CDA Introduction

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Agenda
CDA Introduction

• Interoperability
• Clinical Document Architecture
• Header
• Body: Section and Entry
• Entry Inspection: The Module Principle
• Templates
Interoperability and the Clinical Document Architecture
• Human
  • The “paper world” with documents, forms...
  • “Simple text”
• Application
  • Storage, management of clinical data
  • Context driven analysis
  • Reusability

not an evil, inevitable!
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

Clinical Document (Document Information)

Header

Patient

Author (Physician)

...

...

Body

Body Structures (Text)

Body Entries (Clinical Statements)

Observation

Procedure

Encounter

Medication

External References

External Observation

External Procedure

External Document

...
(e.g. when transformed to HTML)

“Human interoperability guaranteed”
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
- ...

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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**
  - creation of document (as printed on top)
  
  `<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 (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**

```
AssignedCustodian
  classCode*: <= ASSIGNED

1..1 representedCustodianOrganization

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

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

1.
2.
2.1
2.2
Section, mandatory parts

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

narrative block
Formatting NarrativeBlock Content

- **Section.text choice of**
  - content
  - paragraph
  - linkHtml
  - sub / sup
  - br
  - footnote / footnoteRef
  - list
  - table

- **table sequence of**
  - caption
  - col / colgroup
  - thead
    - tr
      - th
  - tbody
    - tr
      - td
    - ...
  - tfoot
    - 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>
## Sections: "Levels"

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

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

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

