

# openEHR: towards a coherent connected ecosystem

- Ian McNicoll
  - Clydebank GP for 15 years
- Health informatician
  - Past Co-chair openEHR International
  - Founding Fellow FCI
  - Hon. research associate, UCL
  - INTEROpen (UK)
- Commercial
  - CEO, freshEHR Ltd.
  - CCIO, inidus Ltd.



FACULTY OF  
**CLINICAL  
INFORMATICS**



# A little history ...

A YEAR IN GENERAL PRACTICE COMPUTING

Dr Ian T McNicoll MBChB, MRCP

Fellow in Computing Experience

August 1985 - August 1986

Chief Scientist Office

Scottish Home and Health Department


Whilst this comment is most applicable to a fully computerised GP record system it has considerable importance if GPs are to make proper and confident use of the patient problem summaries produced by GPASS.

The coding requirements of the GPASS system are currently under major review and one of the most promising options is the READ CODE. This has been developed with microcomputers in mind and has the advantage of being highly structured and hierarchical, allowing data storage and retrieval to take place at different levels of detail according to requirements. It also employs a great number of synonyms, simplifying data entry for both GP and staff and includes a codes for occupations and practical procedures.

A description of the Read Code is reproduced in the Appendix.

The principal concern, therefore, should be that GPASS provides a morbidity coding system which meets the GP's requirements, thereby encouraging morbidity recording. The epidemiologist's needs are less exacting and are catered for by all of the codes under consideration for future use by GPASS.

... collection of three articles we look at aspects of coding for NHS computer systems: a new comprehensive medical coding system; a system for public ICD-9 coding; and a proposal for a national supplies coding system.



James Read MB ChB MRCP  
General Practitioner

## COMPREHENSIVE CODING

A system for coding the whole of medicine has been developed by James Read who, with Tim Benson, outlines it.

The collection and management of medical data using computers requires two key criteria to be met. Firstly, clinicians need to record information in the form, language and detail that is of greatest value to treating individual patients. Secondly, data should be held within the computer in a form which facilitates statistical analysis of aggregated data. Information retrieval and communication between computers. These goals have led to the development of a new comprehensive, computer-based classification, nomenclature and coding system for medicine (the Read Clinical Classification).

### Classification and nomenclature

A statistical classification of medicine consists of a number of categories in which every condition or procedure has an appropriate place. Some conditions or procedures have more than one name and such synonyms or alternative names are incorporated within the classification, so creating a nomenclature. A nomenclature is a list of approved medical terms which must be extensive if it is to be comprehensive.

Attributes of both a statistical classification and a nomenclature are needed to meet the needs of both practising clinicians and the users of statistical information. The Read Clinical Classification is a hierarchical statistical classification with the features of a nomenclature. It has four levels of detail as shown in Table 1.

When thought of as a nomenclature the system has 24948 entries, but is also a hierarchy with 27 first level categories, 273 at the second level, 2770 at the third and so on. Each synonym is linked to the code for the specific category that it is an alternative name for.

### Applications

The clinical uses of the new system include:

- (1) structured medical records and notes;
- (2) mail and recall systems for preventive medical care;
- (3) expert systems and clinical protocols for diagnosis, treatment and follow-up care of patients;
- (4) self-audit, peer-audit and policy planning; and
- (5) administration, including accountancy and financial control.

Statistical applications include:

- (1) clinical trials and research;
- (2) health service management and planning.

### Hierarchical codes

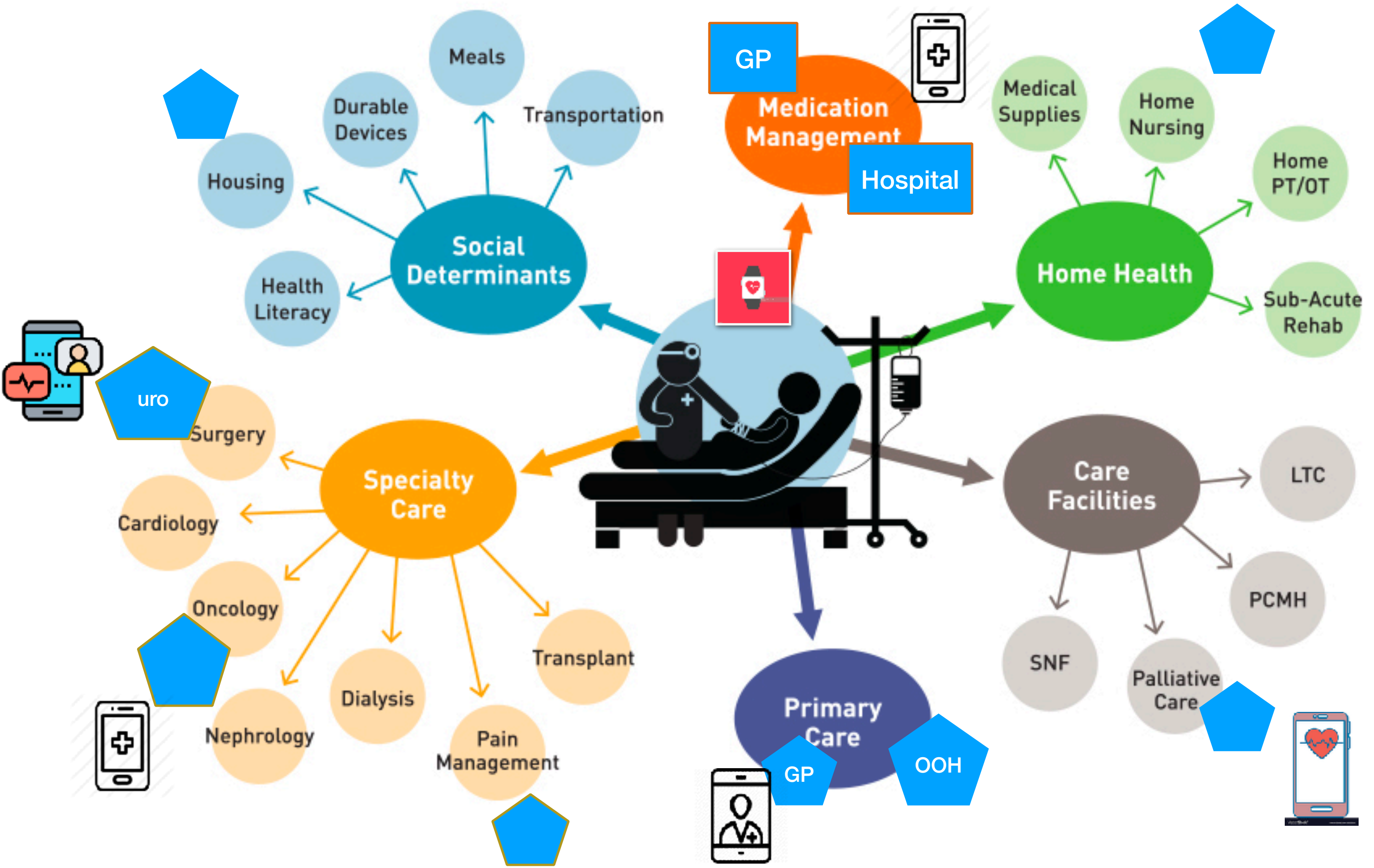
The structure of the hierarchical classification is mapped directly by codes. In the same way that a map grid reference specifies a position on a map, each code specifies its position within the classification.

The Read Clinical Classification has four digit alpha-numeric codes using the numerical 0-9 and the letters A-Z. The first digit relates to level 1, the second to level 2 and so on. Consider the code B136, this is broken down as follows:

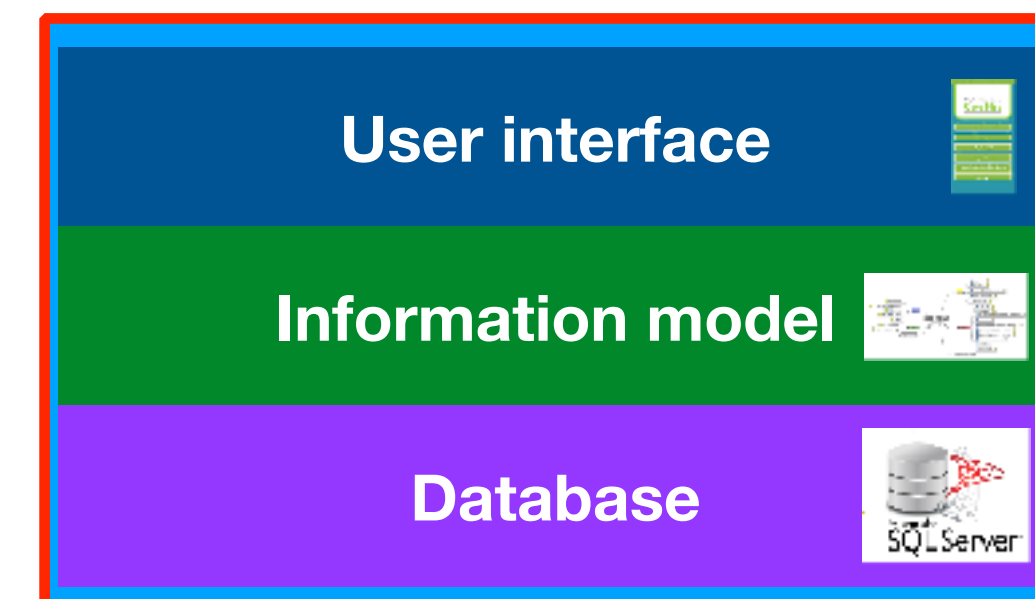
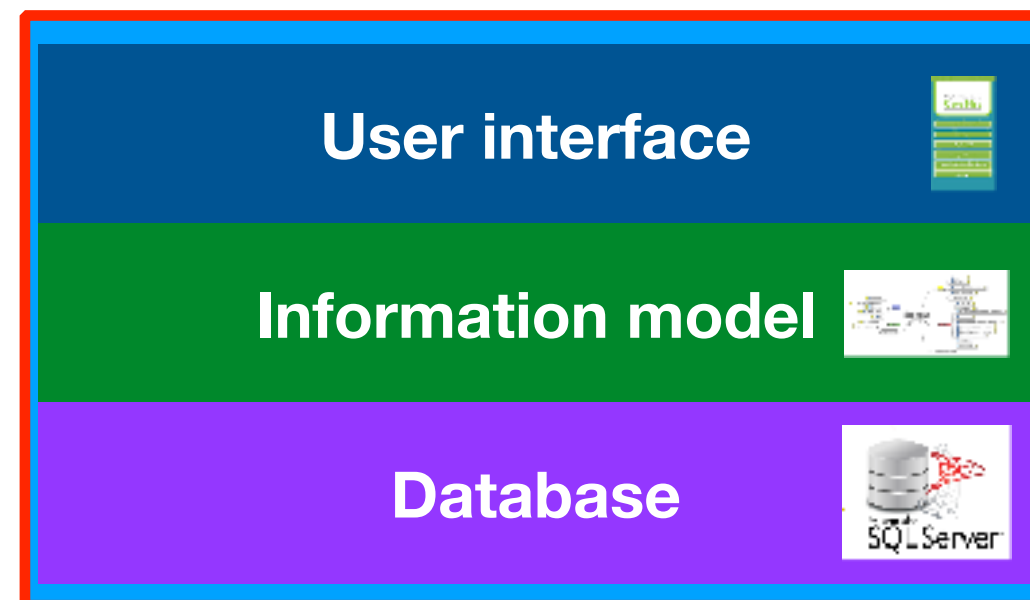
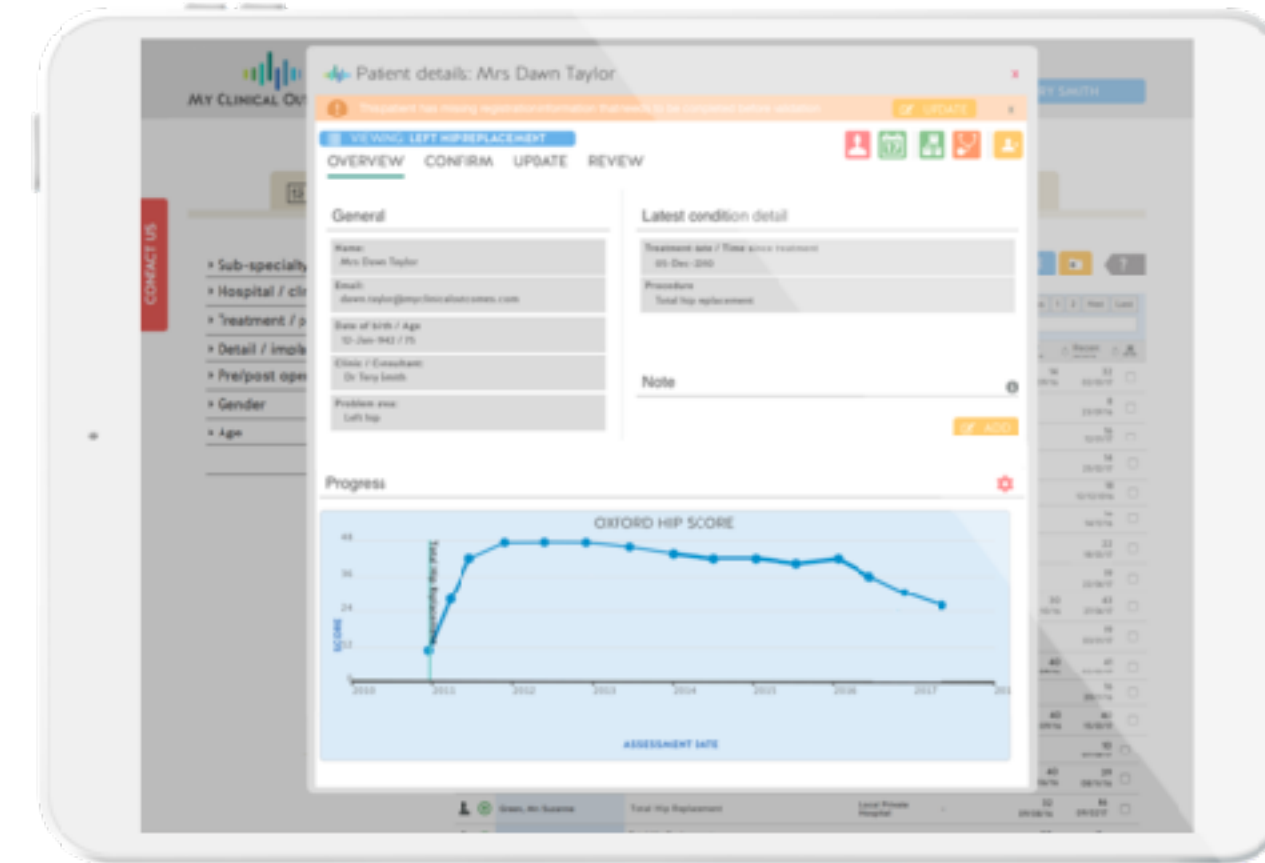
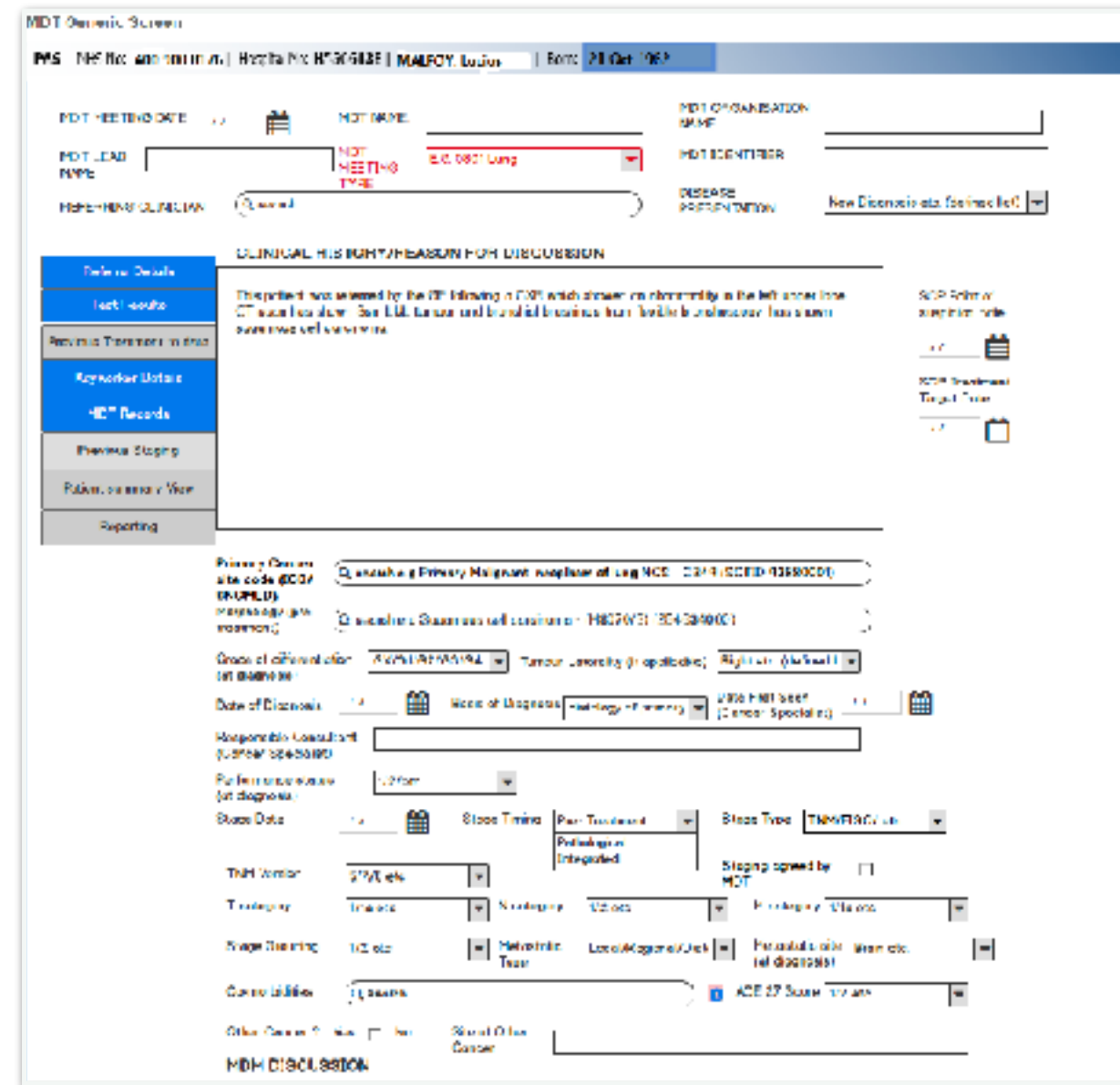
Level	Number of categories or entries
1	27
2	273
3	2770
4	13217
Synonyms	8501
TOTAL	24948

