
  <effectiveTime>
    <low value="1950"/>
  </effectiveTime>
  <value xsi:type="CD" code="195967001"
    codeSystem="2.16.840.1.113883.6.96"
    displayNonce="Asthma"/>
</observation>
Template (entry level)

<table>
<thead>
<tr>
<th>Item</th>
<th>DT</th>
<th>Card</th>
<th>Conf</th>
<th>Description</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>cda:observation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>conf-622</td>
</tr>
<tr>
<td>@ classCode</td>
<td>1..1</td>
<td>F</td>
<td></td>
<td>OBS</td>
<td>conf-7318</td>
</tr>
<tr>
<td>@ moodCode</td>
<td>1..1</td>
<td>F</td>
<td></td>
<td>EVN</td>
<td>conf-7319</td>
</tr>
<tr>
<td>@ cda:templateId</td>
<td>1..1</td>
<td>M</td>
<td></td>
<td>2.16.840.1.113883.10.20.22.4.28</td>
<td>conf-7317</td>
</tr>
<tr>
<td>@ root</td>
<td>1..1</td>
<td>F</td>
<td></td>
<td>2.16.840.1.113883.10.20.22.4.28</td>
<td>conf-10490</td>
</tr>
<tr>
<td>cda:code</td>
<td>CE</td>
<td></td>
<td></td>
<td></td>
<td>conf-7320</td>
</tr>
<tr>
<td>@ code</td>
<td>1..1</td>
<td>F</td>
<td></td>
<td>33969-4</td>
<td></td>
</tr>
<tr>
<td>@ codeSystem</td>
<td>1..1</td>
<td>F</td>
<td></td>
<td>2.16.840.1.113883.6.1</td>
<td></td>
</tr>
<tr>
<td>@ displayName</td>
<td>1..1</td>
<td>F</td>
<td></td>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>cda:statusCode</td>
<td>CS</td>
<td></td>
<td></td>
<td></td>
<td>conf-7321</td>
</tr>
<tr>
<td>@ code</td>
<td>1..1</td>
<td>F</td>
<td></td>
<td>completed</td>
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<td>code from value set: 2.16.840.1.113883.3.68.12.60.68 dynamic</td>
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## Value Set

### AdministrativeGender

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<th>07/24/2012</th>
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<tr>
<td>Display Name</td>
<td>AdministrativeGender</td>
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<tr>
<td>Description</td>
<td>The gender of a person used for administrative purposes (as opposed to clinical gender)</td>
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<tr>
<td>Source Codesystems</td>
<td>2.16.840.1.113883.5.1, 2.16.840.1.113883.5.1</td>
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### Values

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<th>Codesystem</th>
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<td>M</td>
<td>Male</td>
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<td>F</td>
<td>Female</td>
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Template Types

- Document Level Template
- Header Constraints (Templates)
- Section Level Templates
- Entry Level Templates
- ...

...
Templates: all together now

- Document Level Template
- Header Level Templates
- Section Level Template
- Entry Level Templates

Vaccination Doc

- Client
- Author
- Custodian

Vaccinations

- Vaccines
- Reasons
Dr. Kai U. Heitmann, MD, FHL7
Heitmann Consulting and Services, Germany
Immediate Past Chair HL7 Germany
ART-DECOR expert group
Templates Co-chair HL7 International
info@kheitmann.de

Thank you!
Questions?