openEHR

Definition, concepts, platforms

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About me

Background:

- B.Sc. in Medical instrumentation and computer engineering (Institute of Engineering, Porto - PT)
- M.Sc. in Medical informatics (Faculty of medicine – University of Porto, PT)

Past:

- Functional analyst @ HealthySystems & CINTESIS(PT)
- Health informatics engineer & clinical modelling lead @ Better

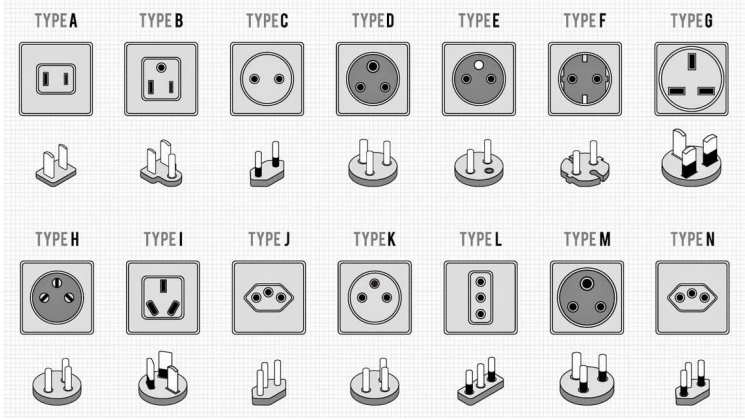
Currently:

- Digital health engineer @ LIH

Other:

- openEHR Portugal associate
- HL7 Portugal associate
- E-MAIS associate - representative of Portugal in the European Federation for Medical Informatics (EFMI)

The problem(s)



Medical data is complex

Complex data types and structures, medical concepts are hard to explain and new evidence is discovered daily

EHR's made by many companies

EHR are usually made by an aggregation of requests made to many companies. Each company made the system in the way they think it's right – no consensus.

Current systems have no domain knowledge

The meaning of the system is usually made by a programmer and his decisions of what's true in the healthcare domain.

Data belongs to the application

- Applications have a limited lifespan
- Patients lifespan >>> applications lifespan

Non-existent "Privacy by design"