BRITISH JOURNAL OF HEALTH CARE COMPUTING MAY 1987

# A patient-centered coherent system?



# What is a 'system'?



# Cancer journey



Jim, 60, PLWC Copier, (aka West Coast Man)  
Purple M&R Resilient, proactive and resourceful. Their strong characters have enabled them to take control of their cancer experience. Confident and happy with their lives.

MDT Dennis, Steven  
PMS: MDT Dennis, Steven | Health Plan: MDT DENNIS | MALDEN, London | Birth: 24 Oct 1967

MDT LEAD: NOT KNOWN  
MDT IDENTIFIER: NOT KNOWN  
MDT ORGANISATION: MDT DENNIS

MDT LEAD TYPE: NOT KNOWN  
MDT IDENTIFIER TYPE: NOT KNOWN  
MDT IDENTIFIER: NOT KNOWN  
MDT IDENTIFIER TYPE: NOT KNOWN

CLINICAL HISTORY/REASON FOR CONSULTATION  
The patient was referred for the GP following a CT scan which showed an abnormality in the left lower lobe of the lung. See LHM for scan and hospital letter. Scan results and hospital letter are available in the patient's record.

Primary Care Organisation: MDT DENNIS  
Date of Diagnosis: 10/10/10  
Site of Diagnosis: Primary Care Organisation

Diagnosis: Colorectal cancer  
Date of Diagnosis: 10/10/10  
Staging: Dukes T2

Summary of treatment and relevant dates:  
Surgery - Resection (March 10) and reversal of stoma (Sept 10)  
Radiotherapy - May-June 2010  
Possible treatment toxicities and/or late effects:  
Diarrhoea following pelvic radiotherapy

Possible treatment toxicities and/or late effects:  
Surgery - Resection (March 10) and reversal of stoma (Sept 10)  
Radiotherapy - May-June 2010  
Possible treatment toxicities and/or late effects:  
Diarrhoea following pelvic radiotherapy

Next symptoms that require referral back to specialist team:  
Diarrhoea for more than two weeks not relieved by loperamide capsules  
Blood or mucus per rectum  
Further change in bowel function  
Abdominal pain that persists for longer than four weeks and does not respond to simple analgesia

Secondary care ongoing management plan: (tests, appointments etc)  
Next GP Review - Jan 2011  
CEA measured in Jan 2011 then annually until 2015  
CT scan (abdo and chest) next due Sept 2011  
Colonoscopy repeat next due Sept 2015

Other advice referrals made (delete or add)  
Dietsician  
Bowel Disease Service

Recommended GP actions in addition to GP Cancer Care Review:  
Please review dose of XXXXX in two months if symptoms of XXXX resolved reduce to 4mg daily

Summary of information given to the patient about their cancer and future prognosis:  
John Smith and his wife have been informed that the cancer in the colon was non-invasive and that he has received surgery and radiotherapy with curative intent. He is aware however that it may recur in the future and we have briefly discussed the further treatment available should this be required. He is fully aware of the symptoms of recurrence and what to do about it if occur.

Additional information including issues relating to lifestyle and support needs:  
I have advised him to quit smoking and referred to smoking cessation clinic.  
He is keen to join local osteoarthritis support group and plans to attend next session in November.

Completing Clinician: Charles Goodenough | Signature: | Date: 20.10.10

You can order Treatment Summary template pack through [bo.moodle.org.uk](http://bo.moodle.org.uk)

### Treatment Summary

Please take this document with you to your GP practice appointment where your diagnosis and cancer care will be reviewed with you.

Please complete this form using BLOCK CAPITALS and block ink.

Patient's name: John Smith | GP contact details: Dr Jones  
Date of birth: 10.10.10 | Record number:  
Address: 3 Park Road | Hospital list:  
Donorcard ID# DEF

Your patient has had the following diagnosis and treatment for cancer and received a summary and ongoing management plan as outlined below. They have not received a copy of this summary. (Delete as applicable)

Diagnosis	Date of diagnosis	Staging
Colorectal cancer	10.10.10	Dukes T2

Summary of treatment and relevant dates:  
Surgery - Resection (March 10) and reversal of stoma (Sept 10)  
Radiotherapy - May-June 2010  
Possible treatment toxicities and/or late effects:  
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Bowel Disease Service

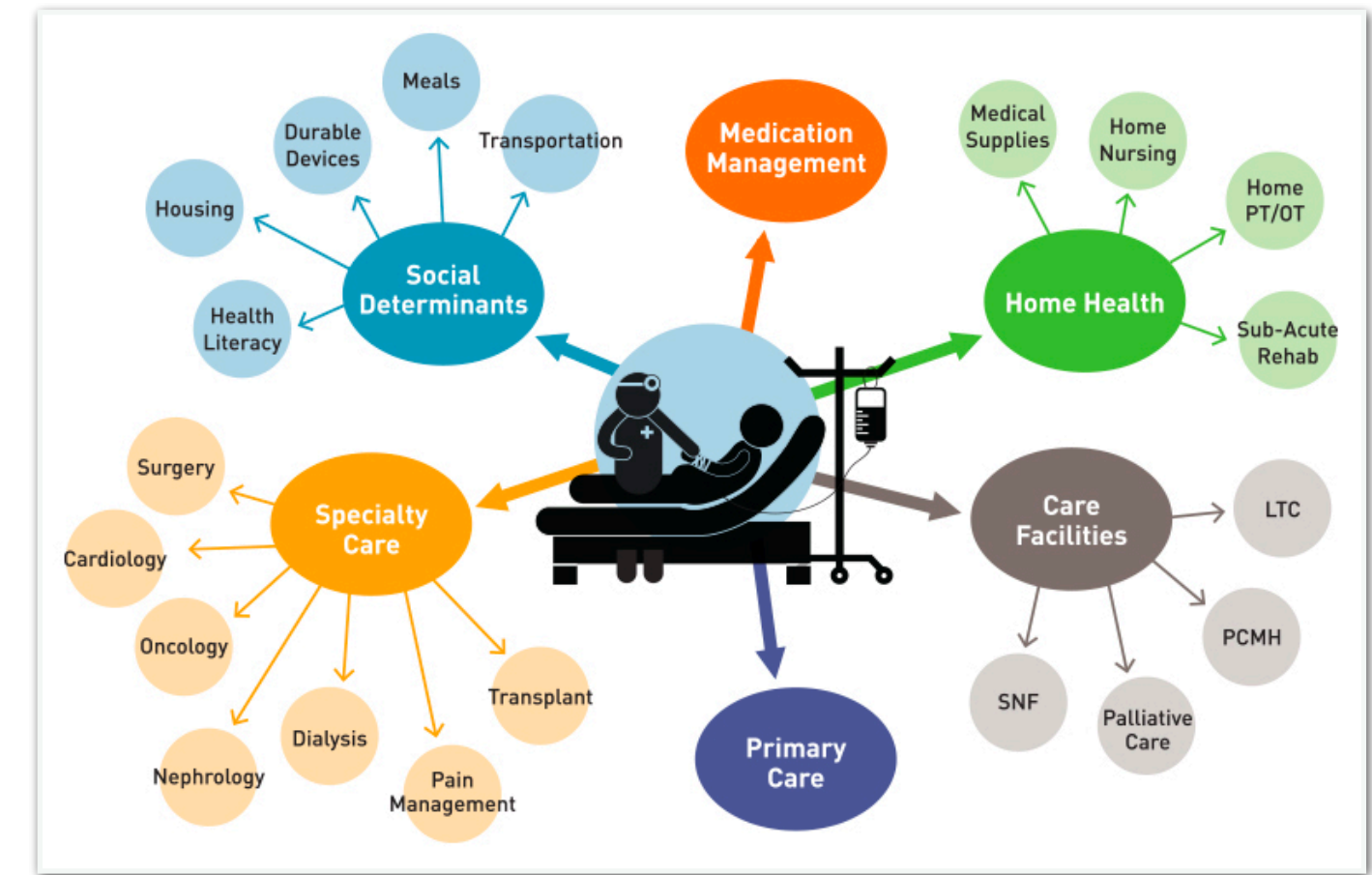
Recommended GP actions in addition to GP Cancer Care Review:  
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Completing Clinician: Charles Goodenough | Signature: | Date: 20.10.10

You can order Treatment Summary template pack through [bo.moodle.org.uk](http://bo.moodle.org.uk)



MY CLINICAL CV  
Patient details: Mrs Dawn Taylor

OVERVIEW CONFIRM UPDATE REVIEW

General  
Name: Mrs Dawn Taylor  
Address: 123 Main Street, London  
Age: 65  
Gender: Female

