



Declarative Health - cityEHR

John Chelsom
Seven Informatics Ltd
john.chelsom@seveninformatics.com





Declarative Health - cityEHR

- Electronic Health Records Using XML
- Open Source, Model-Driven, XML Health Records
- XML Health Records Using XForms



Electronic Health Records Using XML





Patient Data in Healthcare

- Personalised medicine is revolutionizing treatments for
 - cancer
 - diabetes
 - rheumatoid arthritis
 - ...
- Research requires (amongst other things) rich, structured data
 - ideally, gathered in routine clinical care
- XML provides an excellent mechanism for representing clinical data using standards such as HL7 CDA and ISO-13606



Case Notes

- Case Notes was an Enterprise Java application for Electronic Health Records (EHR)
- First live installation at Oxford Radcliffe Hospital in 1999 (still running there in 2019)
- Chosen as the base system for the Summary Care Records system in England in 2003
- Implemented using non-standard XML vocabularies, and a relational database
- > £5m investment
- > 100 person years effort

The screenshot displays the Case Notes software interface. At the top, the patient's name is Ivor Legg, with a date of birth of 18 Jun 1930 and gender listed. The interface includes navigation tabs for Home, Patient Folder, Logout, and Help. Below this, there are buttons for 'Send to In-Tray', 'Mark as Significant', and 'Add Comment'. The main content area is titled 'X-Ray' and contains the following text:

Pre and Post operative views pelvis and right hip.

There is gross displacement of the right head of femur with associated degenerative disease prior to the THR.
Satisfactory post op appearance.

Clinical note; previous CDH.

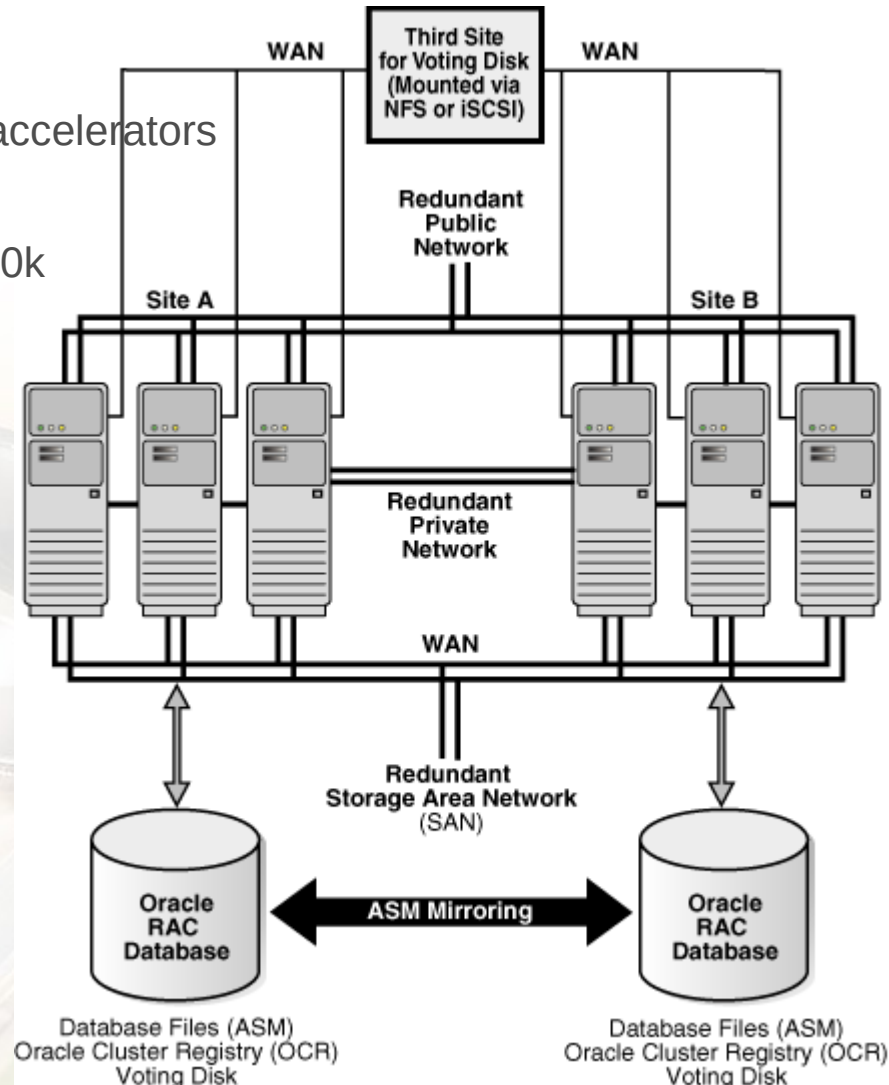
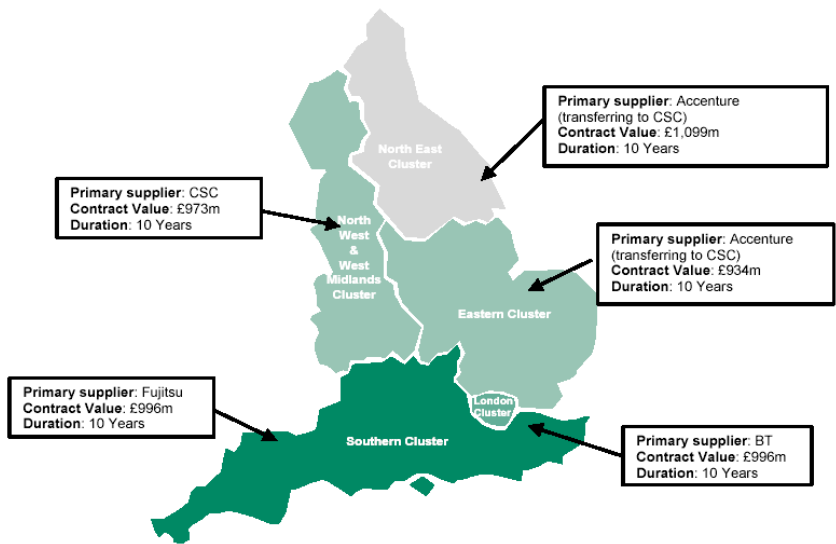
Almost complete loss of joint space in the right hip with moderate associated OA changes.