Clinical data is recorded together with patient identifiable data

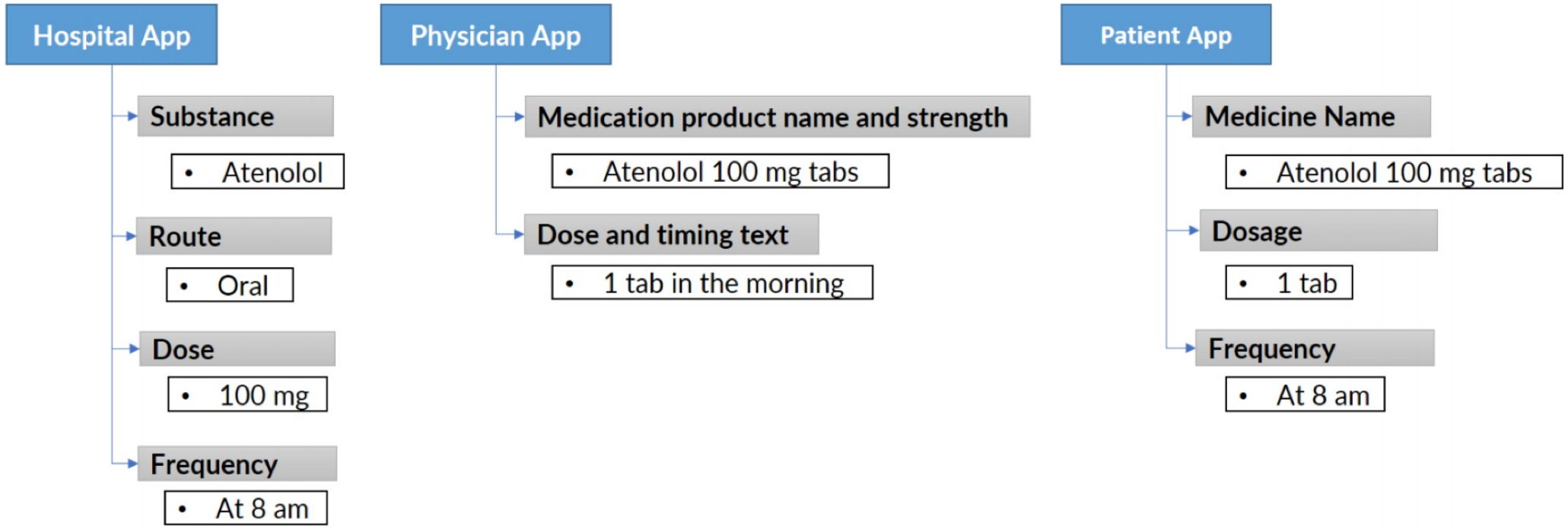
No interoperability

Systems do not know how to "speak" with each other.

No focus on context and semantics

The same clinical concept can be defined in N ways. Care settings and context are not considered – primary, secondary, tertiary, registries.

The problem(s) - Mismatched information models



Mismatched information models between different applications (adapted from Ian McNicoll presentation on openEHR Day London 2017)

- Prescribing medication defined in O(n) different ways by different implementers.
- Replicated concepts, weird structure.

How to mitigate and fix

- Invest on domain knowledge
  - Involve clinical personel ASAP in the development of clinical systems and make them clinically driven

- Semantics, data definition and structured data should be the focus

- Get vendor neutral platforms based on open data standards
  - Lock-in of data is very profitable.
  - Dissociate health records from dependency of clinical softwares

SNOMED CT The global language of healthcare

openEHR

LOINC® from Regenstrief

HL7® FHIR®

What is openEHR

OpenEHR stands for open electronic health record

An open specification/architecture

Provides rules of how to work, share and store health data with the principal idea of separating this data from applications as an agnostic approach. Based on ISO/TR 20514, ISO/TS 18308, etc.

Vendor lock-in and technology avoider

Data belongs to hospital institutions and not to IT companies.

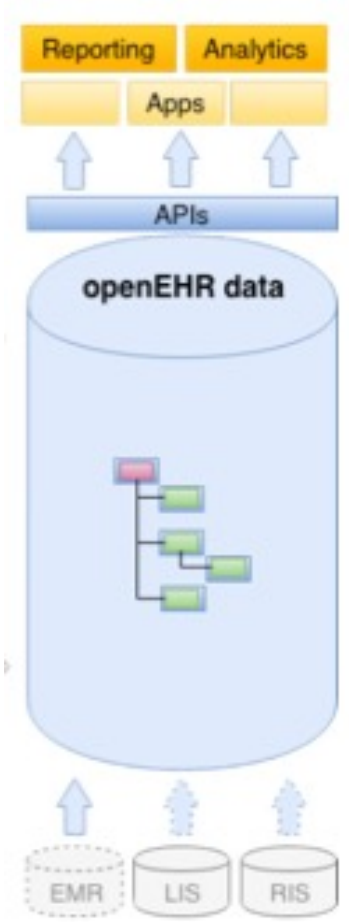
Research friendly

Clinical data is separated from demographics data. Great for secondary use of data.