Latest condition detail  
Oxford Hip Score  
Assessment Date: 2010

Progress  
OXFORD HIP SCORE  
Assessment Date: 2010

### RESPECT Recommended Summary Plan for Emergency Care and Treatment

1. This plan belongs to:

Preferred name

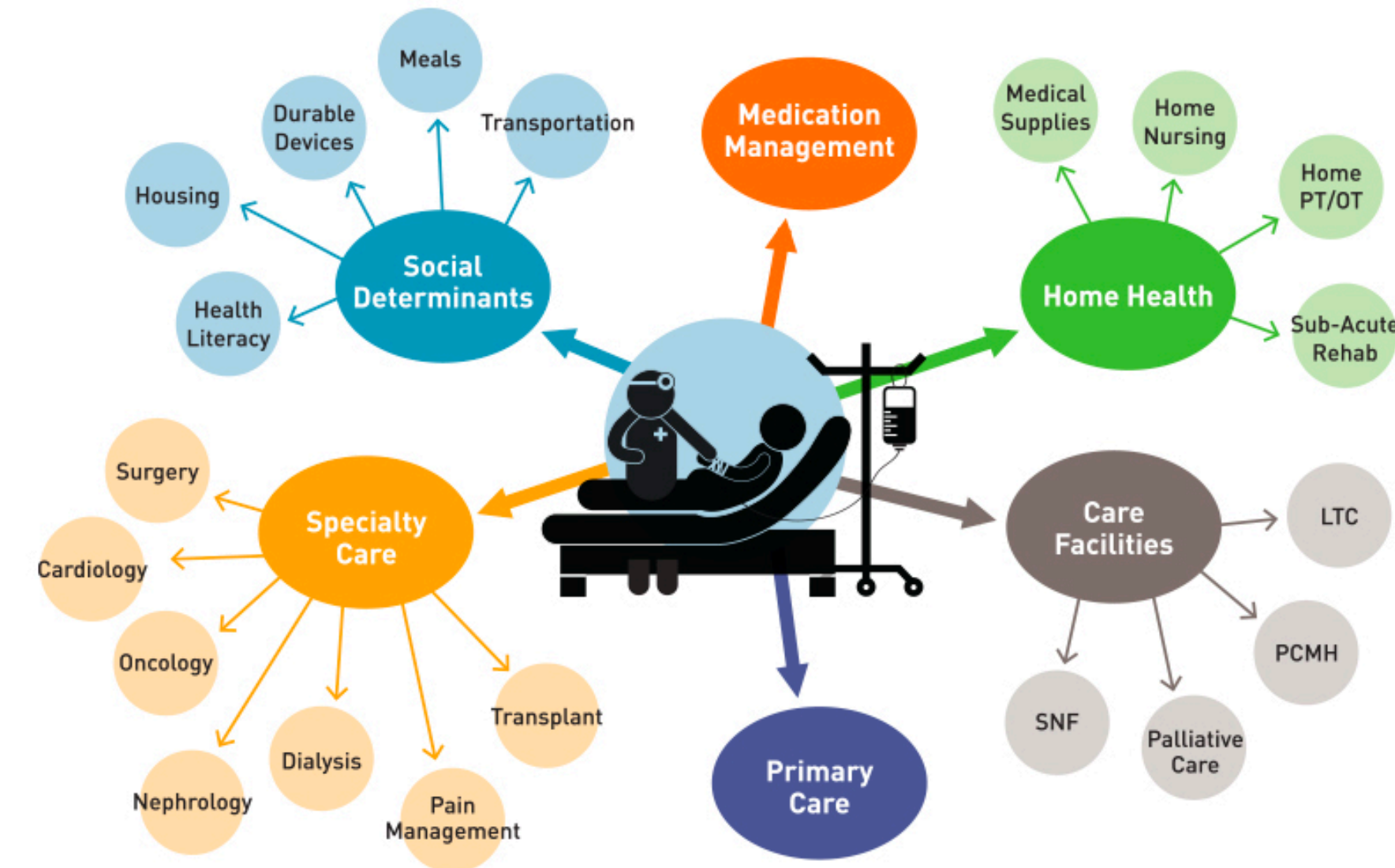
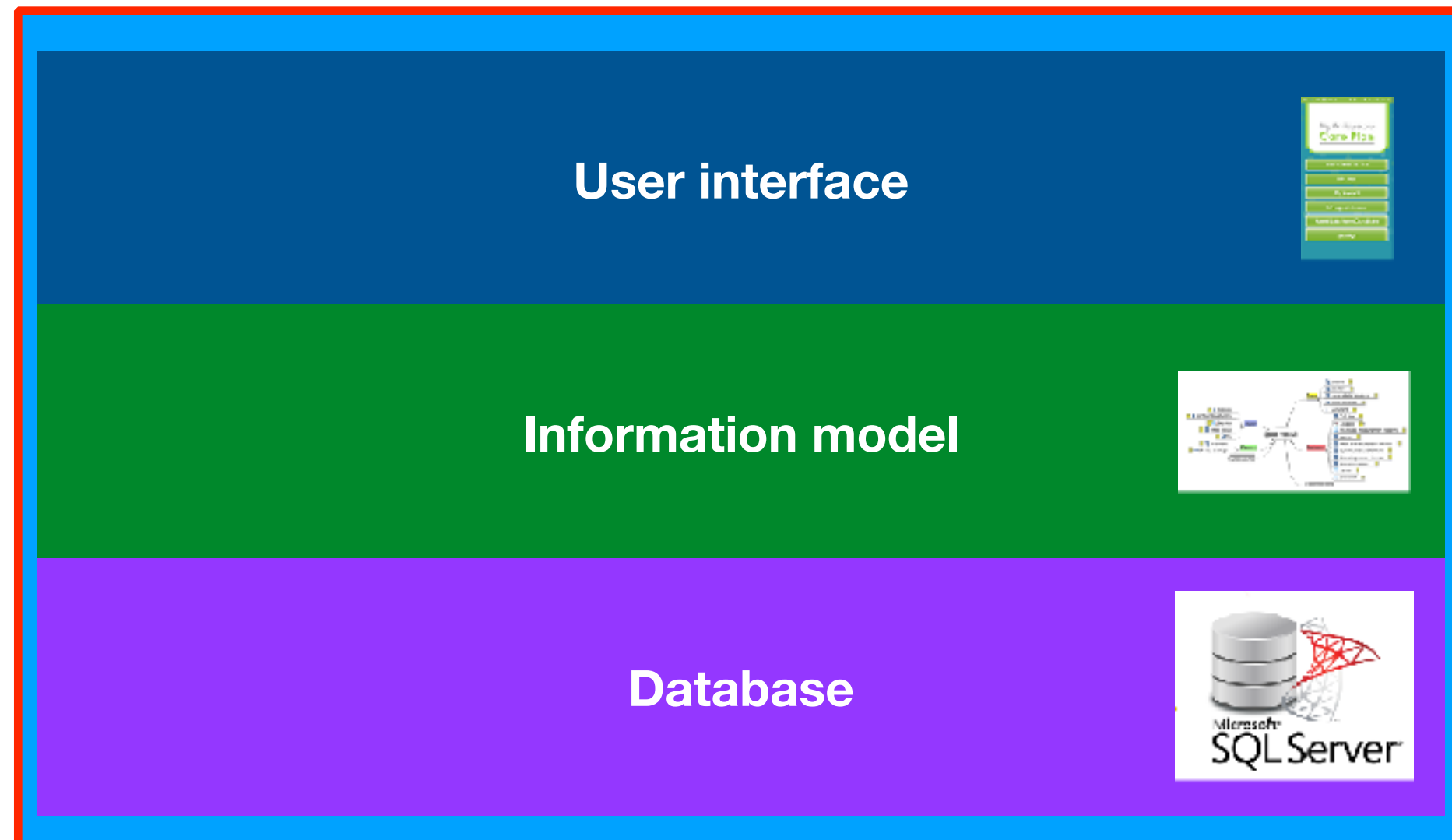
Date completed

# One system to rule them all?

openEHR

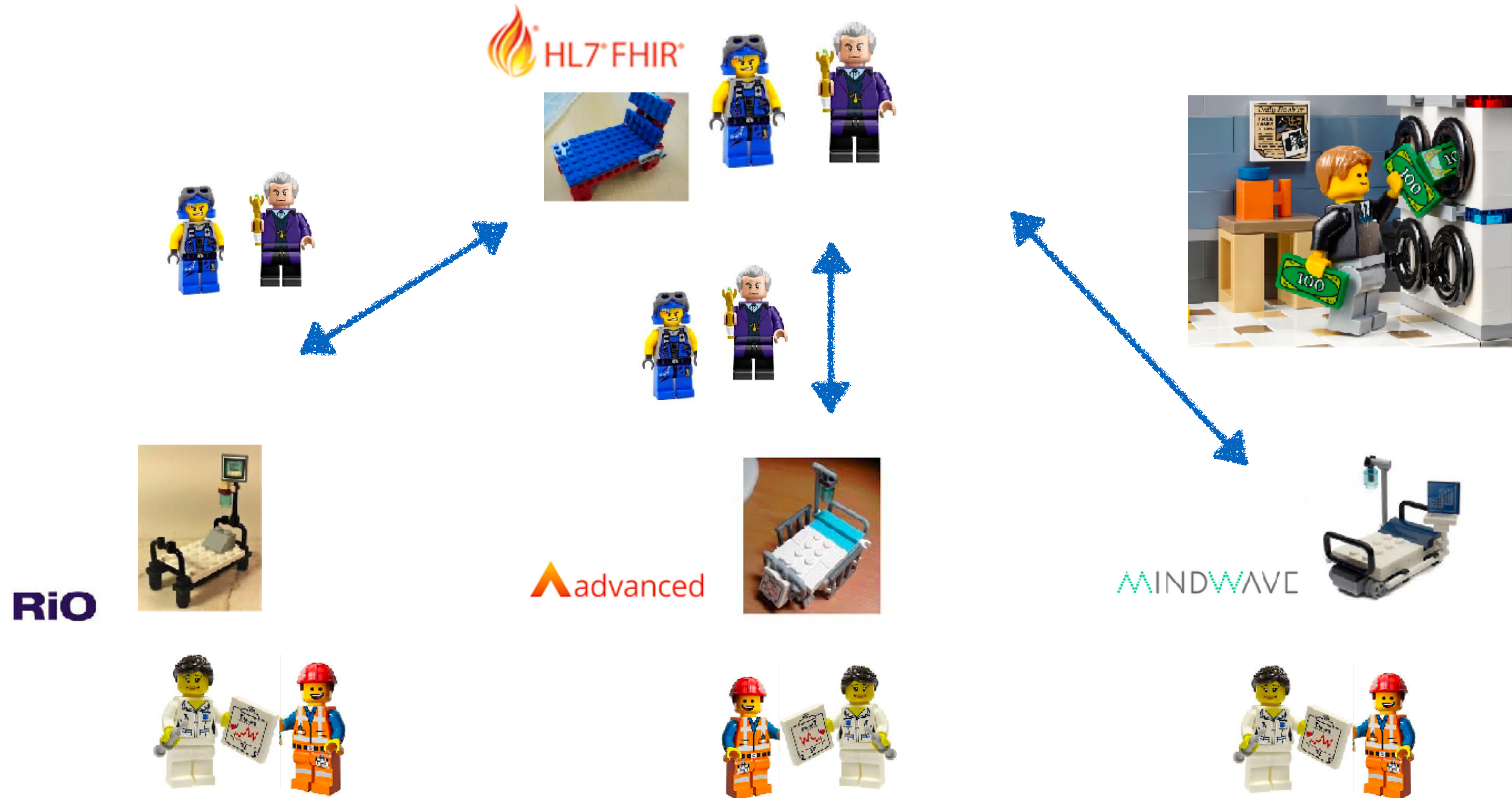
NHS  
Connecting for Health

tpp



# Is 'interoperability' what we want?

openEHR



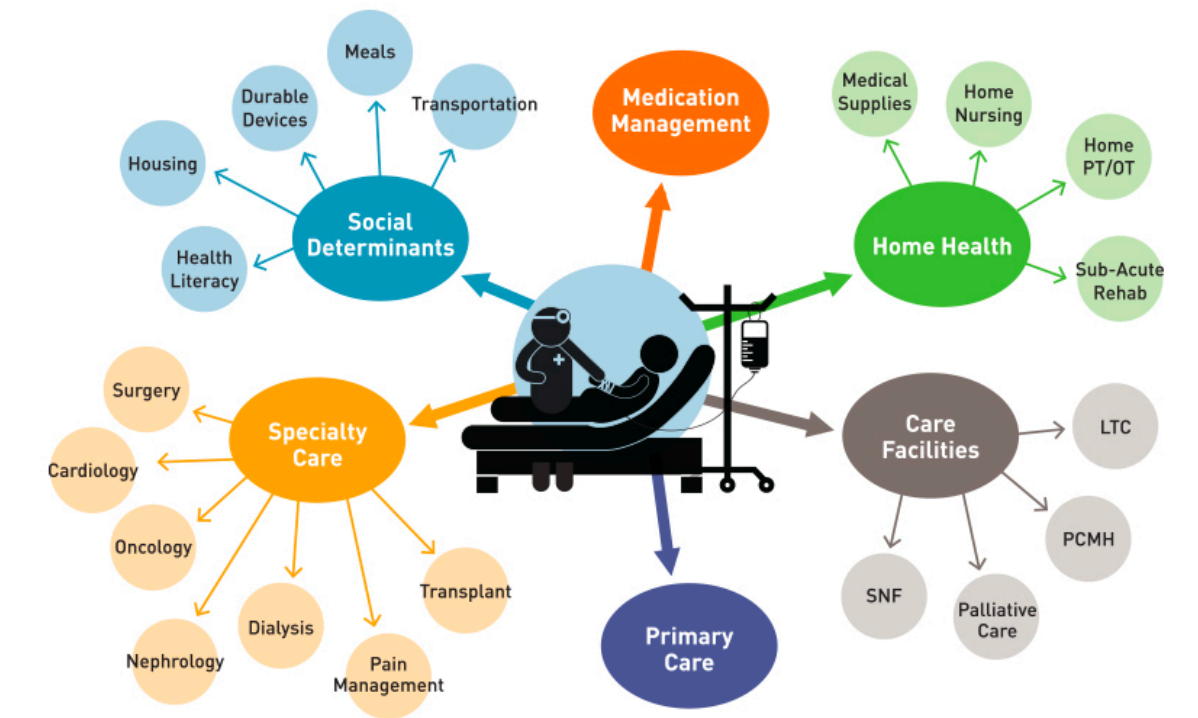
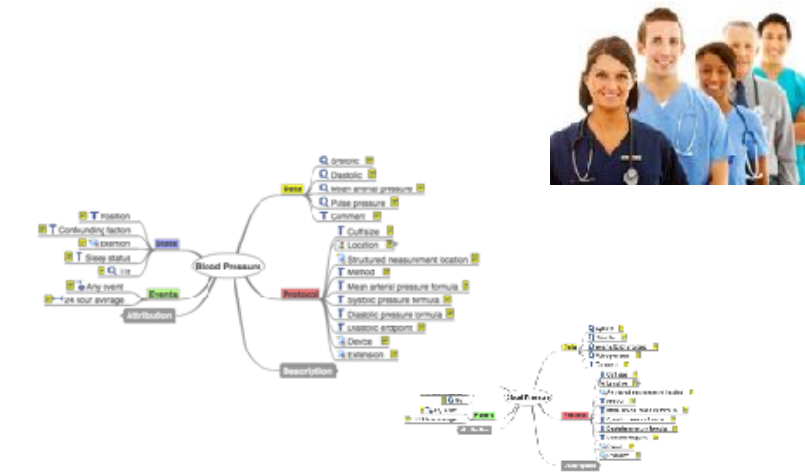
# open Platform - vendor-neutral

openEHR

Apps



Vendor-neutral Information model



openEHR

Technology-neutral datastore (CDR)

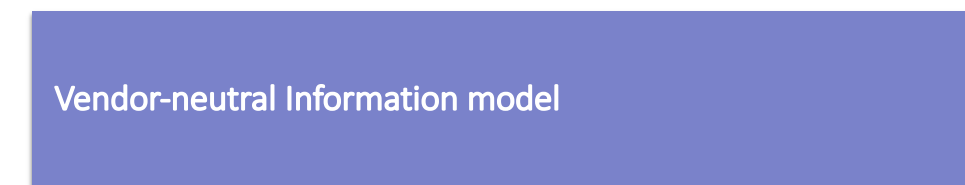




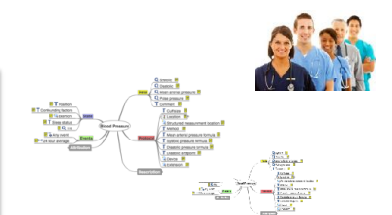
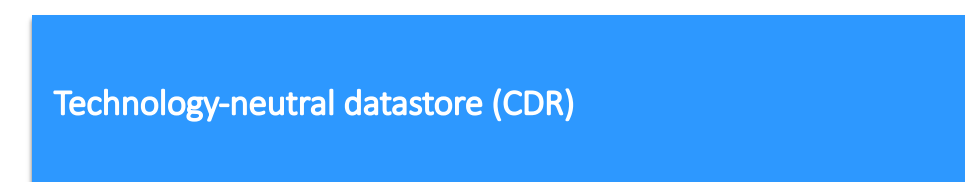
# CDR - Clinical data repository

openEHR

- Smart datastore which natively stores, retrieves, queries openEHR data via a standard API
- All data completely available
- Vendor-neutral querying
- No engineering deployment



