

# The Electronic Health Record

## Why is it still so hard?



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openEHR

# Agenda

0900- 0945	Why is the EHR still so hard?
0945-1030	Intro to archetypes and templates
1030-1100	Coffee
1100-1230	Demo of openEHR tools
1230- 1330	Lunch
1330-1500	Practical openEHR projects
1500-1530	Afternoon break
1530-1630	Practical openEHR projects II
1630-1700	Discussion

# Dr Ian McNicoll

- Scottish General Practitioner for 15 years
- Interest in health computing for 20+ years
  - Full-time health informatics consultant
  - Clinical analyst with Ocean Informatics for 4 years
  - Editor openEHR Clinical Knowledge Manager

# The electronic health record

## Communication

- Conversation
  - Clinician - self
  - Clinician – clinician
  - Clinician – patient
- Computation
  - Decision support
  - Process support
  - Research, audit and analysis

# Searching and sharing

Searching for matching text - “Googling” - is not accurate enough

- Synonyms, mis-spelling
  - MI, heart attack, “hart attack”
- Dates, quantities, negatives
  - “I have excluded asthma in this child”
- To allow accurate searching for and sharing of clinical information we need a **common model of the structure and terms** used in clinical practice.

# Clinical Information models

Computers have no innate ‘understanding’ of human language

- Clinical concepts must ultimately be described as ‘computer models’ to allow searching and computation
  - “Send a reminder to all patients with a blood pressure > 120/80 who have not been seen for 3/12
  - “Show me Mr Ian Smith’s last Cardiology clinic record”
  - “Show me an alert if I try to prescribe a drug to which the patient has an allergy”

# Clinical Information models – Who needs them?

## System developers

- Define local application content
- Define shared content for decision support

## Standards bodies

- National, International, Professional
  - Define shared application content
  - Define clinical message content
  - Define content for secondary analysis

# Is health different?

The need for a shared information model is not unique to health

- We can share other information - why not health information?
- “If the banks can do it, why can’t health?”



# Is the health world different?

- Mobile population
- More providers
  
- More complex treatments
- Lifelong records
  
- Preventable harm to patients
- Increasing knowledge
- Clinical diversity

# Is health information different?

- Narrative data with critical content
- Complex statements
- Variable scope of data use
- Wide variety of technologies, data and data structures
- Functional assessments involving structured approaches
- Critical information sharing often requires precise use of a shared terminology
- Analogue, time series, negation...

# Volume of health knowledge

The total number of concepts and the rate of change is high

- SNOMED medical termset codes some 450,000 atomic concepts and over 1 million relationships

Health care is big, and open-ended:

- *In breadth*, because new information is always being discovered or becoming relevant
- *In depth*, because finer-grained detail is always being discovered or becoming relevant
- *In complexity*, because new relationships are always being discovered or becoming relevant

# Capturing clinical knowledge

Formally (computably) expressed in:

- Terminology - READ, SNOMED-CT
- Medication data bases - FDBE Multilex
- Decision support – guidelines, rules
- Software “**Information model**” – Cerner, Lorenzo, MS HealthVault
- Messaging models – HL7 v2, HL7v3

Informally expressed in:

- Documents – professional protocols – NICE
- Data dictionaries – secondary uses

Continually evolving:

- restructured, new, deprecated

# The Clinical modelling challenge

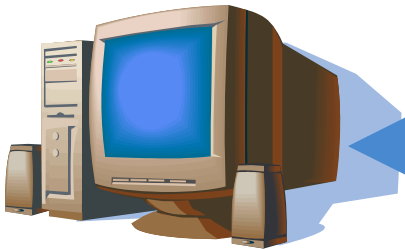
To gather and formalise clinical knowledge in a computable fashion

- to inform application design / message content
- to enable research and public health reporting
- to drive decision support and workflow

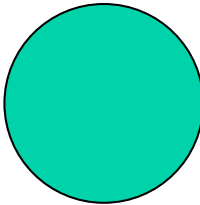
**in a way that is understandable to most clinicians**

# Traditional approach to clinical modelling

Application System



Technical Development




Clinical Knowledge



# Traditional Information model

## Fields

	Name	Description
	TypeId	Retrieves the unique identifier for the item type.

