

# Revisiting ontological foundations of the OpenEHR Entry Model

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# Background

- There is a world out there, and it is infested with ~~evil~~, I mean, non-enlightened clinicians
  - Pragmatically oriented
  - Results driven
- Standards, standards, standards
- Conceptual orientation

# OpenEHR standard

- Two-level
  - Information model
    - Document analogy
    - Basic functions of software systems
  - Clinical model (archetypes)
    - Clinical reality
    - Clinical workflow
    - Four major categories: observation, action, evaluation, instruction

# But...

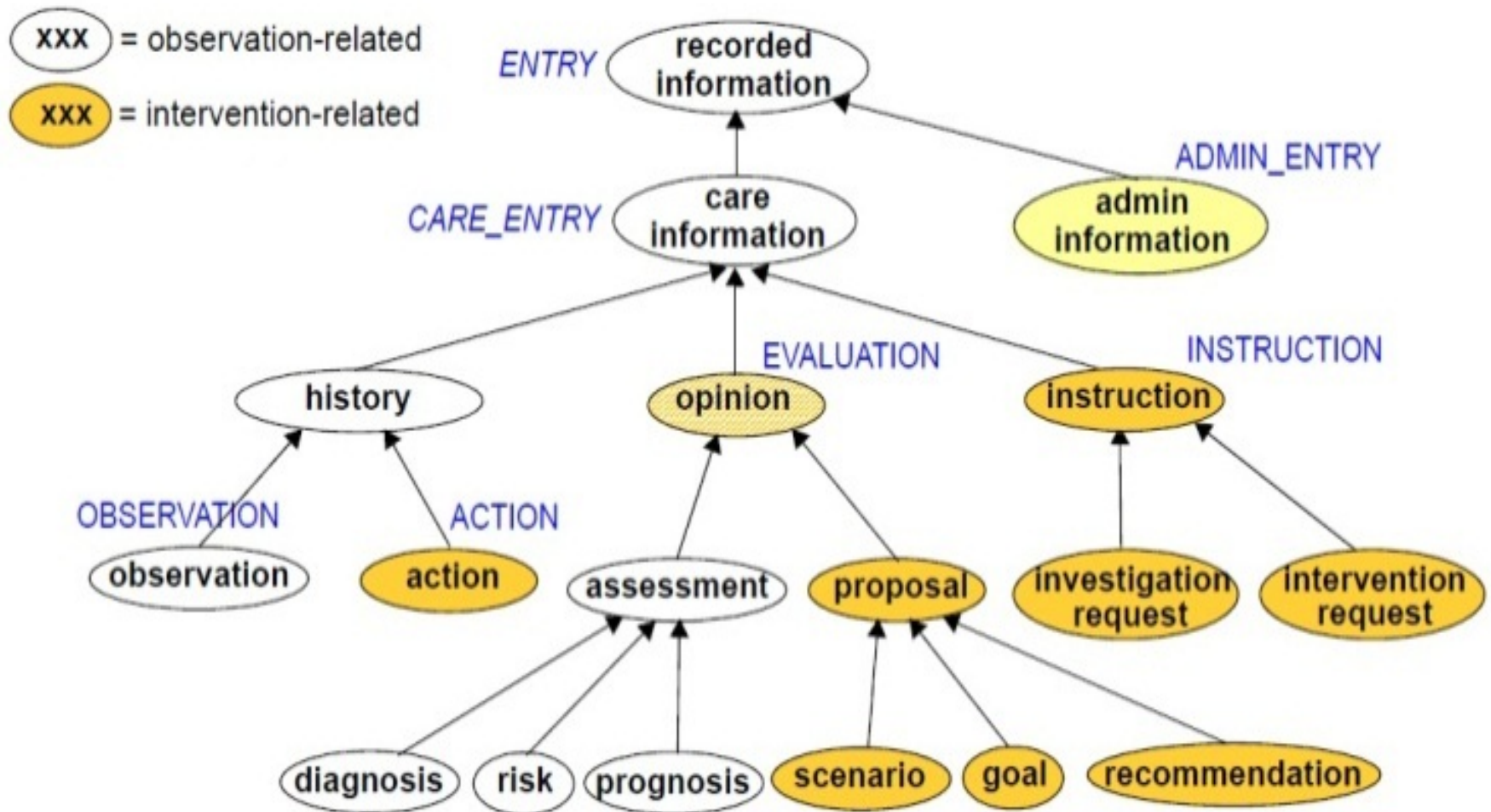
- Are all these locations?
  - Anatomical location → right femur
  - Relative location → 5 cm inferior to the tibial tuberosity
  - Address lines → A composite of (...)address components that describe a low level of geographical/physical description of a location that (...) forms a complete geographical/physical address.
- Have I ever been submitted to a cancelled surgery?
- What is the relation between SNOMED-CT “O/E Blood Pressure reading” and <Sleep status> = “awake”

\*Sleep status - supports interpretation of 24 hour ambulatory blood pressure records.