openEHR



# Vendor-neutral information model for persistence

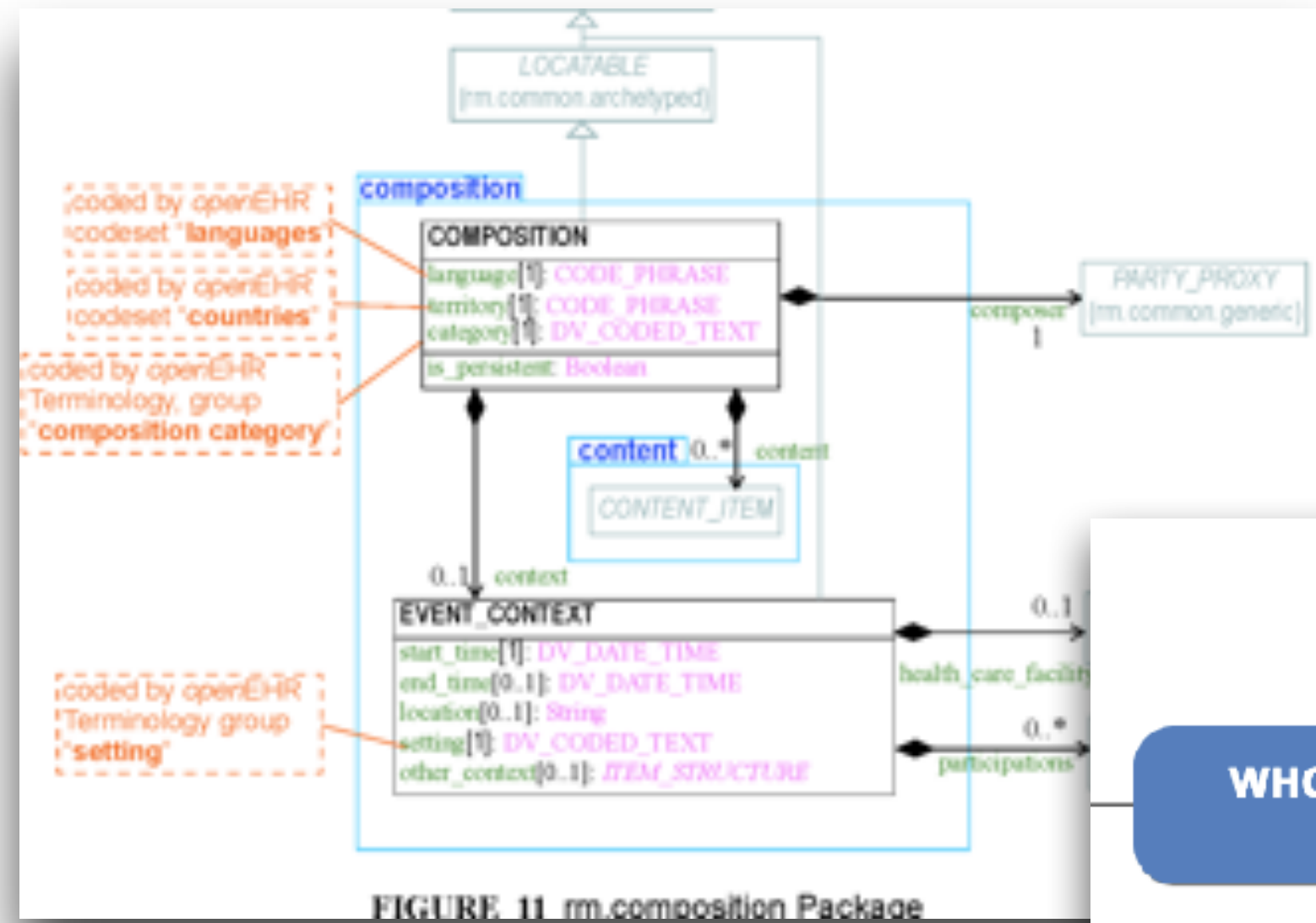
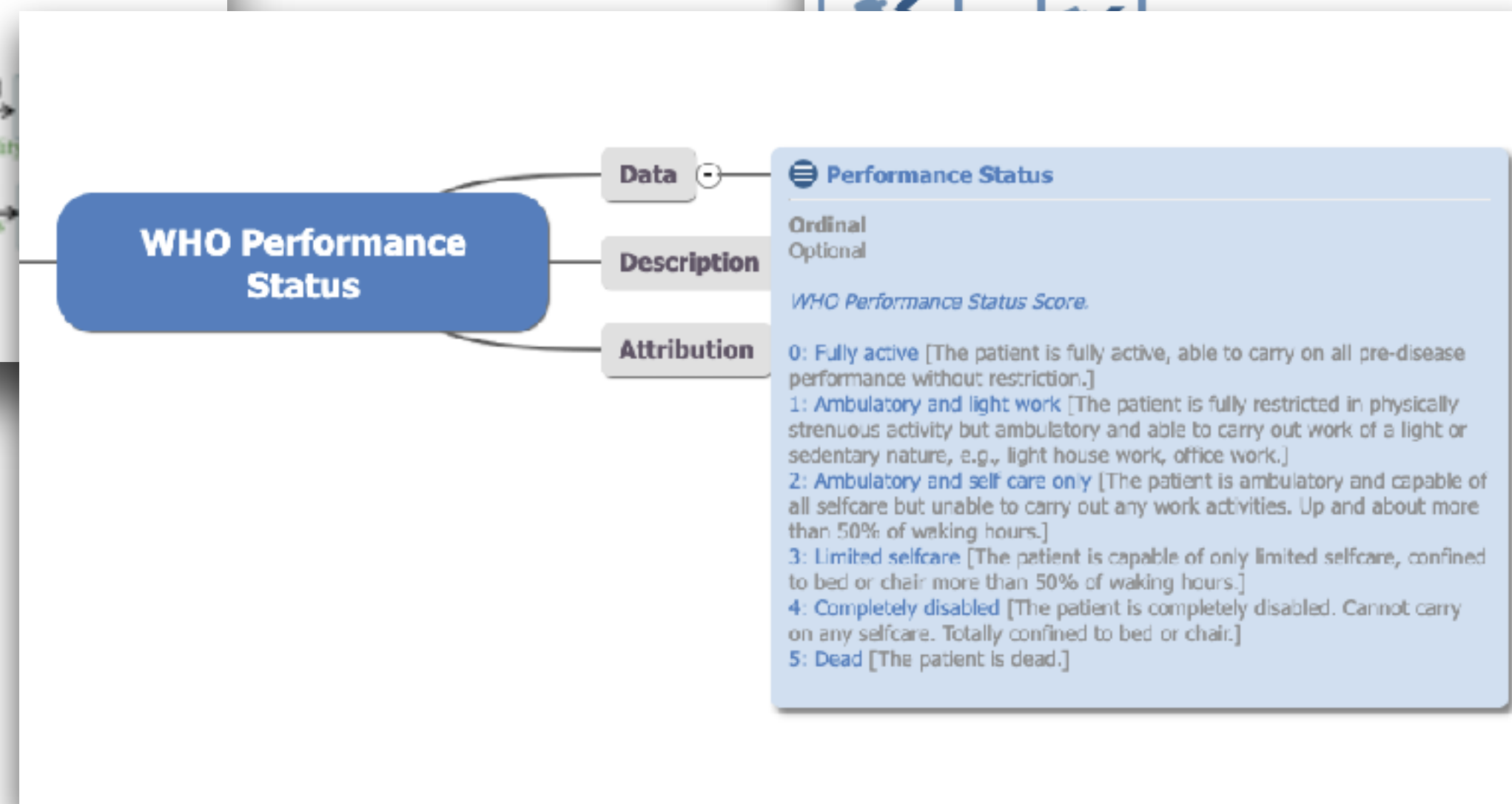
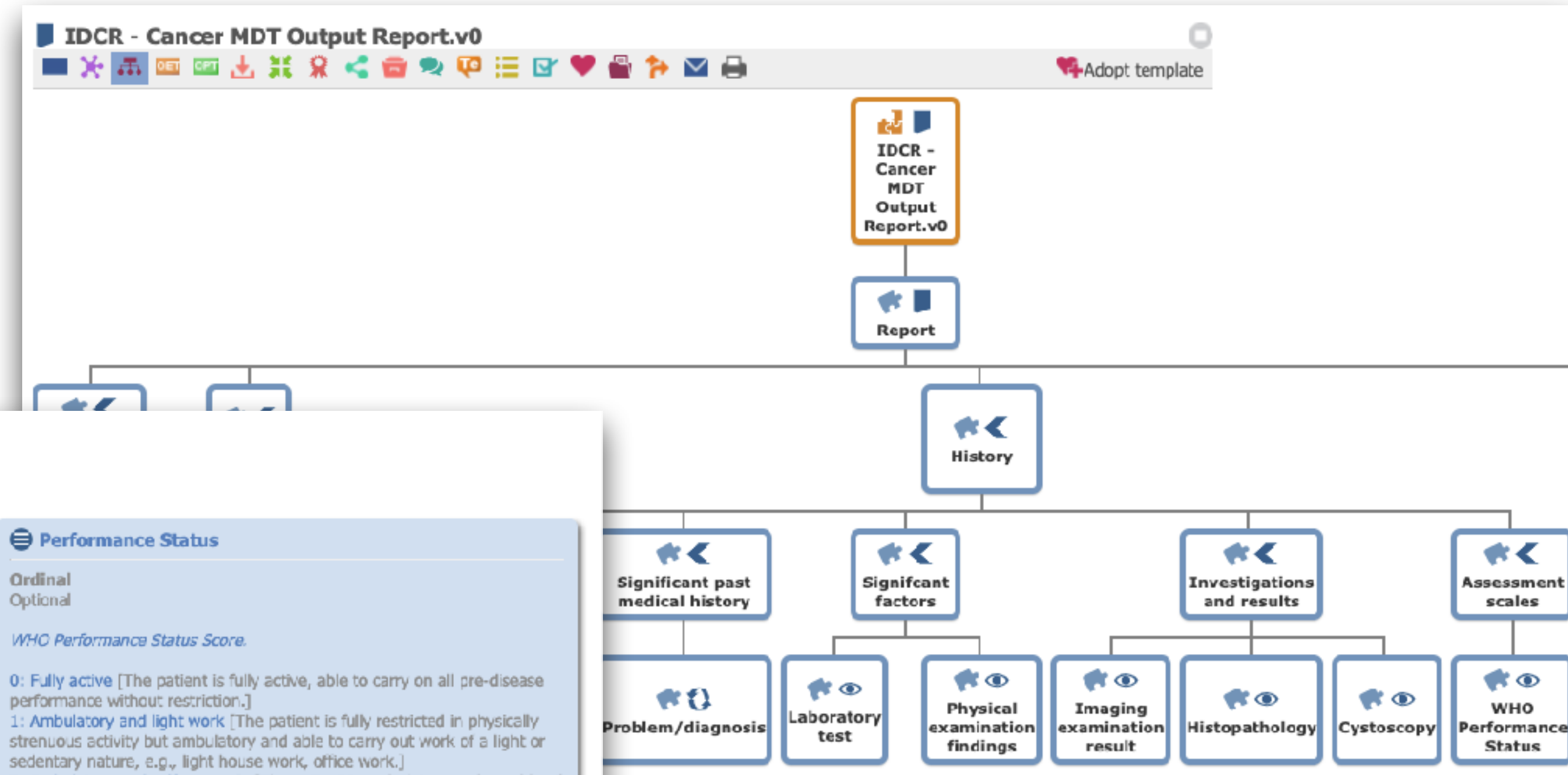