## Properties

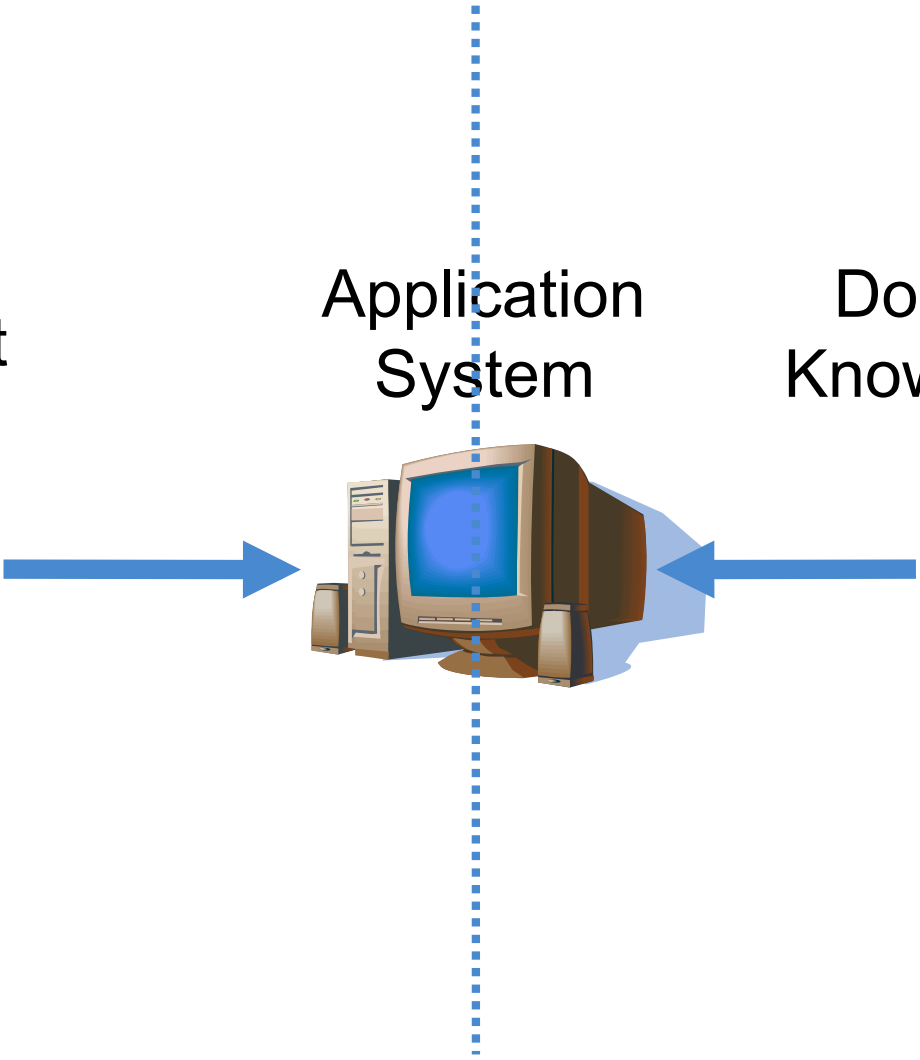
	Name	Description
	AllergenCode	Gets or sets the code for the allergen that causes an allergic reaction.
	AllergenType	Gets or sets the type of allergen that causes an allergic reaction.
	CommonData	Gets the common data for the <a href="#">HealthRecordItem</a> . (Inherited from <a href="#">HealthRecordItem</a> .)
	Created	Gets the audit information associated with the creation of this health record item. (Inherited from <a href="#">HealthRecordItem</a> .)
	EffectiveDate	Gets the date and time that the health record item data was taken. (Inherited from <a href="#">HealthRecordItem</a> .)
	EffectivePermissions	Gets the effective permissions on the item granted to the person retrieving the <a href="#">HealthRecordItem</a> . (Inherited from <a href="#">HealthRecordItem</a> .)
	FirstObserved	Gets or sets the approximate date of the first occurrence of the allergy.
	Flags	Gets the <a href="#">HealthRecordItem</a> flags. (Inherited from <a href="#">HealthRecordItem</a> .)
	HealthRecordItemSignatures	Gets the signatures for the <a href="#">HealthRecordItem</a> . (Inherited from <a href="#">HealthRecordItem</a> .)
	IsDownVersioned	Gets the value indicating if the <a href="#">HealthRecordItem</a> is down-versioned. (Inherited from <a href="#">HealthRecordItem</a> .)
	IsImmutable	Gets a value indicating whether the <a href="#">HealthRecordItem</a> is immutable. (Inherited from <a href="#">HealthRecordItem</a> .)
	IsNegated	Gets or sets a value indicating whether the allergic reaction is negated with treatment.
	IsPersonal	Gets or sets the value indicating if the <a href="#">HealthRecordItem</a> is private. (Inherited from <a href="#">HealthRecordItem</a> .)