# Goal

- The main goal (here) is to use ontologies to analyse OpenEHR standard to make ambiguities visible
- Evaluate what fits in a realist oriented ontology

# OpenEHR Ontology of Recorded Information



# OpenEHR Entry Model

- Ontology of Information
  - Information about the past, present and future
  - Observation and Intervention
- Immediately suitable for alignment
  - Information Artifact Ontology
  - Ontology for General Medical Science

# OpenEHR ontological issues







- Clash of information view, workflow view, temporal view and ontological view
- Action is some (1)information obtained during (2)clinical history taking about a (3)past (4)intervention

*OpenEHR:Action subclassOf report  
and ('is about' some (occurrent  
and (has\_participant some (human\_being  
and (has\_role some patient\_role))))))*

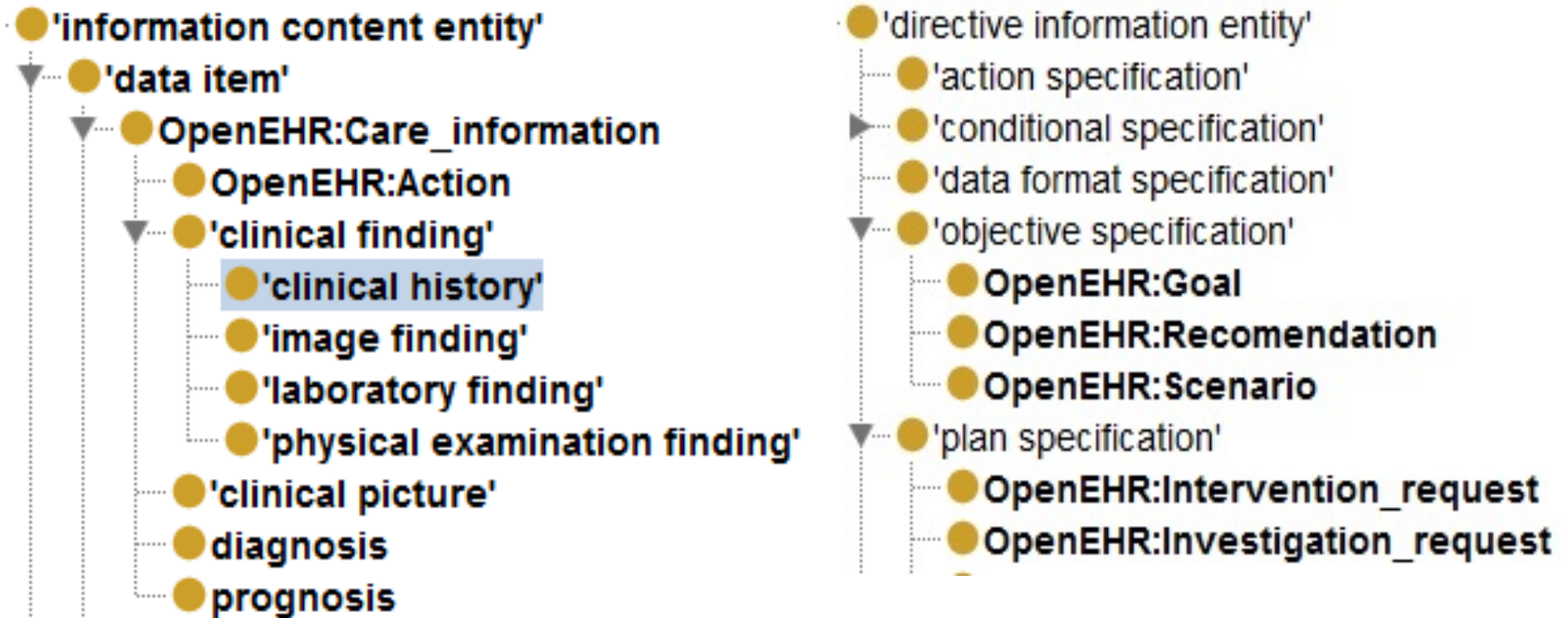


# Archetype representation – Issues

- Lack of distinction between information and reality
  - Found in all levels
  - Action steps and states