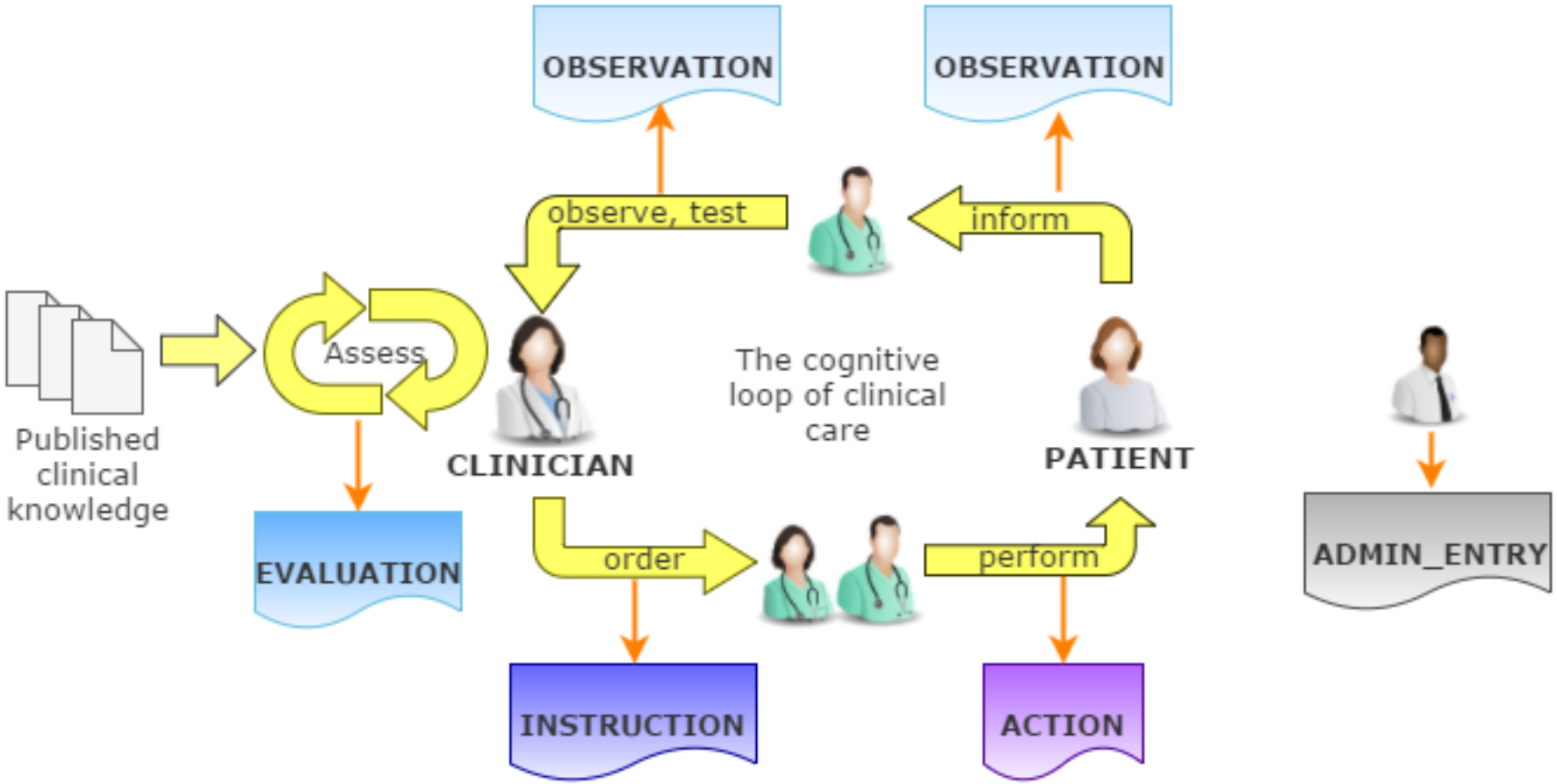
Guideline on how to model HI

Same datatypes will be used across different systems based on openEHR

- Aim is to save detailed fine grained strutured data
- openEHR based systems will always understand the clinical concept (e.g. Blood pressure) in the same way