# Two Level *openEHR-Approach*

Technical  
Development

Application  
System

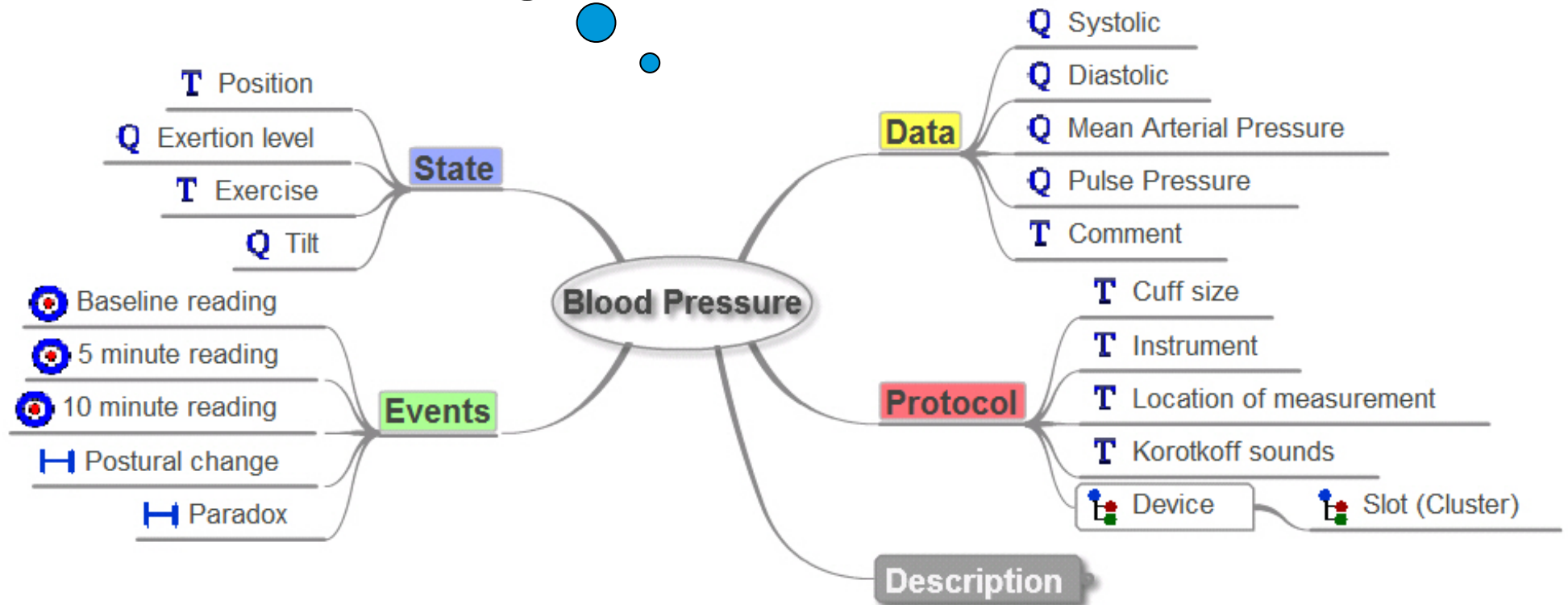
Domain  
Knowledge





# openEHR Archetype

*Intuitive Model*  
of a  
clinical concept



# What is *openEHR*?

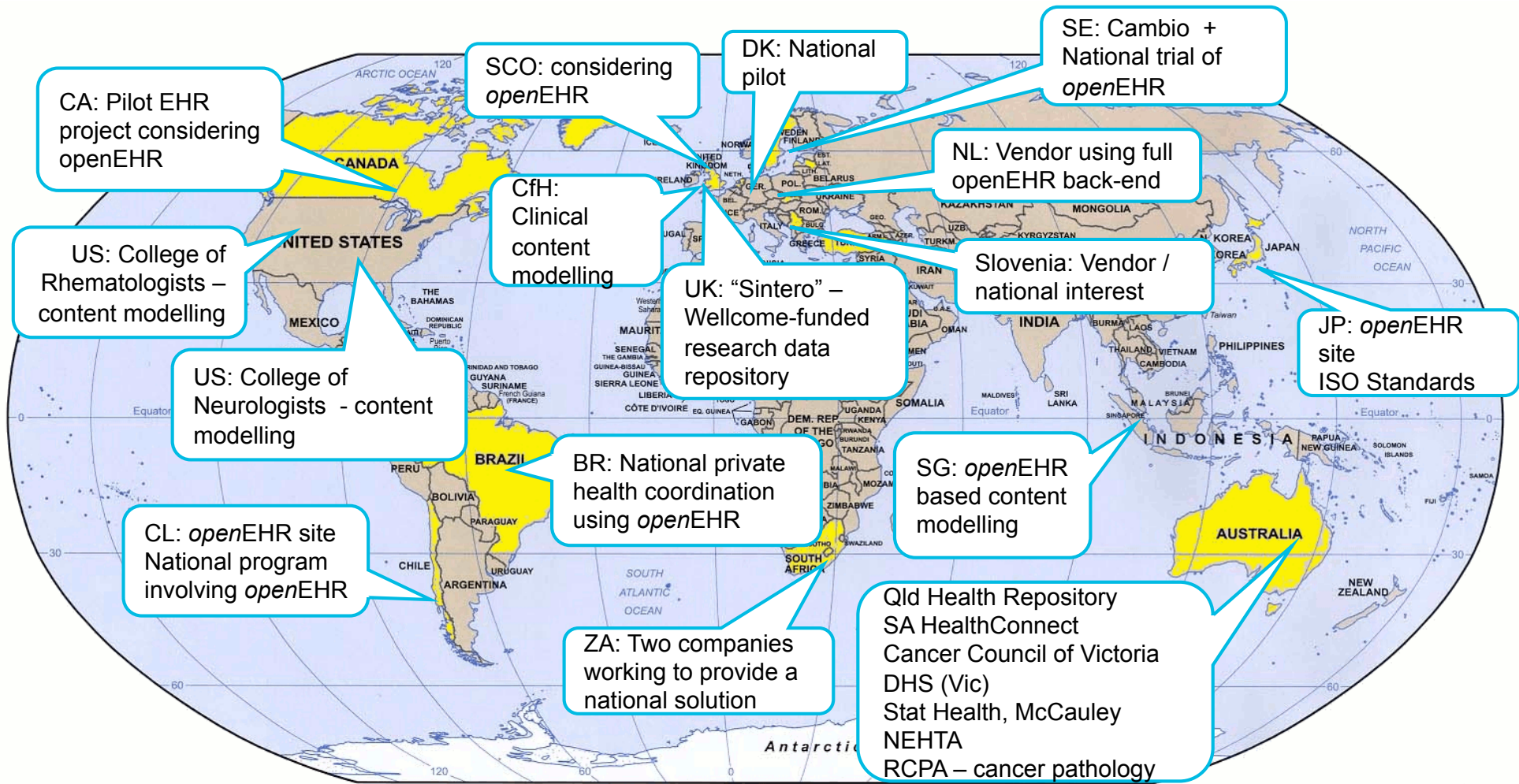
**Open**, freely available specification of an information model for an EHR