Header	Description	Pathway	Reference model
<b>Structure:</b> Careflow step Cardinality: 1..1 ( <i>mandatory</i> )			
	<b>Plan</b> Careflow step	The medication is planned but no execution has taken place	<b>Current state:</b> <b>initial</b>
	<b>Plan suspended</b> Careflow step	The plan to order medication has been suspended	<b>Current state:</b> <b>postponed</b>
	<b>Cancelled</b> Careflow step	The planned administration has been cancelled	<b>Current state:</b> <b>cancelled</b>
	<b>Start time set</b> Careflow step	The time to start this medication has been set	<b>Current state:</b> <b>scheduled</b>
	<b>Prescribe</b> Careflow step	The order has been transferred to the dispensary	<b>Current state:</b> <b>active, initial</b>
	<b>Dispense</b> Careflow step	The medication has been dispensed	<b>Current state:</b> <b>active, initial</b>

# Alignment with IAO and OGMS



# Archetype analysis

- Archetype selection criteria
  - At least one archetype of each main branch
  - Published status
  - Frequency in medical records

# Clinical Knowledge Manager

**openEHR Clinical Knowledge Manager**

Archetypes ▾ Templates ▾ Termsets ▾ Release Sets ▾ Reports ▾ About ▾

Find Resources

**Blood Pressure**

Archetype: Blood Pressure (openEHR-EHR-OBSERVATION.blood\_pressure.v1)

Header | **Data** | State | Protocol | Events | Reference model

**Structure: Tree**  
 Occurrences: 1..1 (mandatory)  
 Cardinality: 0..\* (optional, repeating, unordered)

<b>Q</b>	<b>Systolic</b> Quantity Occurrences: 0..1 (optional) [SNOMED-CT(2003)::163030003] (On examination - Systolic BP reading (finding))	Peak systemic arterial blood pressure - measured in systolic or contraction phase of the heart cycle.	Property: Pressure Units: • 0.0..<1000.0 mm[Hg] Limit decimal places: 0
<b>Q</b>	<b>Diastolic</b> Quantity Occurrences: 0..1 (optional) [SNOMED-CT(2003)::163031004] (On examination - Diastolic blood pressure reading (finding))	Minimum systemic arterial blood pressure - measured in the diastolic or relaxation phase of the heart cycle.	Property: Pressure Units: • 0.0..<1000.0 mm[Hg] Limit decimal places: 0
<b>Q</b>	<b>Mean Arterial Pressure</b> Quantity Occurrences: 0..1 (optional)	The average arterial pressure that occurs over the entire course of the heart contraction and relaxation cycle.	Property: Pressure Units: • 0.0..<1000.0 mm[Hg] Limit decimal places: 0
<b>Q</b>	<b>Pulse Pressure</b> Quantity Occurrences: 0..1 (optional)	The difference between the systolic and diastolic pressure.	Property: Pressure Units: • 0.0..<1000.0 mm[Hg] Limit decimal places: 0
<b>T</b>	<b>Comment</b> Text Occurrences: 0..1 (optional)	Comment on blood pressure measurement.	Free or coded text

**Left Panel: EHR Archetypes**

- Cluster
- Composition
- Element
- Entry
  - Action
  - Evaluation
  - Observation
    - Apgar score (v1)
    - Audiogram result (v1)
    - Autopsy examination (v1)
    - Barthel Index (v1)
    - Blood Pressure (v1)
    - Blood matching (v1)
    - Bodily output (v1)
    - Body mass index (v1)
    - Body temperature (v1)
    - Body weight (v1)
    - Braden Scale (v1)
    - Carer observation (v1)
    - Distraction Hearing Test (v1)
    - ECG recording (v1)

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**Blood Pressure**

Archetype: Blood Pressure (openEHR-EHR-OBSERVATION.blood\_pressure.v1)

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<p><b>T</b> <b>Comment</b> Text Occurrences: 0..1 (optional)</p>	<p>Comment on blood pressure measurement.</p>	<p>Free or coded text</p>

**EHR Archetypes**

- Cluster
- ✓ Apgar score (v1)
- Audiogram result (v1)
- Autopsy examination (v1)
- Barthel Index (v1)
- ✓ Blood Pressure (v1)
- Blood matching (v1)
- ▷ Bodily output (v1)
- ✓ Body mass index (v1)
- ✓ Body temperature (v1)
- ▷ Body weight (v1)
- ▷ Braden Scale (v1)
- ▷ Carer observation (v1)
- Distraction Hearing Test (v1)
- ECG recording (v1)