FIGURE 11 rm.composition Package

Reference model



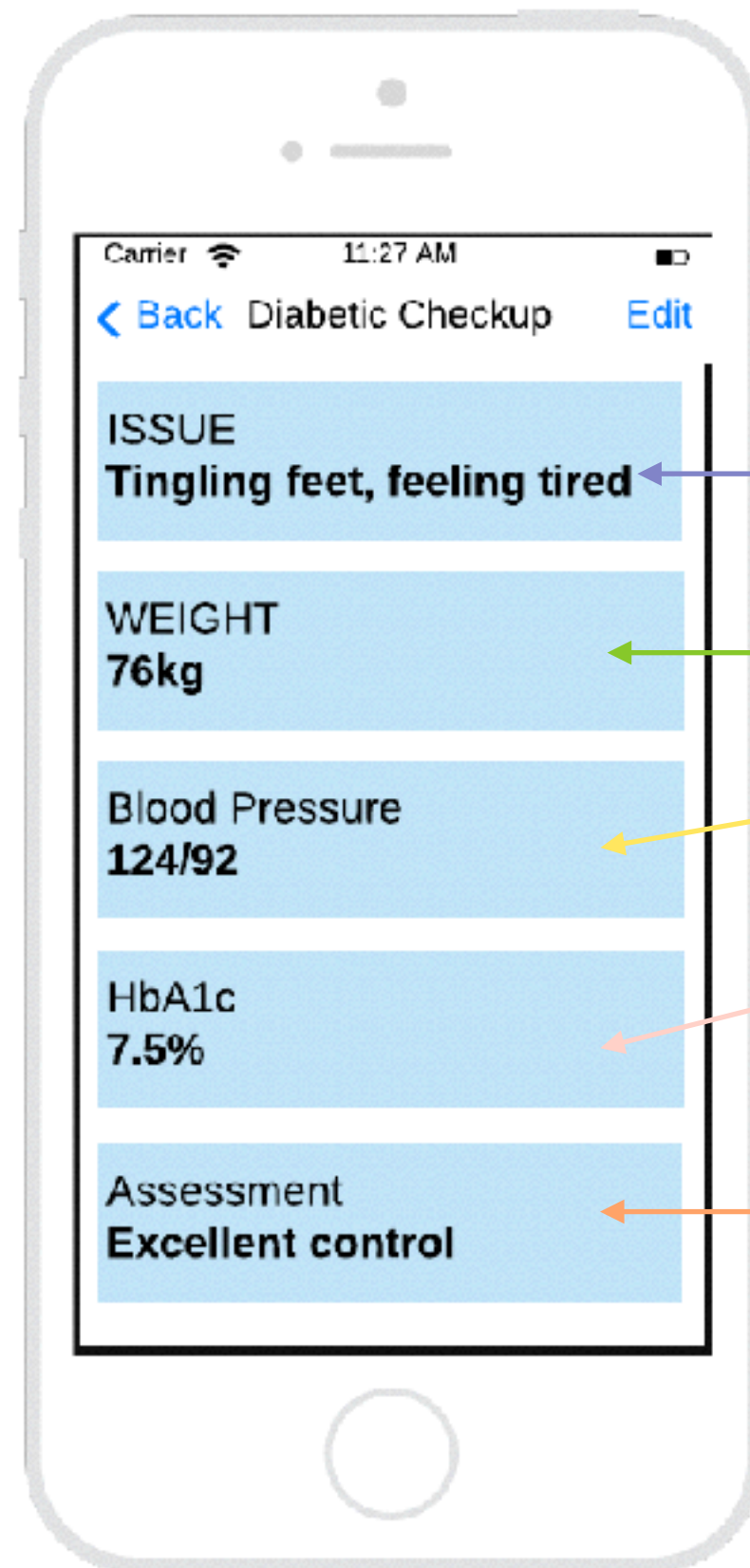
Archetypes



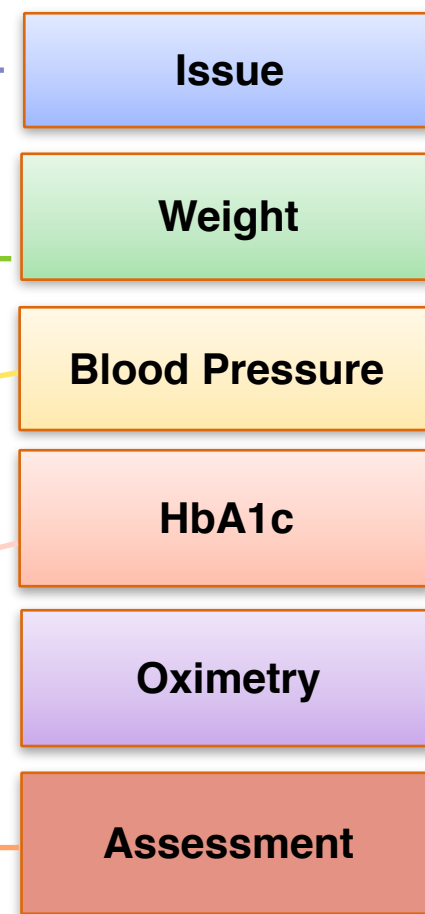
Templates

# Archetypes and templates

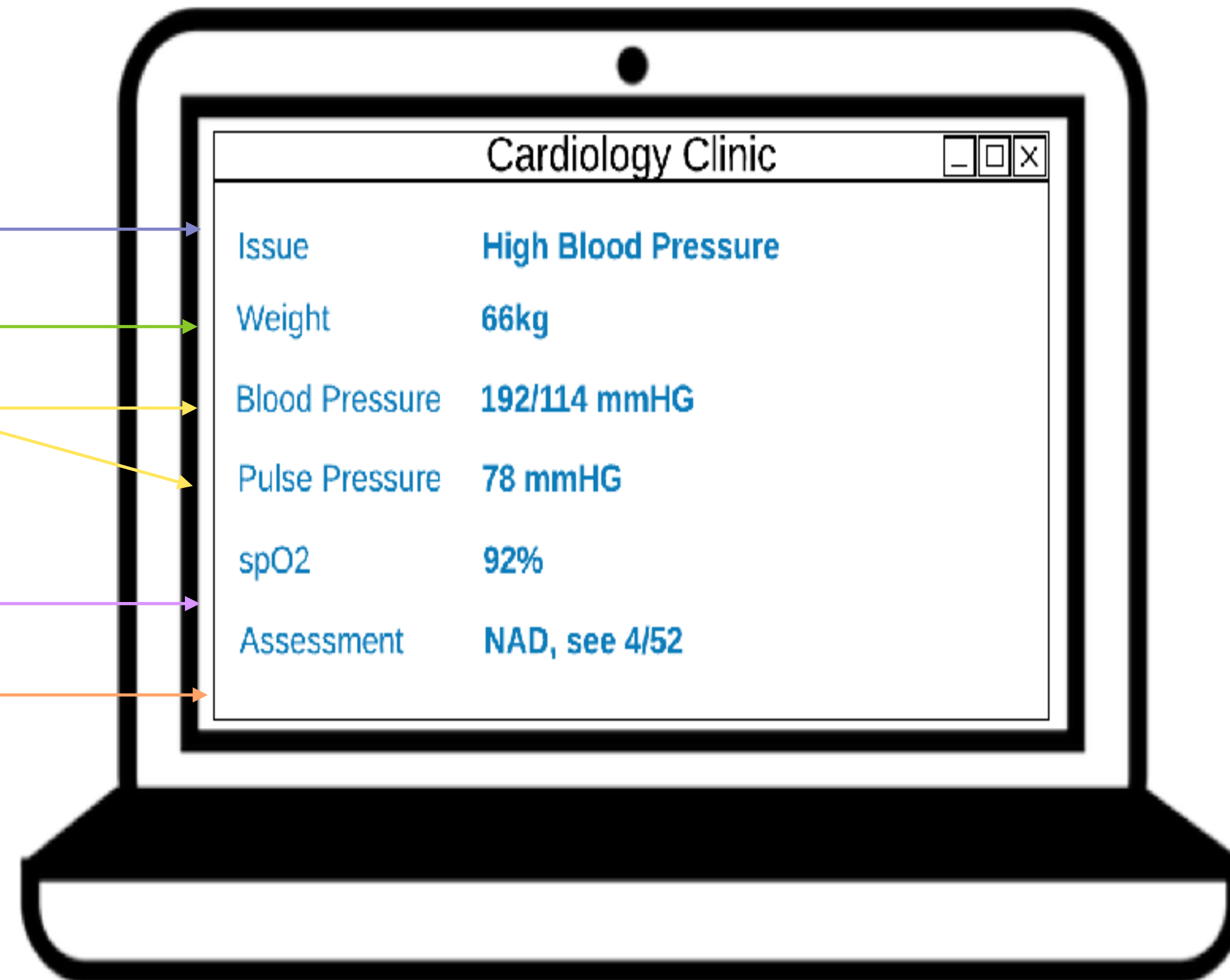
Template underpinning application



Archetypes used in template



Template underpinning application



# openEHR tooling

Archetype Designer Repositories Save Export Import

Covfefe NDS - SBAR\_Care\_Home.v0.0

NDS - SBAR\_Care\_Home.v0.0 (openEHR-EHR-COMPOSITION.encounter.v1)

Definition Description Analytics

g> items> Pulse oximetry> data> Any event> state> Inspired oxygen> Inspired oxygen> Method of oxygen delivery

atCode at0054.1

Occurrences 0..\*

Type TEXT

Free text

Nasal prongs

Mask

Nebuliser

NIV

Limit to list

Default value

Value

<https://tools.openehr.org/>

openEHR Clinical Knowledge Manager

Archetypes Templates Termsets Release Sets Reviews Projects Discussion Reports Tools Help

Dashboard Find Resources Pulse oximetry

Pulse oximetry (Latest revision / latest published)

Adapt archetype

Exertion

Inspired oxygen

Confounding factors

Sensor site

Pre/post-ductal

Oximetry device

Extension

Any event

State

Protocol

Events

Data

Description

Attribution

12 SpO<sub>2</sub>

Q SpOC

12 SpCO

12 SpMet

Waveform

Multimedia image

Interpretation

Comment

Physical activity (v0)

Physical examination findings

PCM score (v0)

Pregnancy status (v0)

Pregnancy test result (v0)

Procedure screening question

Progress note (v1)

PROMIS (v0)

Pulmonary function test result

Pulse deficit (v0)

Pulse oximetry (v1)

Pulse/Heart beat (v2)

qSOFA score (v1)

Refraction assessment (v0)

Respiration (v2)

Richmond agitation sedation

Rinne and Weber test results

SAFAS Score (v0)

SARA ataxia scale (v0)

SCORAD index (v0)

Skeletal age (v0)

Social context screening ques

SOFA score (v0)

Projects & Incubators

New and Modified Resources

<https://openehr.org/ckm>

# NHS Scotland: National Digital Platform



194. It is no longer acceptable in this age that our health service is still using multiple incompatible systems and various platforms. In all our work we have heard

*It is no longer acceptable in this age that our health service is still using multiple incompatible systems...*

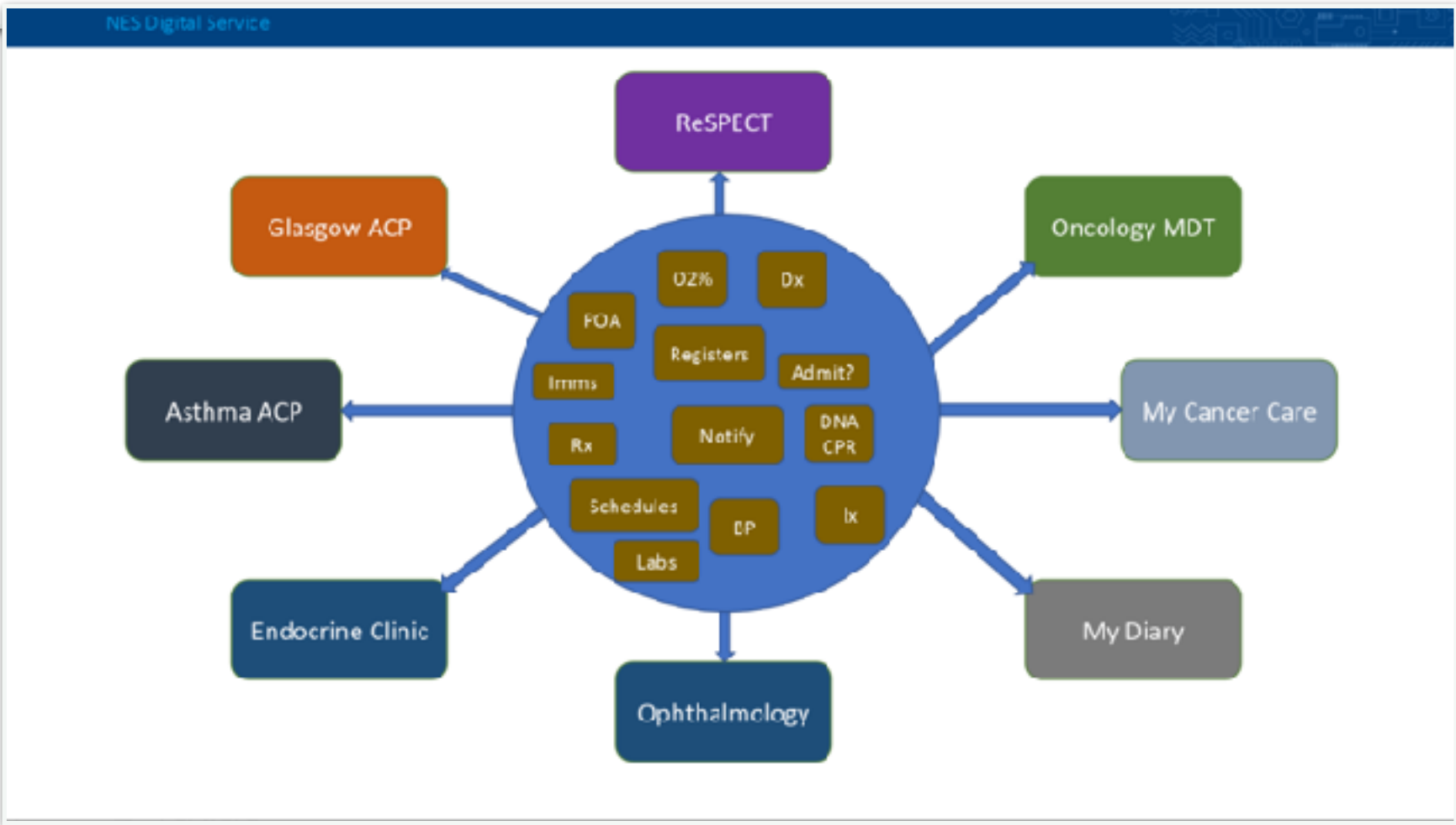
167. We agree the best way forward for data sharing is through a single platform, or spine, for data that other systems connect into and we note witnesses and the Scottish Government are in agreement. Can the Scottish Government advise whether it has had discussions with other countries regarding the use of a single platform?

*...the best way forward for data sharing is through a single platform...*



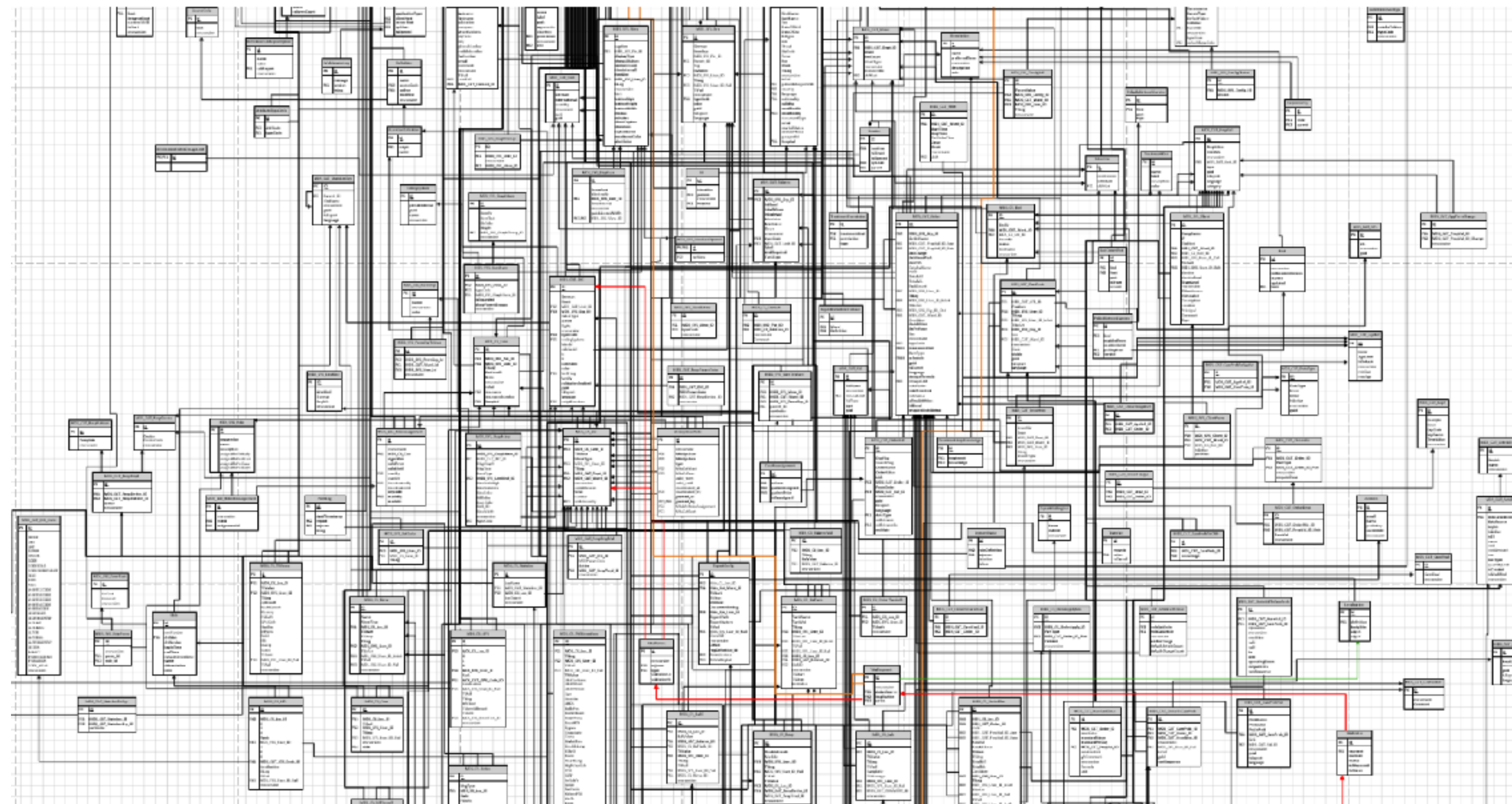
**Open digital platform** 1-2 years

- Enhance the NHS Wales EMPI along open principles to facilitate a more developed Patient/Citizen identification strategy.
- Enhance the NHS Wales Integration and Interaction Engine to provide a truly open platform for NHS Wales.
- Focus the work of the National Data Resource (NDR) programme on the creation of a National Clinical Data Repository in line with open principles whilst progressing the programme as a whole.
- Make migrating the WCP to an open architecture the highest priority for the product in the next 12 months. This will need to address any impacts on the current work programme.