- NOT an application
- Not primarily a software project
  - but open-source software is available
- Platform independent
  - Currently JAVA ,.NET and Ruby implementations
- License allows open or commercial use
- [www.openehr.org](http://www.openehr.org)

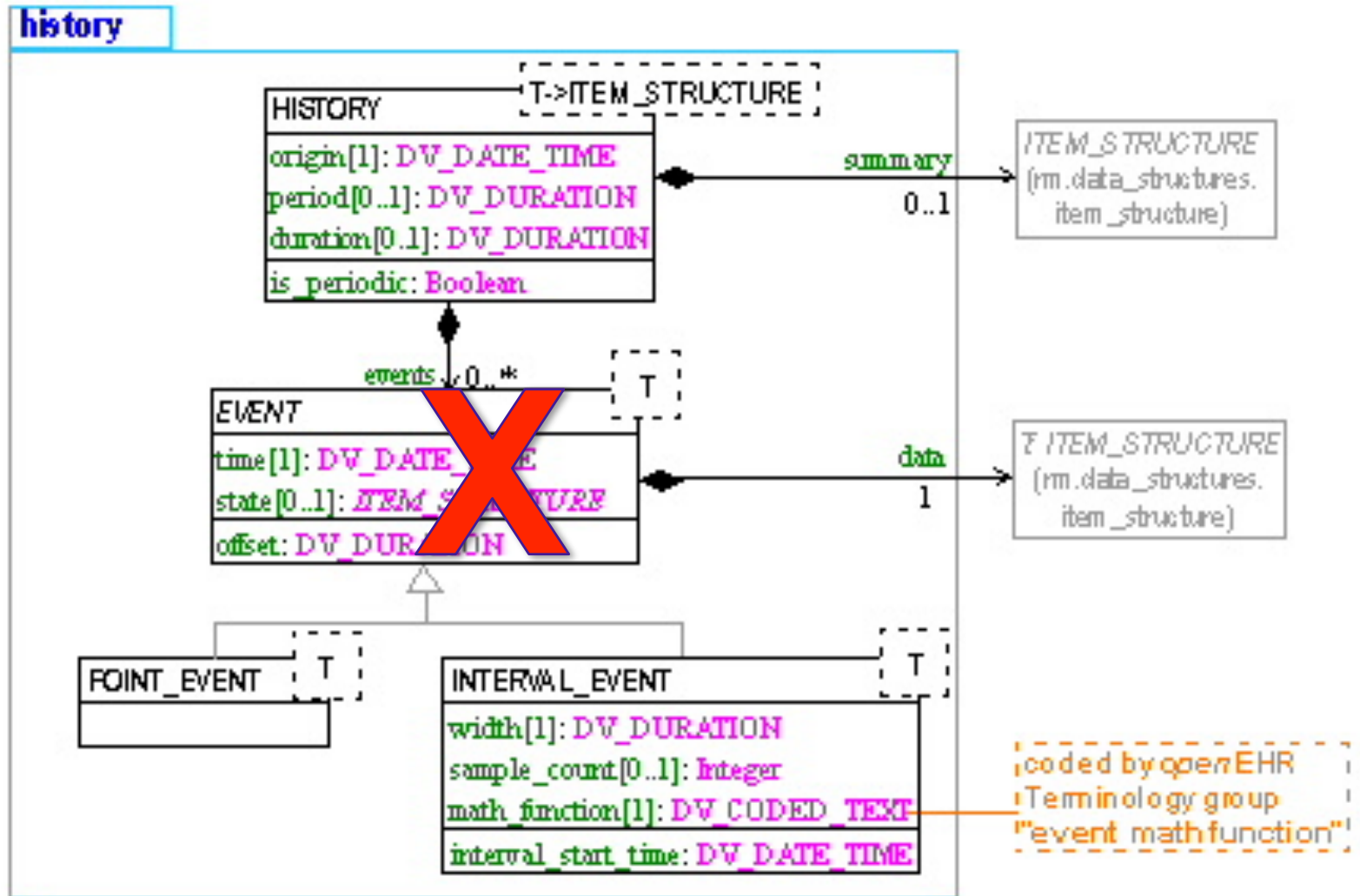
# The *open*EHR Foundation

- **Non-profit organisation** based at UCL
  - Established by UCL and Ocean Informatics in 2000 to own the intellectual property
  - 1000+ Members from 71 countries
  - All specifications & schemas publicly available
  - Software open source (GPL, LGPL, MPL)
  - Grew out of academic EHR projects e.g. GEHR
- Aim is to define an open specification for building an electronic health record.

# A growing clinical community of interest around the world



# openEHR Reference Model



# openEHR Archetype

The screenshot shows the 'Ocean Archetype Editor [Medication action]' window. The title bar includes standard window controls and a menu bar with 'File', 'Edit', 'Publish', 'Language', 'Terminology', 'Tools', and 'Help'. Below the menu bar is a toolbar with icons for file operations. The main area is divided into several sections:

- Archetype file name:** openEHR-EHR-ACTION.medication.v3