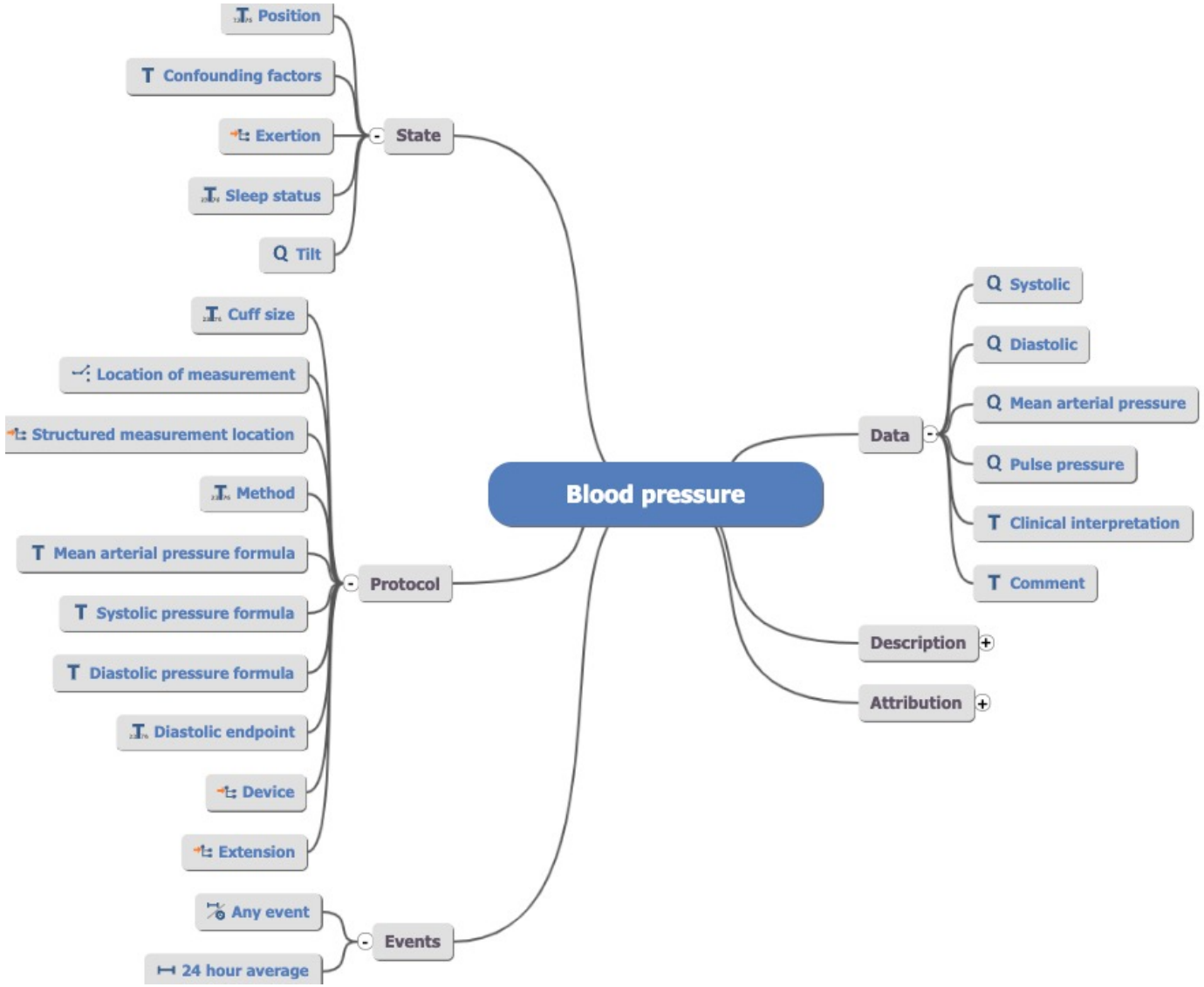
Clinical investigator recording process



Ref: https://specifications.openehr.org/releases/RM/Release-1.0.4/ehr.html

Data models (archetypes)

https://ckm.openehr.org/ckm/archetypes/1013.1.3574/mindmap - *Blood Pressure archetype*



Systolic

Quantity
Optional
[**SNOMED-CT(2003)**::271649006 | Systolic blood pressure]

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

Position

Coded Text
Optional

The position of the individual at the time of measurement.

- Standing [Standing at the time of blood pressure measurement.]
- Sitting [Sitting (for example on bed or chair) at the time of blood pressure measurement.]
- Reclining [Reclining at the time of blood pressure measurement.]
- Lying [Lying flat at the time of blood pressure measurement.]
- Lying with tilt to left [Lying flat with some lateral tilt, usually angled towards the left side. Commonly required in the last trimester of pregnancy to relieve aortocaval compression.]

Cuff size

Coded Text
Optional
[**SNOMED-CT(2003)**::246153002 | Type of cuff]

The size of the cuff used for blood pressure measurement.

Perloff D, Grim C, Flack J, Frohlich ED, Hill M, McDonald M, Morgenstern BZ. Human blood pressure determination by sphygmomanometry. Circulation 1993;88;2460-2470.