# Archetype representation - The good

- 'physical examination finding'
- ▼ ● openEHR-EHR-OBSERVATION.blood\_pressure.v1

Superclasses +

● 'is about' some arterial_blood_pressure
● 'physical examination finding'
● has_part some Blood_pressure_measurement_datum
● is_output_of some Blood_pressure_measuring_process

- 'measurement datum'
- ▼ ● Blood\_pressure\_measurement\_datum
  - Diastolic\_blood\_pressure\_data
  - Mean\_arterial\_pressure\_data
  - Pulse\_pressure\_data
  - Systolic\_blood\_pressure\_data

Superclasses +

● Blood_pressure_measurement_datum
● is_output_of some Systolic_blood_pressure_measuring_process

- 'planned process'
- ▼ ● Blood\_pressure\_measuring\_process
  - Cuff\_based\_auscultation\_blood\_pressure\_measuring\_process
  - Diastolic\_blood\_pressure\_measuring\_process
  - Systolic\_blood\_pressure\_measuring\_process

Superclasses +

● 'planned process'
● has_output some openEHR-EHR-OBSERVATION.blood_pressure.v1
● has_participant some (human_being and ((has_part some Artery) and (has_quality some arterial_blood_pressure)) and (has_role some patient_role))

# Prescription

Description: MedicationAdministrationInstruction

Equivalent classes 

- 'action specification'  
and ('is about' some  
    (plan  
      and (is\_realized\_by only medication\_administration))))

Description: Patient001Prescription

Types 

☰ MedicationAdministrationInstruction

- 'is about' some  
    (plan  
      and (is\_realized\_by only  
          (medication\_administration  
          and (has\_participant some  
              ('Processed Material'  
              and (has\_part some  
                  (paracetamol  
                  and (bearer\_of some  
                      (mass  
                      and (inverse (denotes) some  
                          ('mass measurement datum'  
                          and (has\_part value miligram)  
                          and ('has measurement value'  
                          value "500"))))))))  
          and (bearer\_of only  
              (QuantityQuality  
              and (hasNumberOfGrains value  
                  "1"^^int))))  
          and (has\_participant value patient001))))

Description: ParacetamolPrescriptions

Equivalent classes 

- 'information content entity'  
and ('is about' some  
    (plan  
      and (is\_realized\_by only  
          (medication\_administration  
          and (has\_participant some  
              ('Processed Material'  
              and (has\_part some paracetamol))))))

Description: FulfilledPatientPrescriptions

Equivalent classes 

- 'information content entity'  
and ('is about' some  
    (plan  
      and (is\_realized\_by some  
          (medication\_administration  
          and (has\_participant value patient001))))

# Archetype representation - The Bad

- Unclear relations between archetype and data
  - “Bad” ontological distinctions

<b>T</b>	<b>Location of measurement</b> Coded Text Occurrences: 0..1 (optional)	Common body sites where blood pressure is recorded.	<ul style="list-style-type: none"><li>• Right arm [The right arm of the person.]</li><li>• Left arm [The left arm of the person.]</li><li>• Right thigh [The right thigh of the person.]</li></ul>
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- Completely implicit relations

**Archetype: Medication action (openEHR-EHR-ACTION.medication.v1)**

Header | **Description** | Pathway | Reference model

**Structure:** Tree  
Cardinality: 1..1 (mandatory)

<b>A</b>	<b>Unnamed SLOT</b> Slot (Tree) Occurrences: 1..1 (mandatory)	<b>Include:</b> openEHR-EHR-ITEM_ TREE.medication.v1 Or openEHR-EHR-ITEM_TREE.medication- vaccine.v1 <b>Exclude:</b> All not explicitly included archetypes
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Included



# Archetype representation – The ugly

- Epistemic and non-referential assertions
  - Examiner dependent entities (Korotkoff sound)
  - Clinical heuristics
    - Confounding factors:” Comment on and record other incidental factors that may be contributing to the blood pressure measurement. For example, level of anxiety or 'white coat syndrome'; pain or fever; changes in atmospheric pressure etc.”
  - Causality, indications, “Reason for Ceasing”

# Conclusions and afterthoughts

- Some (a lot) of alignment is feasible
- Ontological analysis can actually improve archetype creation
- Clinical medicine may actually require application-KB with “unicornic entities” – but few

# Limitation and future work

- Weak axiomatization
- Limited archetype sample
- No coverage of restrictions – templates are still extremely useful!
- No coverage of “information model” issues
- Future work
  - Increase sample size and represent real records
  - Representation of contextual and language-related entities
  - Improve axiom definition

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Thank you!

Questions?

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