- Navigation tabs:** Header, Definition (selected), Terminology, Display, Interface, Description.
- Protocol:** A checkbox labeled 'Protocol' is currently unchecked.
- Action description / Pathway:** A sub-tabbed area with 'Action description' selected and 'Pathway' as an alternative.
- Tree View:** A hierarchical list of archetype elements. The 'Name of medication' element is selected and highlighted in yellow. Other elements include Administration instructions, Strength per dose unit, Dose unit, Form, Dose, Dose frequency, Dose duration, Route, Is long term, Indications, Generic name, Safety limits, Administration information, Dispensing information, Reason for commencement, Reason for ceasing, Own medication?, and Additional instructions.
- Constraint / Details:** A panel for configuring the selected element. It includes:
  - Occurrences:** Min: 1, Max: 1, and an 'Unbounded' checkbox.
  - Description:** A text box containing 'The name of the intervention - which may be coded'.
  - Runtime name constraint:** A text box with a dropdown arrow.
  - Encoding options:** Three radio buttons: 'Free text or coded' (selected), 'Internal codes', and 'Terminology'.



# Archetype modelling paradigm

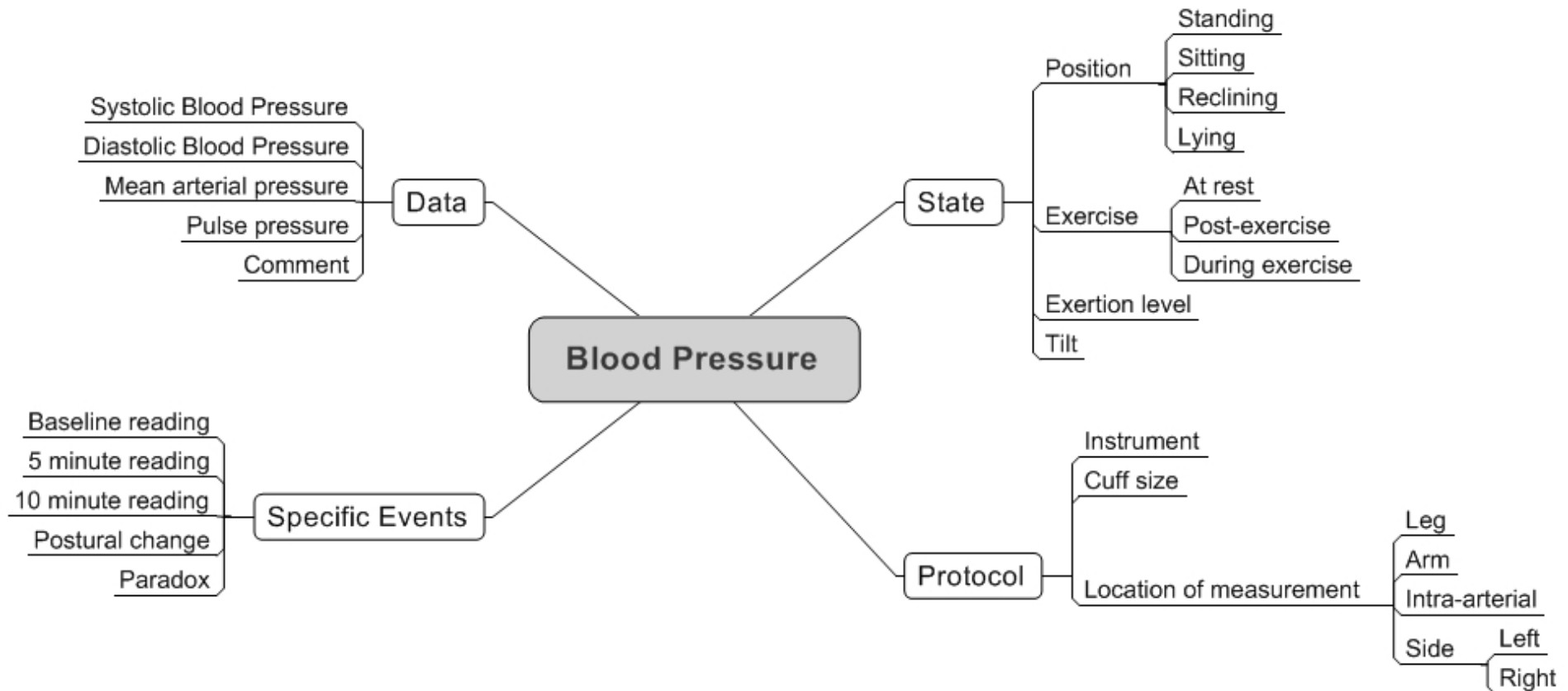
Requires:

- ~~Minimum Dataset?~~
- Maximum Dataset

Each archetype is inclusive of

**ALL** attributes clinicians might want to capture about a discrete concept

# Blood Pressure archetype





# openEHR Template

The screenshot displays the Ocean Template Designer interface. The main workspace shows a hierarchical tree for a template named "[SCIMP Cardiology1.oet]". The tree structure is as follows:

- content
  - Pulse
    - data
      - Any event
        - data
          - Normal statements
            - Present
          - Findings
            - Description
            - Rate
            - Rhythm
            - Volume
            - Character
            - Number of missed beats per minute
            - Pulse deficit
    - protocol
      - Device
      - Location of measurement
  - Blood Pressure
    - data
      - any event
        - data
          - Systolic
          - Diastolic
          - Mean Arterial Pressure
          - Pulse Pressure
        - Comment
    - state
      - Baseline reading

The Archetype Repository panel on the right lists various concepts, including:

- Postural oedema (v1)
- Pregnancy test (v1)
- Pulse (v1)
- Respirations (v1)
- Speech (v1)
- Story or history (v1)
- Substance use (v1)
- Tendon and Babinski reflexes (v1)
- Tobacco use (v1)
- Tympanogram (v1)
- Urinalysis (v1)
- Urine output (v1)
- Uterine contractions (v1)
- Warble Tones Hearing Test (v1)
- Word List Hearing Test (v1)
- evaluation
- instruction

The Template Node Properties panel shows the following configuration:

Occurrences	mandatory, not repeating [1..1]
<b>Information</b>	
Annotation	
Description	*
<b>Annotation</b>	Information about this node

**Observations: History**

Symptom

Clinical description

---

**BP**

systolic  mm[Hg]

diastolic  mm[Hg]