- Adult Thigh [A cuff used for an adult thigh.]
- Large Adult [A cuff for adults with larger arms.]
- Adult [A cuff that is standard for an adult.]
- Small Adult [A cuff used for a small adult.]
- Paediatric/Child [A cuff that is appropriate for a child or adult with a thin arm.]
- Infant [A cuff used for infants.]
- Neonatal [A cuff used for a neonate, assuming cuff is the appropriate size for maturity and birthweight of the neonate.]

Archetypes vs templates

- Archetype – defines a clinical concept or a clinical instrument (e.g.: Blood pressure, body temperature, NEWS2)

- Template – defines a use case within a context (e.g.: Vital signs measurement during the encounter with the patient)

Archetypes:

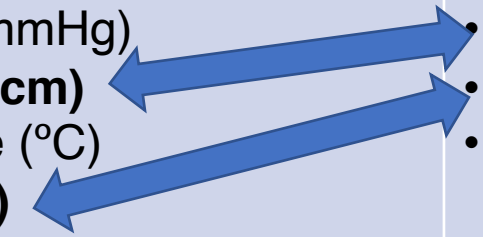
Templates:

CKM:

Archetypes reusability

- The same archetype can be reused in diferent templates.
  - Data elements can be constrained if not necessary for a specific use case.

Template - Vital signs	Template - BMI
Archetypes: • Blood pressure (mmHg) • **Body height (m, cm)** • Body temperature (ºC) • **Body weight (kg)** • Respiration (/min)	Archetypes: • **Body height (m, cm)** • **Body weight (kg)** • Body mass index (kg/m2)



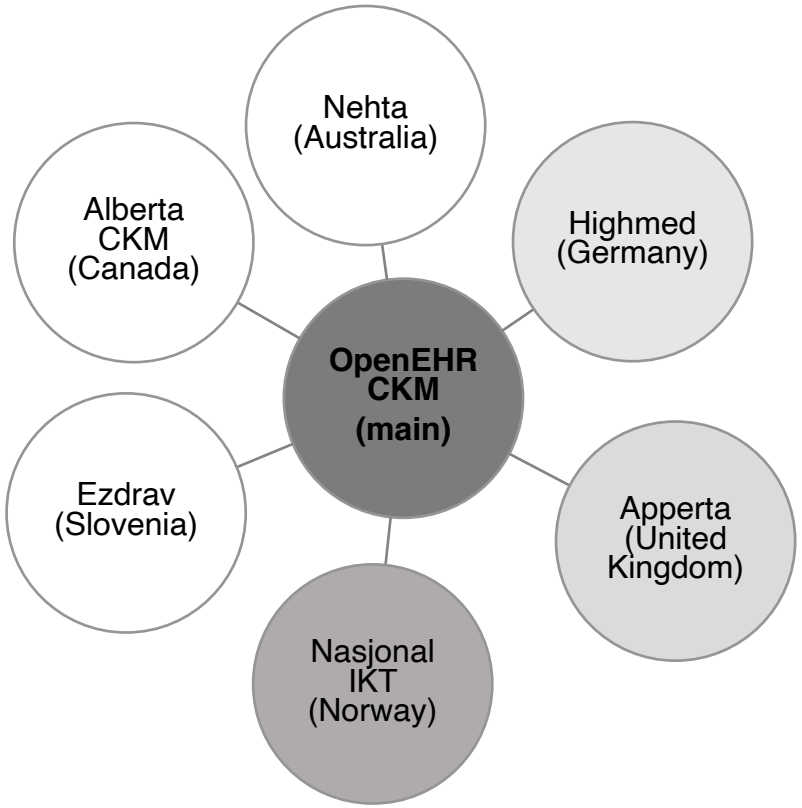
Archetypes are defined once and only changed if new clinical evidence proves that is necessary to be modified.

openEHR – Clinical Knowledge Manager (CKM)

https://ckm.openehr.org/

- Main **web tool** that makes the management of clinical models' resources (archetypes and templates)
- Created in April 2009, product from Ocean Health System (ex-Ocean Informatics).
- Currently under management of the openEHR community.
- **Free registration** for individuals from all around the world, focused on giving added value to the repository on a voluntary basis.
- All non-technical healthcare area professions are also encouraged to contribute, it is not a requirement to be a physician to redound.
- Has functionality for **translations** of archetypes.