# RDBMS - 'so 20th century'?

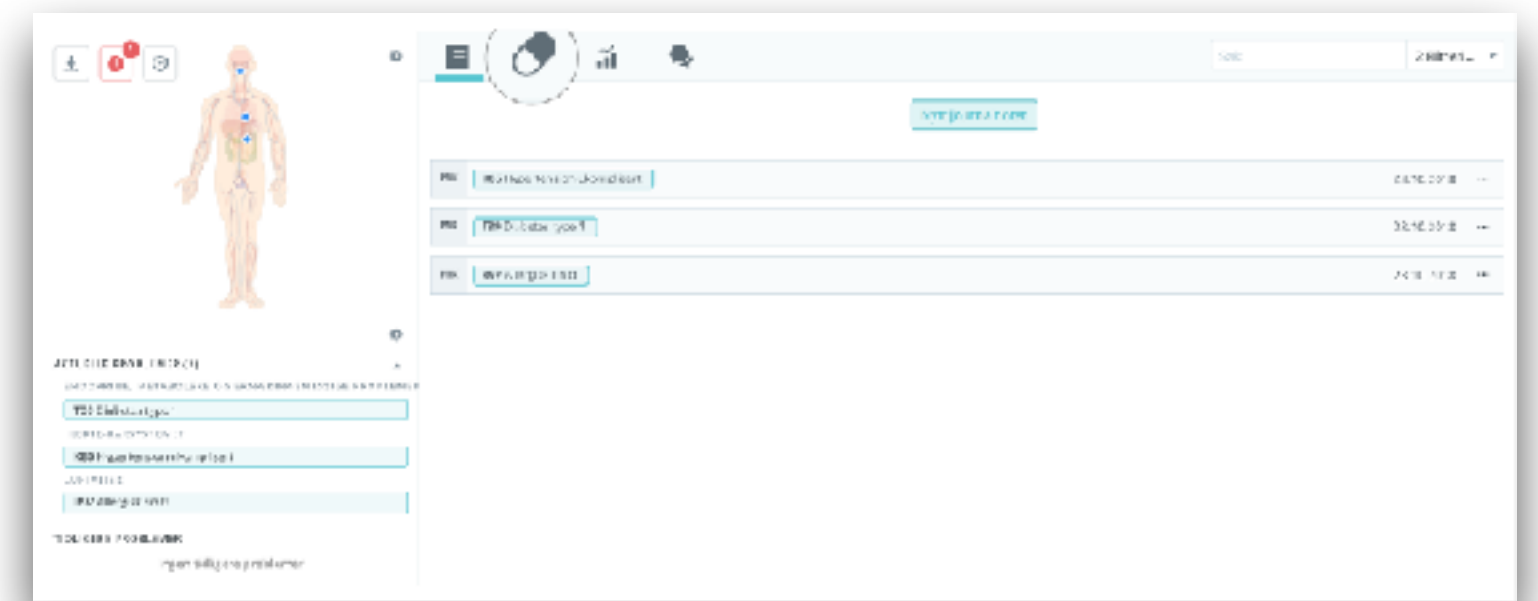
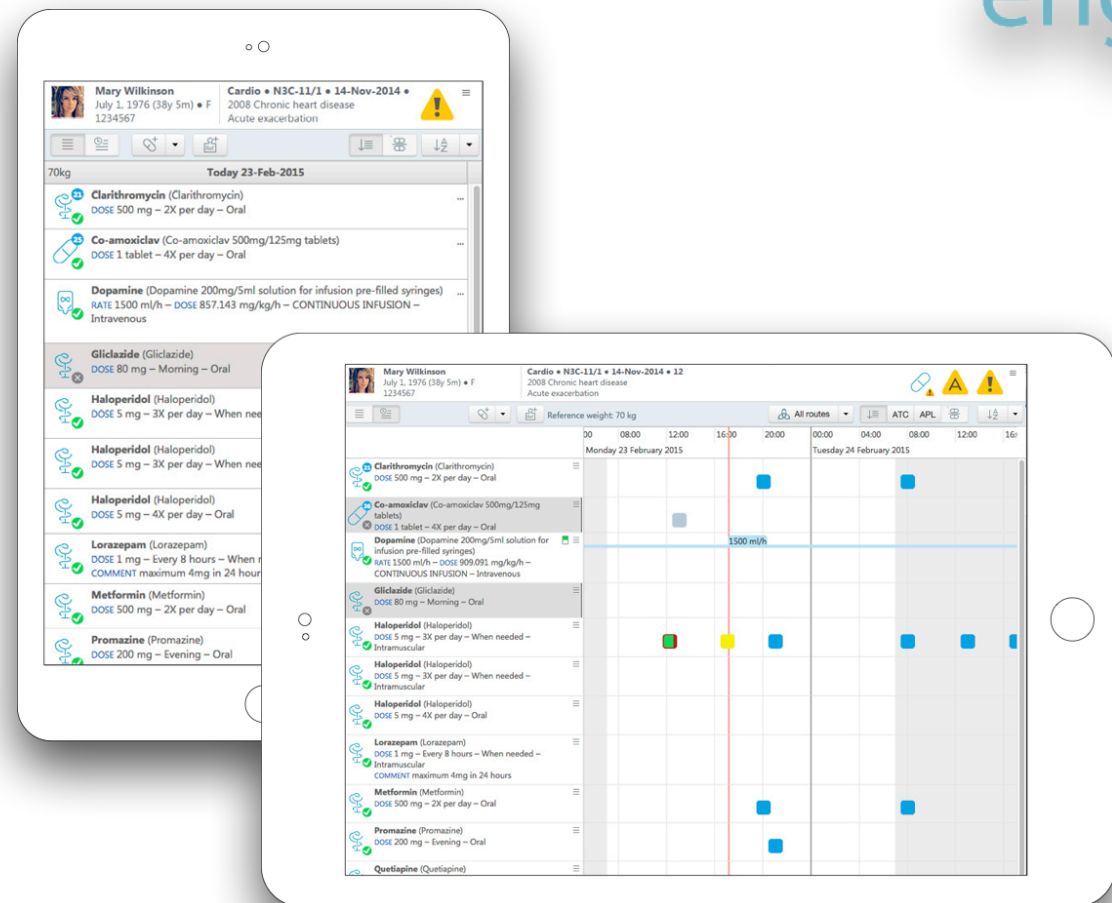
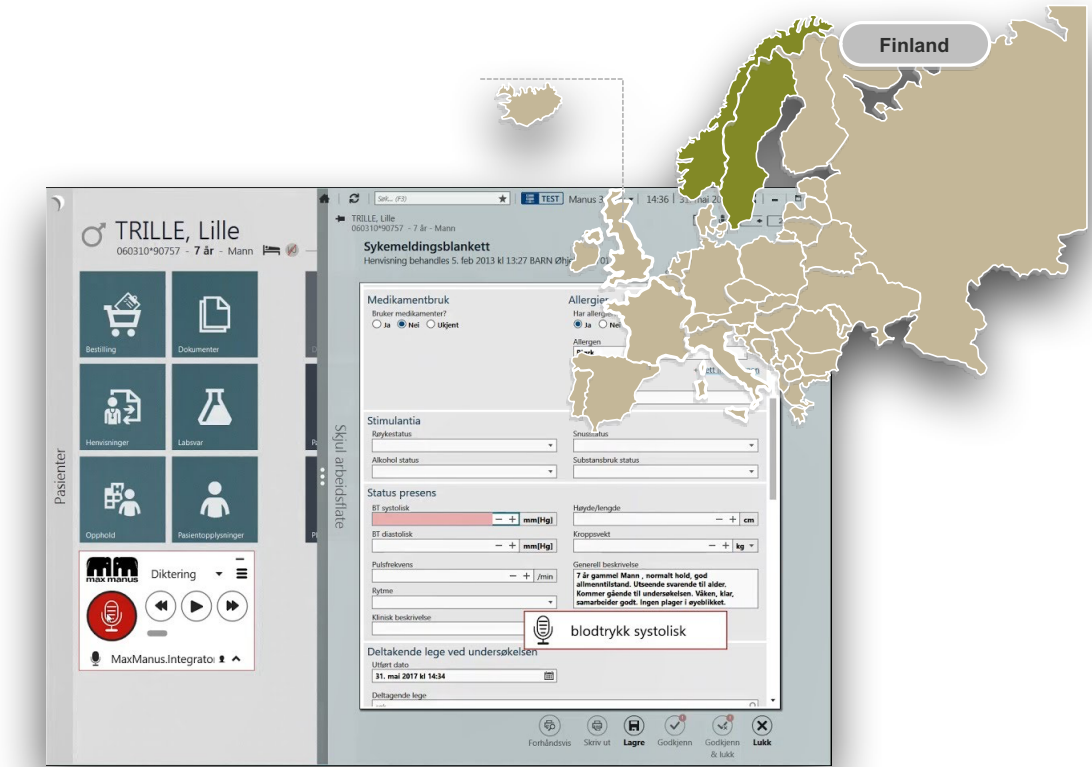
## PDMS Database



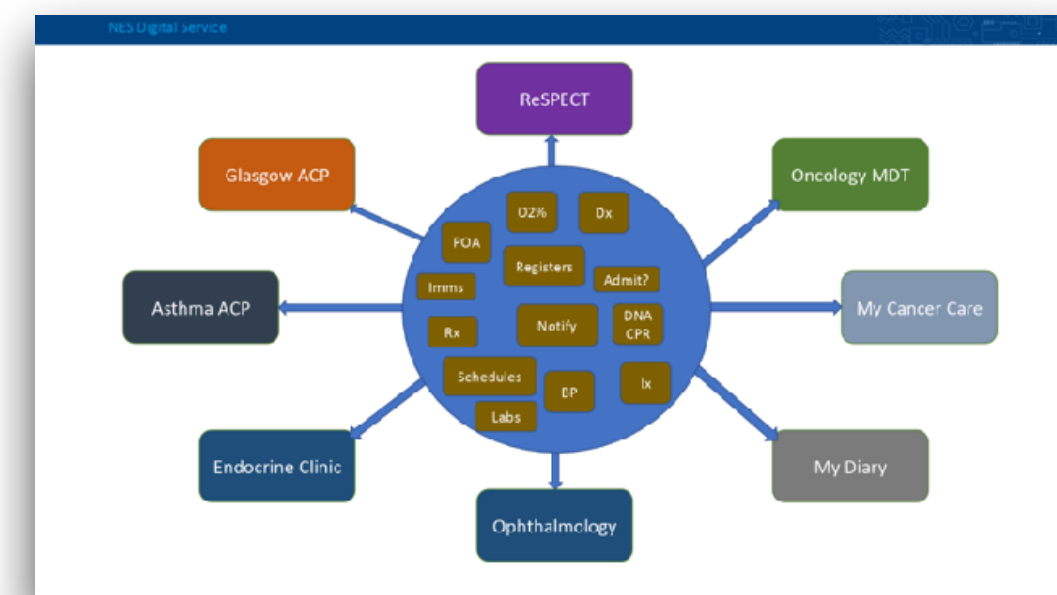
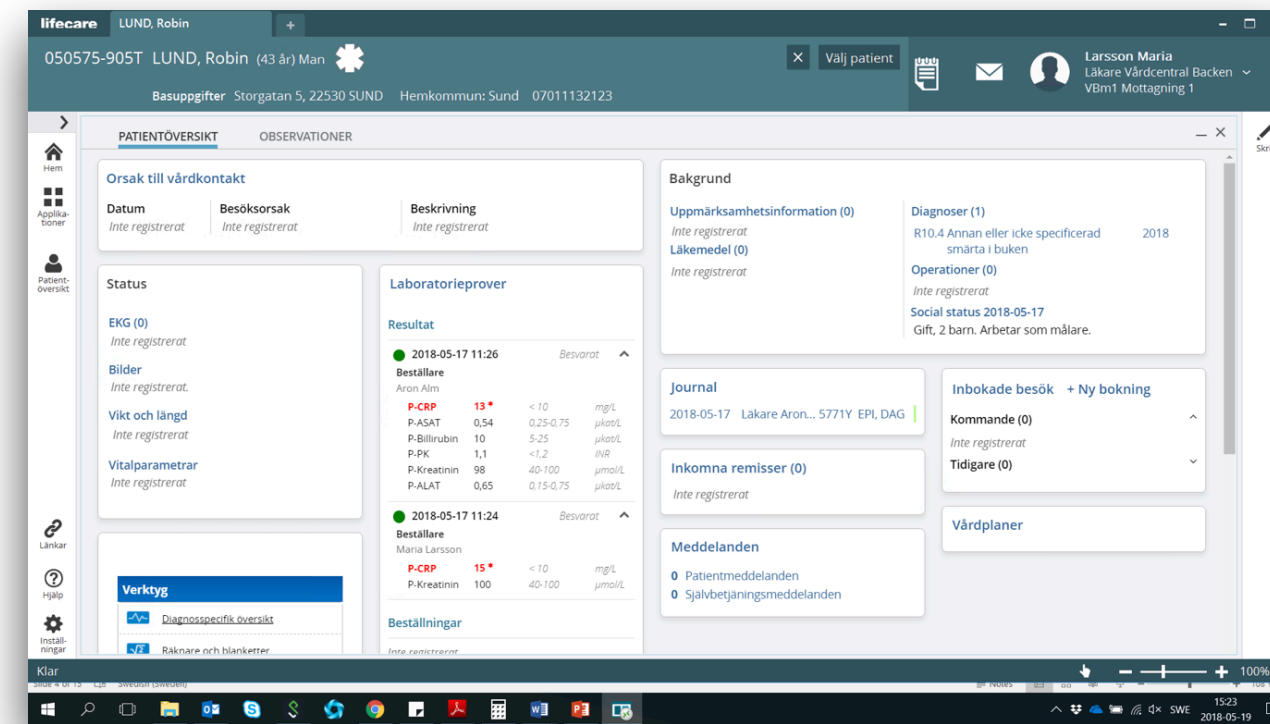
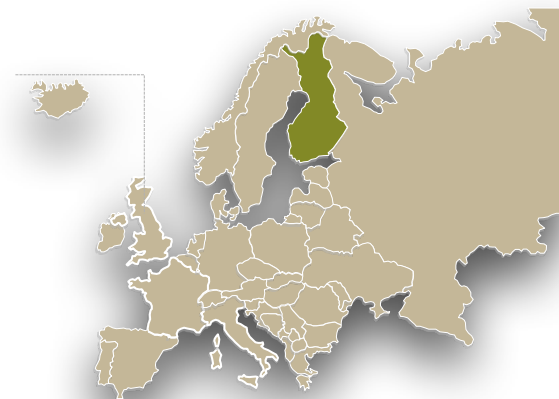
# openEHR applications - at scale

openEHR

Genomics  
england



UNA



# Covid-19

openEHR

Registrer ny:

Screening COVID-19

Anamnese

Er noen av følgende symptomer tilstede hos pasienten?