**Weight**  kg

---

**Examination of the uterus**

Normal statements

Clinical description

**Size**

Fundal height  cm    Weeks

Assessment of liquor volume

Number of fetuses

---

**Assessment**

Rationale

---

**Urinalysis**

Glucose

Bilirubin

Ketones

Specific gravity

Blood

pH

Protein

Urobilinogen

Nitrite

Leukocytes

Comments

---

**Fetal movements**

Presence

---

**FH Rate**  /min     Present

---

**Examination of the fetus**

Identifier

**Normal statements**

Clinical description

Lie of the fetus

Presentation

Position

Engagement

Size relative to gestation

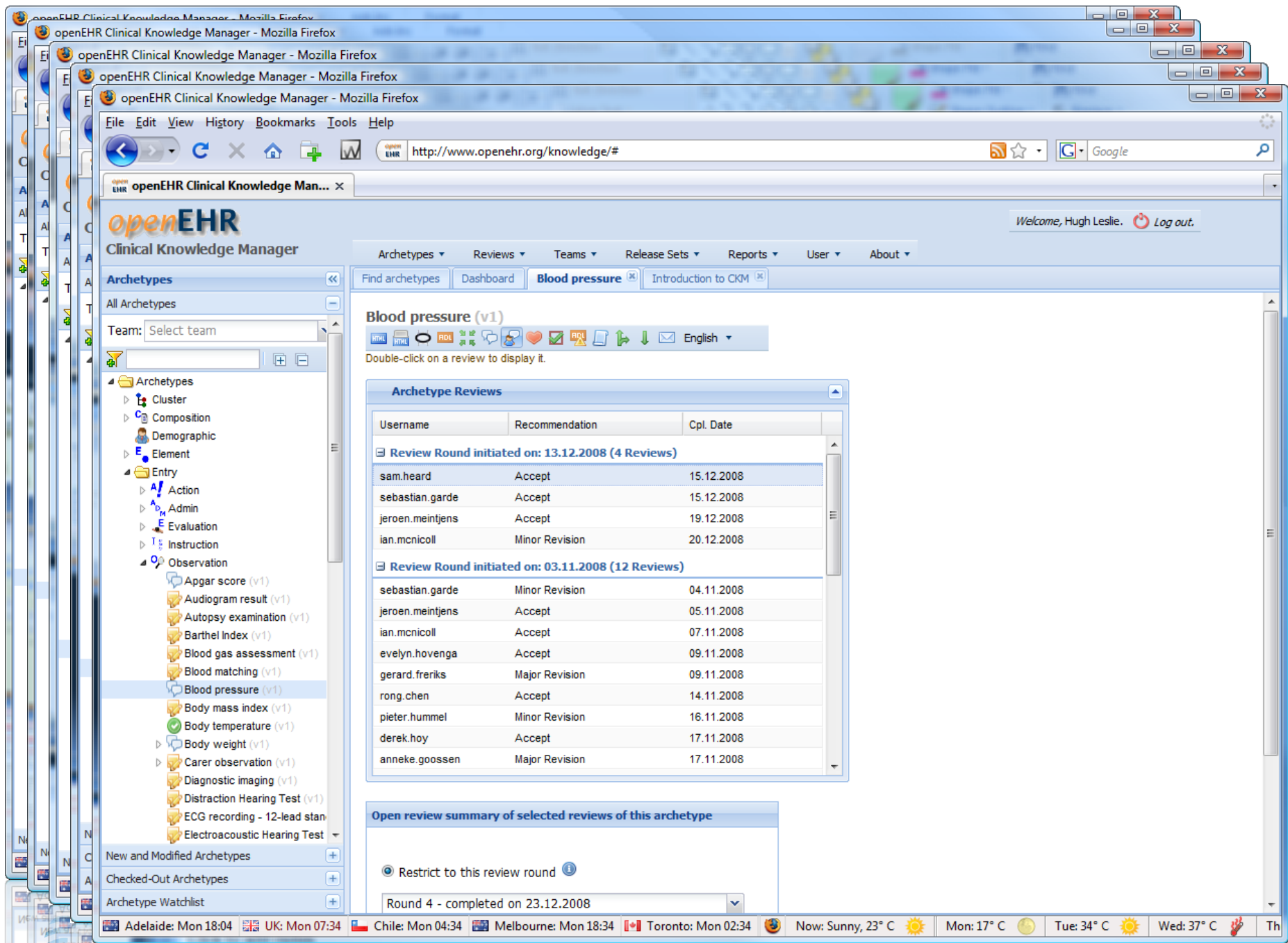
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**Follow up**

Service

Details

Appointment date and time



File Edit View History Bookmarks Tools Help

http://www.openehr.org/knowledge/#

openEHR Clinical Knowledge Man...

openEHR  
Clinical Knowledge Manager

Welcome, Hugh Leslie. Log out.

Archetypes Revisions Teams Release Sets Reports User About

Archetypes

Find archetypes Dashboard Blood pressure Introduction to CKM

All Archetypes

Team: Select team

- Archetypes
  - Cluster
  - Composition
  - Demographic
  - Element
  - Entry
    - Action
    - Admin
    - Evaluation
    - Instruction
    - Observation
      - Apgar score (v1)
      - Audiogram result (v1)
      - Autopsy examination (v1)
      - Barthel Index (v1)
      - Blood gas assessment (v1)
      - Blood matching (v1)
      - Blood pressure (v1)
      - Body mass index (v1)
      - Body temperature (v1)
      - Body weight (v1)
      - Carer observation (v1)
      - Diagnostic imaging (v1)
      - Distraction Hearing Test (v1)
      - ECG recording - 12-lead stan
      - Electroacoustic Hearing Test

### Blood pressure (v1)

Double-click on a review to display it.

#### Archetype Reviews

Username	Recommendation	Cpl. Date
<b>Review Round initiated on: 13.12.2008 (4 Reviews)</b>		
sam.heard	Accept	15.12.2008
sebastian.garde	Accept	15.12.2008
jeroen.meintjens	Accept	19.12.2008
ian.mcnicoll	Minor Revision	20.12.2008
<b>Review Round initiated on: 03.11.2008 (12 Reviews)</b>		
sebastian.garde	Minor Revision	04.11.2008
jeroen.meintjens	Accept	05.11.2008
ian.mcnicoll	Accept	07.11.2008
evelyn.hovenga	Accept	09.11.2008
gerard.freriks	Major Revision	09.11.2008
rong.chen	Accept	14.11.2008
pieter.hummel	Minor Revision	16.11.2008
derek.hoy	Accept	17.11.2008
anneke.goossen	Major Revision	17.11.2008

#### Open review summary of selected reviews of this archetype

Restrict to this review round

Round 4 - completed on 23.12.2008

Adelaide: Mon 18:04 UK: Mon 07:34 Chile: Mon 04:34 Melbourne: Mon 18:34 Toronto: Mon 02:34 Now: Sunny, 23° C Mon: 17° C Tue: 34° C Wed: 37° C

# What problems does openEHR solve ?

- A full specification for an electronic health record
  - Rich robust and rigid technical specification
  - Clinical information content is defined and controlled independently by clinicians
    - A small number of 'expert clinicians' to design archetypes and to engage with the international work
    - A larger number of 'interested clinicians' to check that templates accurately reflect their local information requirements
  - Integration with external terminologies
    - SNOMED-CT, ICDx, LOINC
    - Drug references, Local terminologies