Below the text is an X-ray image of a pelvis and right hip. The interface also features a calendar on the left side for filtering events by month and year, and a 'Show Key' button at the bottom.

User Name: Peter Graves

National Programme for IT

- Case Notes was scaled up to 55 million patients
- Systems integrators LogicCMG and BT
- Clustered Oracle database and Java hardware accelerators
- Estimated 90 – 100 Tb database
- 1Tb storage in BT's data centre cost approx £100k
- Total budget was £100m's
- Infrastructure cost was > £5 per patient





Failure of EHR

- The National Programme for IT failed – as a result of top-down design, poor quality products, feasting frenzy for systems integrators and consultants
- It failed to deliver its ambitious objectives, but also set the the whole UK Health Informatics industry back a decade
- We continue to spend £100m's on poor quality systems (not just in the UK)
- I dream of the day when we can offer an EHR system which is
 - Free (as in freedom of speech *and* free beer)
 - Completely based on open standards
 - Configured by clinicians to hold the information they need
 - Massively scalable
 - Deployable by a schoolboy

Raspberry Pi Beowulf Cluster

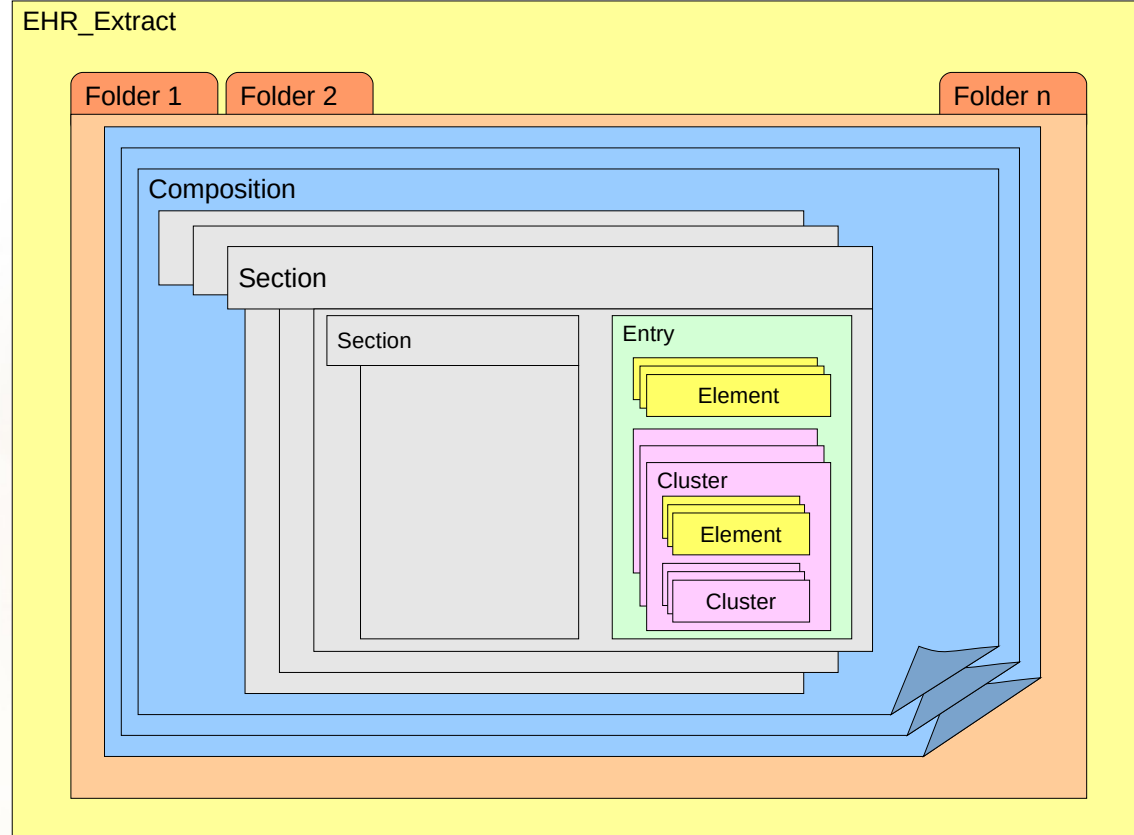


In 2018, my son (then aged 14) deployed the open source cityEHR
On a cluster of 16 Raspberry Pi 3s
To demonstrate scalability of XML health records on commodity hardware



Structure of a Health Record

- ISO-13606 standard
- Started as a European standards activity, adopted by ISO
- Defines the general structure of a health record (amongst other things)



Structure of a Health Record

CHUMLEY-WARREN, Arthur (Mr) Born: 13-Feb-1947 (70 years) Gender: Male
Patient Id 67676767 NHS Number 123456789

Dashboard Patient Search Patient Cohort **Folder** Quit Admin Registration

In Progress New Hide Events Summaries Letters Forms Pathways **Care Setting:** cityEHR Feature Demo Show

cityEHR Feature Demo (20)

- Current Observations
- Allergies and Warnings
- Bone Chemistry
- Laboratory Test Results
- Update Patient Demographics
- Feature Demonstration
- Hospital Anxiety and Depression Scale
- DAS 28**
- DAS 68
- Diagnosis
- Family History
- Fracture Record
- Medication

01-Aug-2017 - DAS 28 *