Hoste \*  
 Tilstede  Ukjent  Fraværende

Kortpustet \*  
 Tilstede  Ukjent  Fraværende

Feber \*  
 Tilstede  Ukjent  Fraværende

BEAU85459309

S B COVID-19 A R R

Breathing

SPO2 (on arrival) Respiration rate



Registrer ny:

Resultat COVID-19

Covid-19 smitte er:

Positiv prøve - bekreftet

**Negativ prøve - fremdeles mistanke**

Negativ prøve - avkrefet

Pasienten forblir mistenkt smittet av COVID-19

Circulation

Heart rate 22 bpm Blood pressure 120/80 Cap refill > 3 secs

Abdomen Current IV fluids

Soft None

Registrer ny:

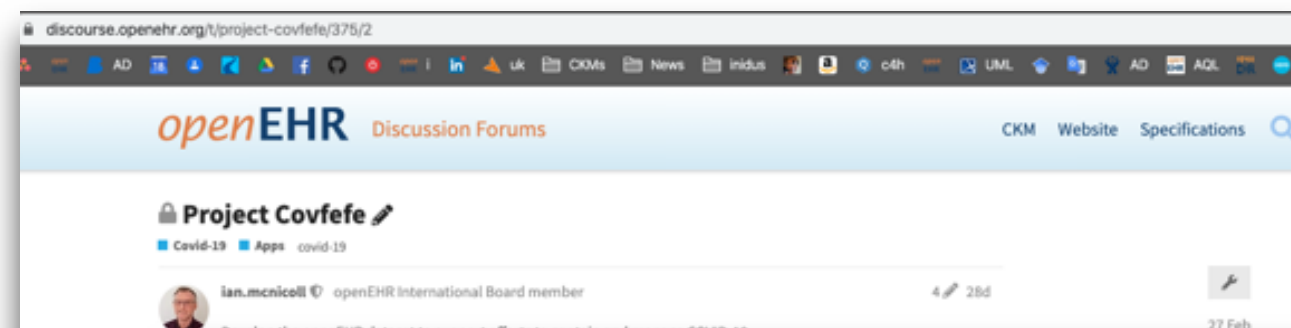
Isolasjon/karantene COVID-19

**Isolasjon/karantene av mulig smittet**

Isolasjon/karantene av smittet

Start for isolasjon/karantene  
 24. mar 2020 kl 13:31

Dato for når prosedyren er avsluttet



openEHR COVID-19 Project

Covid-19 Apps covid-19

ian.mcnicoll openEHR International Board member

Some of you may have become gently aware of a project that a small number of openEHR folks (mostly from vendors) have been quietly working on for the past few days. This came from an idea that @Bna of DIPS and his team had discussed of the need for some kind of app to help hospitals screen patients for risk of Covid-19.

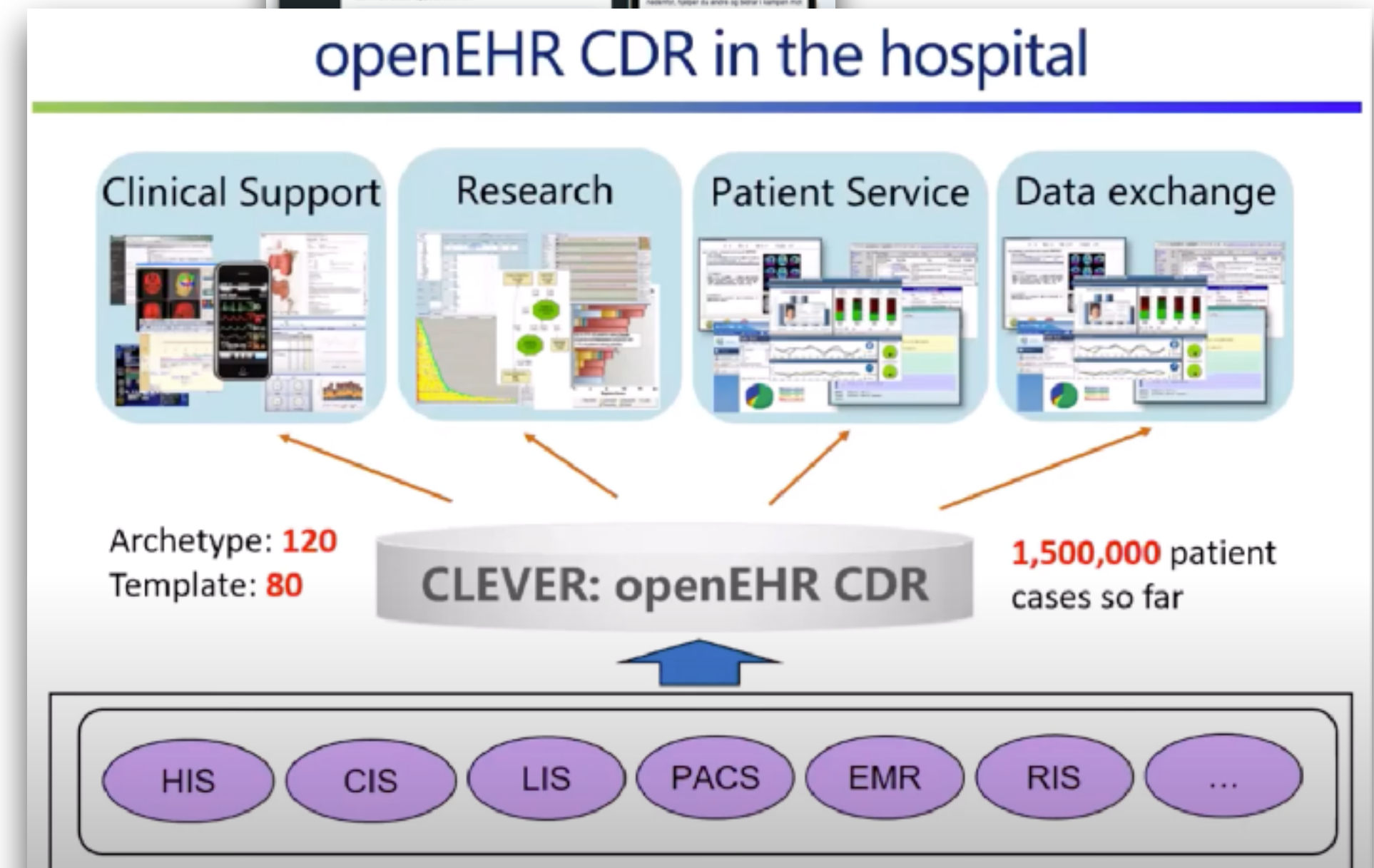
Basically this is the primary use case (good old fashioned paper form) from the US

HeraldNet.com - 4 Mar 20

How medical pros decide whether to test someone for COVID-19 | HeraldNet.com

This checklist could be useful to prospective patients — as well as health-care workers.

A citizen-facing equivalent has been produced by NHS-111 in the UK, using the Public Health England Risk assessment advice



<https://www.youtube.com/watch?v=oAzjHdiioDY&feature=youtu.be>



# EY - connected Health ecosystem

openEHR

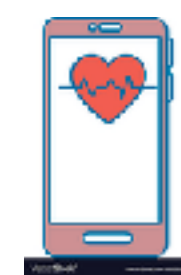
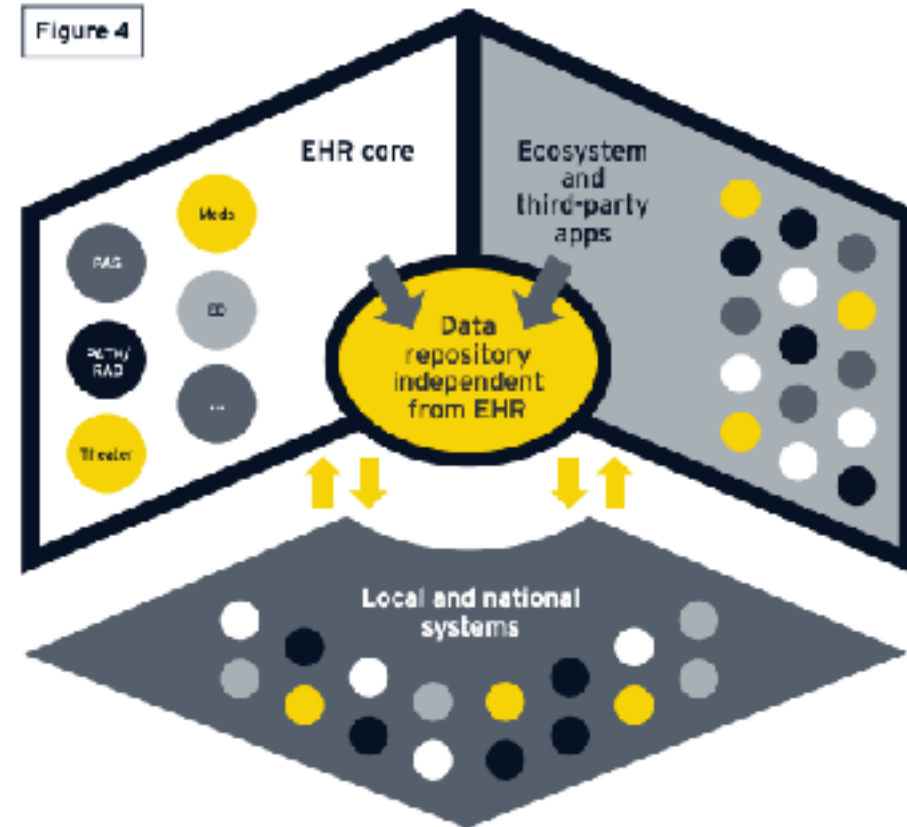


Figure 4



openEHR

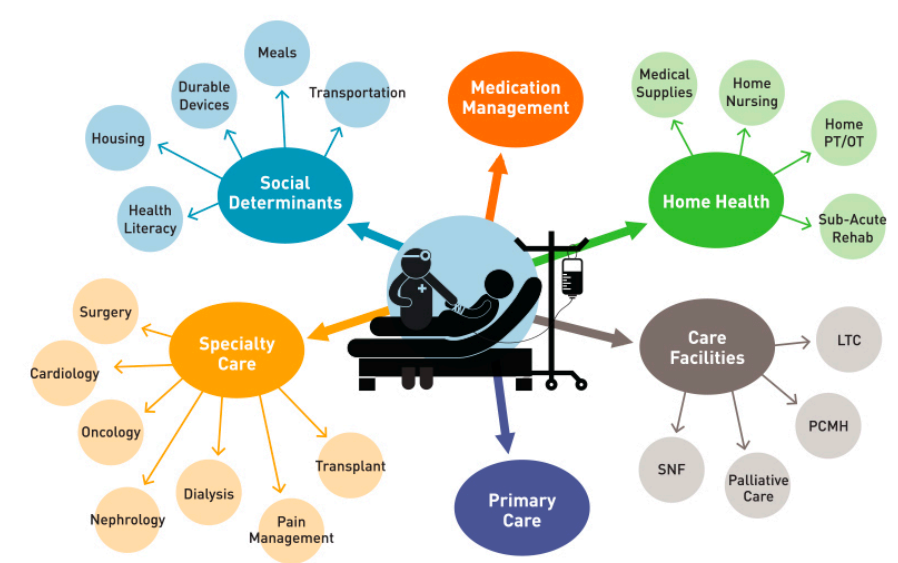
MINDWAVE

HL7 FHIR

RiO



advanced

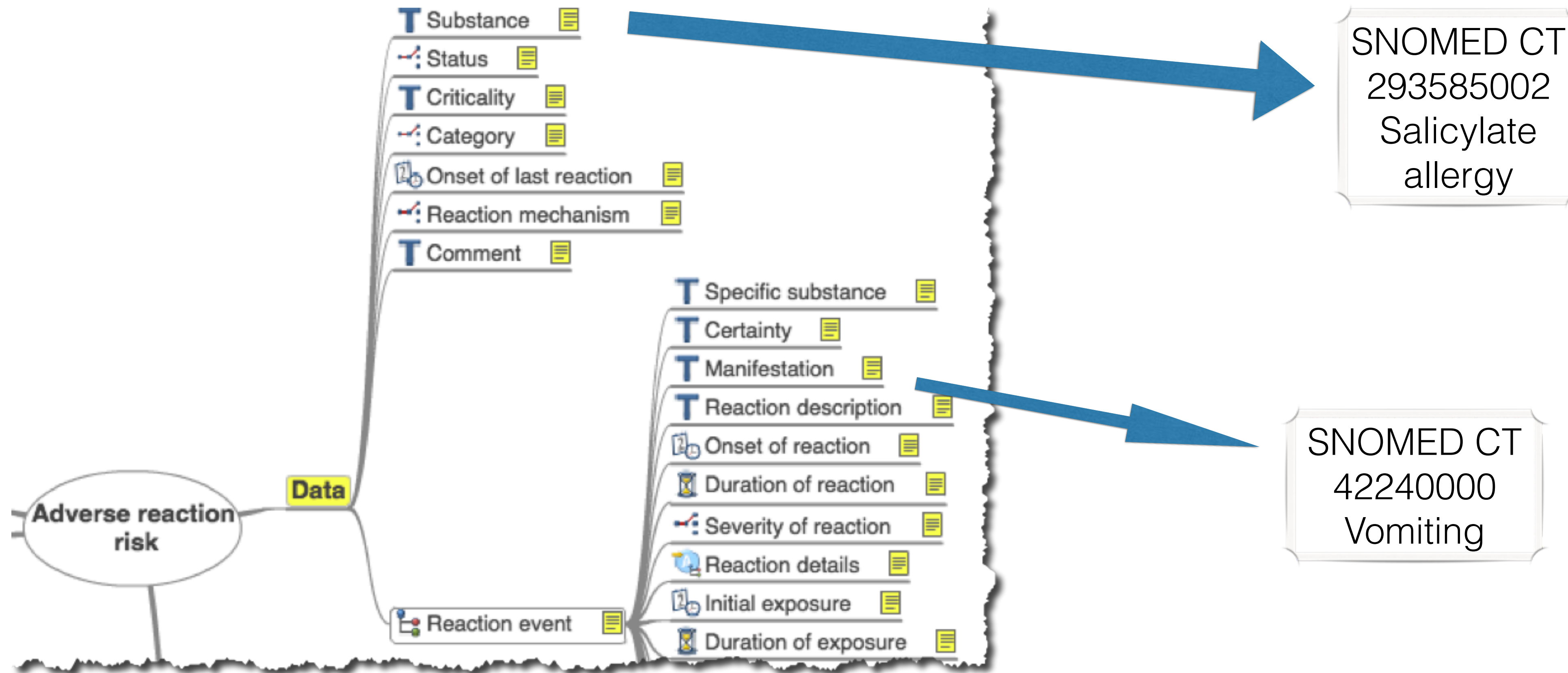


How will you design information architecture to unlock the power of data?  
 Creating the right data environment for a connected health ecosystem