# Why are standards still difficult?

Diversity of clinical practice and clinical recording standards cannot be resolved with a technical solution

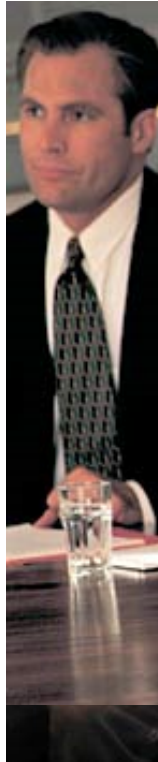
- But technology can help facilitate the conversations necessary to resolve these issues

We must put clinicians in the driving seat and equally make them responsible for clinical standards development

# dys- interoperability

- The “usual suspects”
  - Clinical ego, technophobia, vendor lock-in
- Innovation, research
  - The little MS-Access database or Excel spreadsheet
- Information granularity
  - “Family History of breast cancer”
    - Specialist Breast Cancer unit
    - Research Breast Cancer Genetics Unit
- Organisational, operational constraints
  - Legacy systems
    - The better the system, the bigger the problem
  - National / regional / local policies and guidelines

# Developing clinical standards





# openEHR Clinical Knowledge Manager

The screenshot displays the openEHR Clinical Knowledge Manager interface. The top navigation bar includes 'Archetypes', 'Reviews', 'Teams', 'Release Sets', 'Reports', 'Users', and 'About'. The user is logged in as 'Ian McNicoll'. The main content area is titled 'Review Summary' and shows details for the 'Respirations' archetype.

**Data**

<p><b>T</b> <b>Depth</b> Coded Text Occurrences: 0..1 (optional)</p>	<p>Depth of respiration</p>	<ul style="list-style-type: none"> <li>• Normal (Normal depth of breathing)</li> <li>• Shallow (Shallow breathing)</li> <li>• Deep (Deep breathing)</li> <li>• Variable (The respiration depth varies)</li> </ul>	<p>[20-Feb-2009]:</p> <p>Reorder — normal, shallow, deep, variable</p>
<p><b>Abnormal respiratory pattern</b> Choice Occurrences: 0..1 (optional)</p>	<p>A specific abnormal respiratory pattern. Other patterns may be entered as free text or terminology subset defined at template level.</p>	<p>Choice of:</p> <ul style="list-style-type: none"> <li>• Coded Text</li> <li>• Kussmaul's respiration (Deep chest breathing with or without gasp seen.)</li> <li>• Cheyne-Stokes respiration (Cheyne-Stokes respiration is a breathing pattern characterised by periods of hyperventilation alternating with periods of apnea)</li> <li>• Ataxic respiration (Ataxic breathing is one of varying tidal volumes and rates.)</li> <li>• Respiratory alternans (Respiratory alternans is a breathing pattern characterised by a short period of abdominal inward movement during inspiration followed by a period of chest wall inward movement during inspiration.)</li> <li>• Apneustic respiration (Apneustic respiration is a breathing characterized by deep, gasping inspiration with a pause at full inspiration followed by</li> </ul>	<p>[06-Feb-2009]:</p> <p>What is figure 43.1 in the cheyne-stokes respiration?</p> <p>What does 309155007 mean?</p> <p>ventilation, A -&gt; ventilation, a</p> <p>[20-Feb-2009]:</p> <p>Require concise descriptions — suggest shorten text to the core description.</p> <p>Kussmaul's respiration (Deep chest breathing with or without gasp seen)</p> <p>Cheyne-Stokes respiration (Cheyne-Stokes respiration is a breathing pattern characterised by periods of hyperventilation alternating with periods of apnea)</p> <p>Ataxic respiration (Ataxic breathing is one of varying tidal volumes and rates)</p> <p>Respiratory alternans (Respiratory alternans is a breathing pattern characterised by a short period of abdominal inward movement during inspiration followed by a period of chest wall inward movement during inspiration)</p>



# Embrace diversity

- Break the endless cycling between
  - Central 'ruthless standardisation'vs.
  - Unconstrained local variation
- Develop methodologies and associated tools that embrace the need for both
- Allow standards to develop both
  - Organically
  - By diktat (where circumstances are favourable)
  - But in a controlled and cooperative environment

# Positively manage diversity

- Democratised clinical content modelling
  - Non-proprietary approach, widest natural community possible
  - Modelling tools and methodologies must be
    - Clinically orientated, non-technical, minimise demands on clinical time
      - Web 2.0 “social network” applications
- Capture content at all organisational levels
  - Include diverse models
    - Today’s outlier may be tomorrow’s standard
  - Communicate who is modelling what
    - “Archetype nursery”
  - Hierarchical clinical content modelling
    - Top-down advice, bottom-up modelling (mostly)
      - “Middle-out” ? E. Coiera

# Managing diversity