openEHR CKM instances



Main:

- openEHR CKM (**International**): https://ckm.openehr.org/ckm/

National:

- Apperta (**United Kingdom**): https://ckm.apperta.org/ckm/
- Nasjonal IKT (**Norway**): https://arketyper.no/ckm/
- Highmed (**Germany**): https://ckm.highmed.org/ckm/
- Ezdrav (**Slovenia**): http://ukz.ezdrav.si/ckm/

Extra: openEHR and HL7 FHIR

- Aim of each is different! And work great together.

	FHIR	openEHR
Primary aim	EHR data Exchange	Fine grained EHR data structure & persistence
Also does	Data persistence	Data exchange
Moto	80/20 rule (Pareto law)	Maximum dataset
Main concepts & availability	Resources R4: ~140 resources (11 normative)	Archetypes 882 active archetypes (160 published)
Concepts managed by	FHIR team – workgroups per resource	openEHR community
Age	7y (since 2015 - uses information learned from HL7 v2 era ~1989 + CDA)	30y (since 1992 - called GEHR)

Based on: Allwell-Brown, Eneimi. (2016). A Comparative Analysis of HL7 FHIR and openEHR for Electronic Aggregation, Exchange and Reuse of Patient Data in Acute Care.

- FHIR is great for Exchange and for not-so-complex projects and supports very common clinical use. openEHR is good for persisting fine-grained detailed data for a patient's lifespan and more complex use cases.

Extra: openEHR and HL7 FHIR

- Posting data using openEHR OR FHIR: Blood pressure

openEHR (left)
Concept: blood pressure archetype
openEHR-EHR-OBSERVATION.blood_pressure.v2

```
"vital_signs/blood_pressure:0/any_event:0/systolic|magnitude": 200,
"vital_signs/blood_pressure:0/any_event:0/systolic|unit": "mm[Hg]",
"vital_signs/blood_pressure:0/any_event:0/systolic/_name|value": "Systolic blood pressure",
"vital_signs/blood_pressure:0/any_event:0/systolic/_name|code": "271649006",
"vital_signs/blood_pressure:0/any_event:0/systolic/_name|terminology": "SNOMED-CT"
"vital_signs/blood_pressure:0/any_event:0/systolic/_mapping:0|match": "=",
"vital_signs/blood_pressure:0/any_event:0/systolic/_mapping:0/target|value": "Systolic blood pressure",
"vital_signs/blood_pressure:0/any_event:0/systolic/_mapping:0/target|code": "8480-6",
"vital_signs/blood_pressure:0/any_event:0/systolic/_mapping:0/target|terminology": "LOINC",
"vital_signs/blood_pressure:0/any_event:0/clinical_interpretation": "High blood pressure",
"vital_signs/blood_pressure:0/any_event:0/diastolic|magnitude": 189,
"vital_signs/blood_pressure:0/any_event:0/diastolic|unit": "mm[Hg]",
"vital_signs/blood_pressure:0/any_event:0/diastolic/_name|value":"Systolic blood pressure",
"vital_signs/blood_pressure:0/any_event:0/diastolic/_name|code":"21794005",
"vital_signs/blood_pressure:0/any_event:0/diastolic/_name|terminology": "SNOMED-CT"
"vital_signs/blood_pressure:0/any_event:0/diastolic/_mapping:0/target|value": "Systolic blood pressure",
"vital_signs/blood_pressure:0/any_event:0/diastolic/_mapping:0/target|code": "8462-4",
"vital_signs/blood_pressure:0/any_event:0/diastolic/_mapping:0/target|terminology": "LOINC",
"vital_signs/blood_pressure:0/any_event:0/position|code": "at1003", -- lying (openehr atcode)
"vital_signs/blood_pressure:0/any_event:0/confounding_factors": "Patient was anxious",
"vital_signs/blood_pressure:0/method|code": "at1036",
```

FHIR (right)
Concept: Observation resource