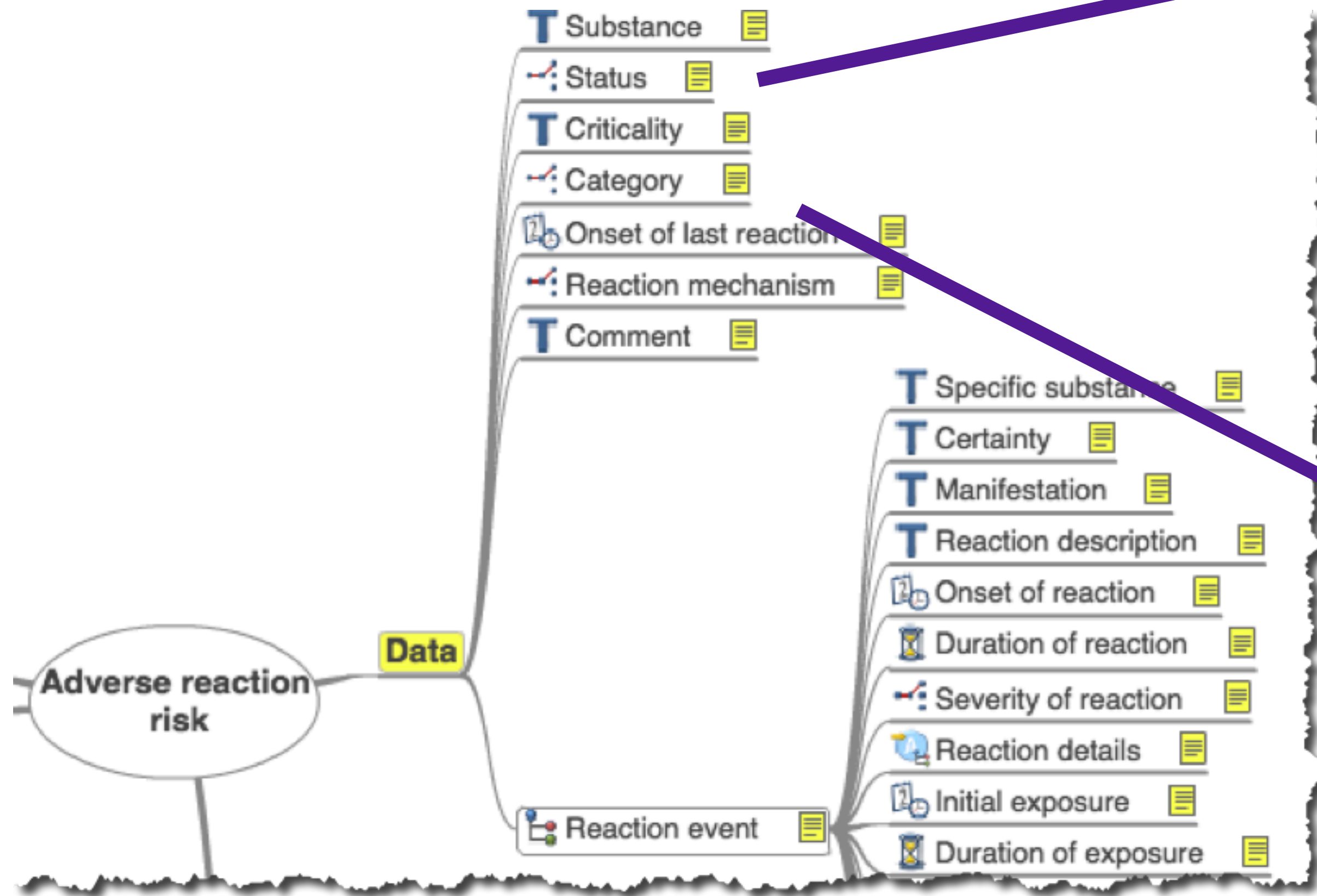
The better the question. The better the answer.  
 The better the world works.

EY  
 Building a better working world

# Information models and Terminology -1



# Information models and Terminology -2



- **Suspected** [A low level of clinical certainty about the propensity of a reaction to the identified 'Substance'.]
- **Likely** [A reasonable level of certainty about the propensity for a reaction to the identified 'Substance'.]
- **Confirmed** [A high level of certainty about the propensity for a reaction to the identified 'Substance', which may include clinical evidence by testing or re-challenge.]
- **Resolved** [The previously known reaction to the identified 'Substance' has been clinically reassessed and considered no longer to be an active risk.]
- **Refuted** [The propensity for a reaction to the identified 'Substance' has been clinically reassessed or has been disproved with a high level of clinical certainty by re-exposure or deliberate challenge.]

- **Immune mediated** [Immune mediated reaction, including allergic reactions and hypersensitivities.]
- **Non-immune mediated** [A non-immune mediated reaction, which can include pseudo-allergic reactions, side effects, intolerances, drug toxicities (for example, to Gentamicin).]
- **Indeterminate** [The physiological mechanism could not be determined.]

Good use-cases for a reference terminology?

# Querying - AQL and terminology


POST localhost:8080/ehrbase/rest/openehr/v1/query/aql Send 200 OK 1.4 s 892 B

JSON Auth Query Header 2 Docs

```
1 {
2   "q": "select
3     a_a/data[at0002]/items[at0022]/value/defining_code/code_string as admin_gender,
4     e/ehr_id/value as ehr_id,
5     a/context/start_time/value as time,
6     a/composer/name as author
7
8   from EHR e contains COMPOSITION a contains EVALUATION a_a[openEHR-EHR-EVALUATION.gender.v1]
9
10  WHERE a_a/data[at0002]/items[at0022]/value/defining_code/code_string
11  matches{TERMINOLOGY('expand', 'org.hl7.fhir.r4', 'url=http://terminology.hl7.org/ValueSet/v2-0001')}"
12 }
```

Preview Header 12 Cookie Timeline

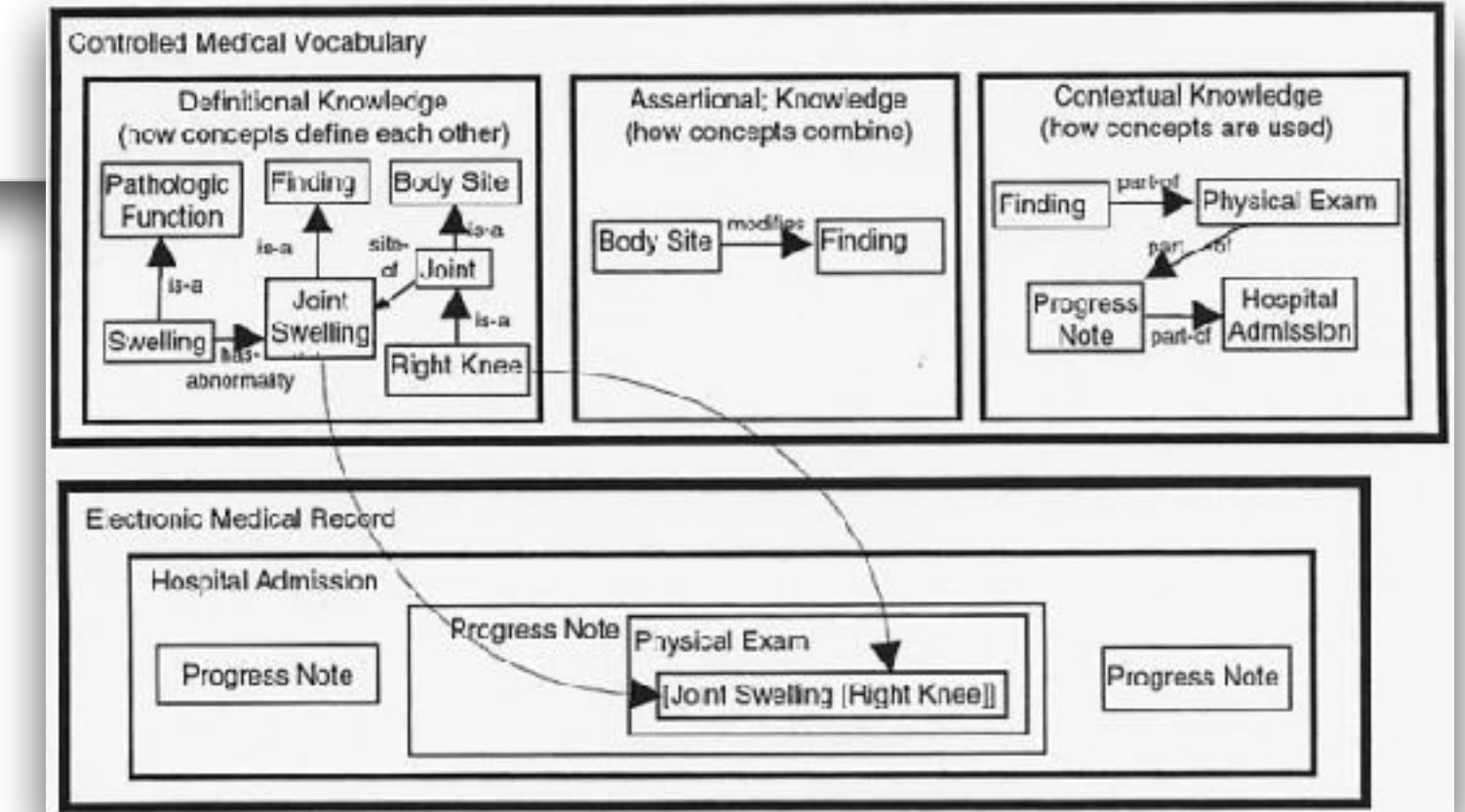
```
1 {
2   "q": "select \na_a/data[at0002]/items[at0022]/value/defining_code/code_str
3     ehr_id,\na/context/start_time/value as time,\na/composer/name as author\n \n
4     a_a[openEHR-EHR-EVALUATION.gender.v1] \n\nWHERE a_a/data[at0002]/items[at0022]
5     \nmatches{TERMINOLOGY('expand', 'org.hl7.fhir.r4', 'url=http://terminology.hl7
6
7   "columns": [
8     {
9       "path": "/data[at0002]/items[at0022]/value/defining_code/code_string",
10      "name": "admin_gender"
11    },
12    {
13      "path": "/ehr_id/value",
14      "name": "ehr_id"
15    },
16    {
17      "path": "/context/start_time/value",
18      "name": "time"
19    },
20    {
21      "path": "/composer/name",
22      "name": "author"
23    }
24  ],
25  "rows": [
26    [
27      "F",
28      "3a92c98e-9e05-4d3b-a544-722ef3c84478",
29      "2020-03-01T18:09:52.921+00:00",
30      "Dr. Yamamoto"
31    ],
32    [
33      "M",
34      "3a92c98e-9e05-4d3b-a544-722ef3c84478",
35      "2020-03-01T18:09:52.921+00:00",
36      "Dr. Yamamoto"
37    ]
38  ]
39 }
```



# Why not 'just' terminology?

- “SNOMED CT is the lingua-franca of healthcare”
- “We need to build an ‘ontology’ of healthcare records”
- Ignores the importance (if only practically) of the information model in managing state and context.

Review > Methods Inf Med. 1998 Nov;37(4-5):394-403.  
**Desiderata for controlled medical vocabularies in the twenty-first century**  
 J J Cimino <sup>1</sup>



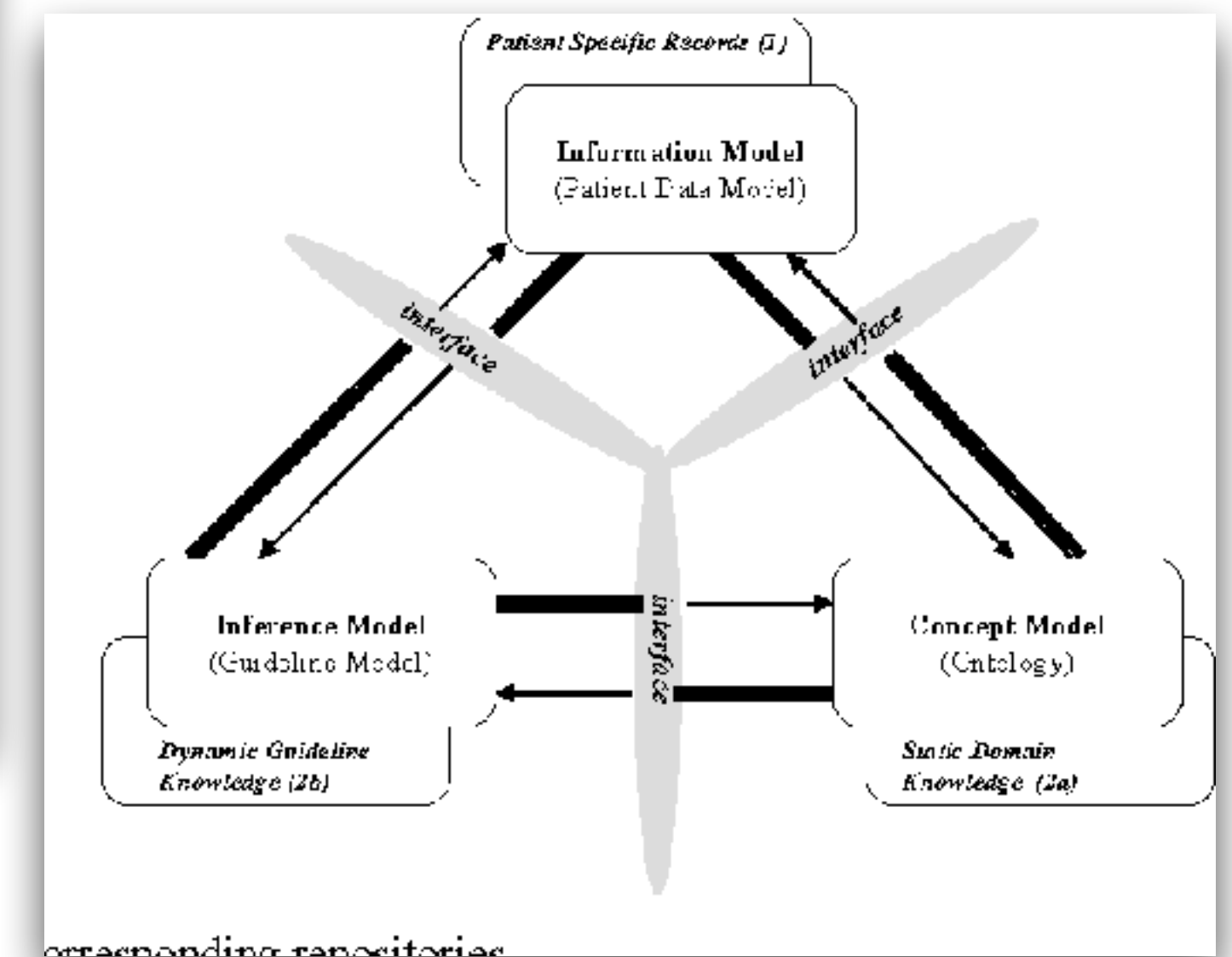
MANCHESTER 1821  
 The University of Manchester

## Conclusion

GALEN: 'making the impossible very difficult'  
 The ontology inquisition: making the very difficult effectively impossible?

Diol Health Informatics Group

Alan Rector :  
<https://slideplayer.com/slide/4781146/>



# Handling context / state

vaccineCode	Σ I	1..1	CodeableConcept	Vaccine product administered Binding (example): The code for va vaccine-code.html)
wasNotGiven	?! I	1..1	Boolean	

Carry **ALL** of the meaning in SNOMED CT

Vaccination procedure = "61761000000109 | Second measles, mumps and rubella vaccination  
**not done** (situation) |"  
notGiven = "true"

Distribute meaning between information model and SNOMED CT

Vaccination procedure = "170433008 | Measles mumps and rubella vaccination - second dose  
(procedure) |"  
notGiven = "true"  
resonNotGiven = "213257006 | Generally unwell (finding) |"

# Next steps?

- SNOMED CT 'free' sets - more!!
- Build on the IPS and COVID-19 free sets
- Scales, Scores, 'metadata' ??
- Lab analytes, histopathology findings ??



# Next steps?

- Education that terminology/ontology cannot solve all of the issues in standardising health and care records - we need information models
- SNOMED CT+ FHIR + openEHR
- build on existing work e.g. FHIR Vital signs advice





# openEHR International : [openehr.org](http://openehr.org) *open*EHR