```
<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"/>
      </observation>
    </entry>
  </section>
</component>
```
Referencing Entries

section component

code

title

text

entry

123.456

blablablah
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)

<table>
<thead>
<tr>
<th>Database</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>

**Blood Pressure**

120 80

**Observation**

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

Blood pressure 120/80 mmHg

DRIV (is derived from)
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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td>familyHistory</td>
<td>text</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

COMP (component)

narrative is the original authenticated content

<section>
<text>
Patient with onset of asthma in his teens.
</text>
<entry typeCode="COMP">
Observation
asthma
</entry>
</section>
Entry Inspection: The Module Principle

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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

**Observation**

classCode*: <= OBS  
moodCode*: <= x_ActMoodDocumentObservation  
id: SET<st> [0..*]  
code*: CD CWE [1..1] <= ObservationType  
negationInd: BL [0..1]  
derivationExpr: ST [0..1]  
text: ED [0..1]  
statusCode: CS CNE [0..1] <= ActStatus  
effectiveTime: IVL<TS> [0..1]  
priorityCode: CE CWE [0..1] <= ActPriority  
repeatNumber: IVL<INT> [0..1]  
languageCode: CS CNE [0..1] <= HumanLanguage  
value: ANY [0..1]  
interpretationCode: SET<CE> CNE [0..*]  
methodCode: SET<CE> CWE [0..*]  
targetSiteCode: SET<CD> CWE [0..*]
Clinical Statement Types

- Organizer relationships

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

**Observation**
- typeCode*: := COMP
- contextConductionInd*: BL [1..1] "true"
- sequenceNumber: INT [0..1]
- seperatableInd: BL [0..1]

Has components:
- Organizer
- 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

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• 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)

- component
  - Systolic BP (Observation)
  - Diastolic BP (Observation)

Statement #4567

- 180 mm HG
- 120 mm HG
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

<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>Skin color</td>
<td>blue all over</td>
<td>blue at extremities body pink (acrocyanosis)</td>
<td>no cyanosis body and extremities pink</td>
</tr>
<tr>
<td>Pulse rate</td>
<td>absent</td>
<td>&lt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Reflex irritability</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>Muscle tone</td>
<td>none</td>
<td>some flexion</td>
<td>active movement</td>
</tr>
<tr>
<td>Breathing</td>
<td>absent</td>
<td>weak or irregular</td>
<td>strong</td>
</tr>
</tbody>
</table>

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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
Interspersed Exercise 1

• Possible Solution

Observation: *Agpar Sum Score*
  - code: 
  - effectiveTime: 
  - value: 

Observation *Appearance*
  - code: 
  - value: 

Observation *Pulse*
  - code: 
  - value: 

Observation *Grimace*
  - code: 
  - value: 

Observation *Activity*
  - code: 
  - value: 

Observation *Respiration*
  - code: 
  - value:

– 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

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Mouse Style#22

Modell

“Reality”
Mini Intro and Outro Templates
...with CDA you aren’t there yet...

Generic models
...need something
...to fill the gap
...to semantic interoperability
Templates
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 Release 1 (STU)**

**Patient**
- id: II 1..1
- addr: AD 0..*
- telecom: TEL 0..*
### Allergies Section (entries optional)

<table>
<thead>
<tr>
<th>Item</th>
<th>DT</th>
<th>Card</th>
<th>Conf</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cda:templateId</td>
<td>II</td>
<td>1.1</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>@ root</td>
<td></td>
<td>1.1</td>
<td>F</td>
<td>2.16.840.1.113883.10.20.22.2.6</td>
</tr>
<tr>
<td>cda:code</td>
<td>CD</td>
<td>1.1</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>@ code</td>
<td></td>
<td>1.1</td>
<td>F</td>
<td>48786-2</td>
</tr>
<tr>
<td>@ codeSystem</td>
<td></td>
<td>1.1</td>
<td>F</td>
<td>2.16.840.1.113883.6.1</td>
</tr>
<tr>
<td>@ displayname</td>
<td></td>
<td>1.1</td>
<td>F</td>
<td>Allergies, adverse reactions, alerts</td>
</tr>
<tr>
<td>cda:title</td>
<td>ST</td>
<td>1.1</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>cda:templateId</td>
<td>II</td>
<td>1.1</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>@ root</td>
<td></td>
<td>1.1</td>
<td>F</td>
<td>2.16.840.1.113883.10.20.22.4.30 Allergy Problem Act</td>
</tr>
</tbody>
</table>
<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" displayName="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" displayName="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>@classCode</td>
<td>1.1</td>
<td>F</td>
<td>OBS</td>
<td></td>
<td>conf-7318</td>
</tr>
<tr>
<td>@moodCode</td>
<td>1.1</td>
<td>F</td>
<td>EVN</td>
<td></td>
<td>conf-7319</td>
</tr>
<tr>
<td>cda:templateId</td>
<td>1.1</td>
<td>M</td>
<td></td>
<td></td>
<td>conf-7317</td>
</tr>
<tr>
<td>@root</td>
<td>1.1</td>
<td>F</td>
<td>2.16.840.1.113883.10.20.22.4.23</td>
<td>conf-10480</td>
<td></td>
</tr>
<tr>
<td>@code</td>
<td>1.1</td>
<td>F</td>
<td>33998-4</td>
<td></td>
<td>conf-7320</td>
</tr>
<tr>
<td>@codeSystem</td>
<td>1.1</td>
<td>F</td>
<td>2.16.840.1.113883.6.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@displayNamo</td>
<td>1.1</td>
<td>F</td>
<td>Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@statusCode</td>
<td>1.1</td>
<td>M</td>
<td></td>
<td>completed</td>
<td>conf-7321</td>
</tr>
<tr>
<td>@code</td>
<td>1.1</td>
<td>F</td>
<td>2.16.840.1.113883.5.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@codeSystem</td>
<td>1.1</td>
<td>F</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@displayNamo</td>
<td>1.1</td>
<td>F</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@value</td>
<td>1.1</td>
<td>M</td>
<td>CONF</td>
<td>code from value set: 2.16.840.1.113883.3.66.12.60.68 dynamic</td>
<td>conf-7322</td>
</tr>
</tbody>
</table>

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## Value Set

### AdministrativeGender

<table>
<thead>
<tr>
<th>Version</th>
<th>07/24/2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version Label</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>AdministrativeGender</td>
</tr>
<tr>
<td>Description</td>
<td>The gender of a person used for administrative purposes (as opposed to clinical gender)</td>
</tr>
<tr>
<td>Source Codesystems</td>
<td>2.16.840.1.113883.5.1</td>
</tr>
</tbody>
</table>

### Values

<table>
<thead>
<tr>
<th>Level/Type</th>
<th>Code</th>
<th>Display Name</th>
<th>Codesystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-L</td>
<td>M</td>
<td>Male</td>
<td>2.16.840.1.113883.5.1</td>
</tr>
<tr>
<td>0-L</td>
<td>F</td>
<td>Female</td>
<td>2.16.840.1.113883.5.1</td>
</tr>
<tr>
<td>0-L</td>
<td>UN</td>
<td>Undifferentiated</td>
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</tr>
</tbody>
</table>
Template Types

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

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Templates: all together now

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

Vaccination Doc
- Client
- Author
- Custodian

Vaccinations
- Vaccines + Reasons

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Thank you!

Questions?