Effective Time 01-8-2017 14:10:03.595

Disease Activity Score (DAS 28)

Count Swollen Joints 3 Tender Joints 1

ESR 23

Visual Analogue Scale 2

DAS Score 3.52

Cluster

Element

Entry

Section

EHR_Extract

Composition



Clinical Statement

120 Normal
80

These data carry no meaning.

In ISO-13606, data items are modelled as Element, and grouped as Cluster

Blood Pressure +			
	Measurement date	Systolic (mmHg)	Diastolic (mmHg)
X	12-2-2019	120	80

The Clinical Statement is the lowest level of modelling that carries useful clinical context.

It is the point in the model at which data becomes information.

In ISO-13606 the Clinical Statement is modelled as Entry.

HL7 Clinical Document Architecture

CHUMLEY-WARREN, Arthur (Mr) Born: 13-Feb-1947 (70 years) Gender: Male
 Patient Id 67676767 NHS Number

XML Document Viewer

Download Close

```

+ (xxforms:instance()
else ''"/>
</observation>
</entry>
<entry cityEHR:layout="Unranked" cityEHR:rendition="#CityEHR:EntryProperty:Form" cityEHR:initial
<observation>
<typeId root="cityEHR" extension="#HL7-CDA:Observation"/>
<id root="#ISO-13606:Entry:DAS28ESR" extension="#ISO-13606:Entry:DAS28ESR" cityEHR:origi
<code code="" codeSystem="cityEHR" displayName="ESR"/>
<value root="#ISO-13606:Element:Double" extension="#ISO-13606:Element:Double" xsi:type='
</observation>
</entry>
<entry cityEHR:layout="Unranked" cityEHR:rendition="#CityEHR:EntryProperty:Form" cityEHR:initial
<observation>
<typeId root="cityEHR" extension="#HL7-CDA:Observation"/>
<id root="#ISO-13606:Entry:DAS28VAS" extension="#ISO-13606:Entry:DAS28VAS" cityEHR:origi
<code code="" codeSystem="cityEHR" displayName="Visual Analogue Scale"/>
<value root="#ISO-13606:Element:DAS28VAS" extension="#ISO-13606:Element:DAS28VAS" xsi:ty
</observation>
</entry>
<entry cityEHR:layout="Unranked" cityEHR:rendition="#CityEHR:EntryProperty:Form" cityEHR:initial
<observation>
<typeId root="cityEHR" extension="#HL7-CDA:Observation"/>
<id root="#ISO-13606:Entry:DAS28Total" extension="#ISO-13606:Entry:DAS28Total" cityEHR:c
<code code="" codeSystem="cityEHR" displayName="DAS Score"/>
<value root="#ISO-13606:Element:DAS28Total" extension="#ISO-13606:Element:DAS28Total" xs
and not((for $i in xxfi
return $i castable as
and not((for $i in xxfi
return $i castable as
and not((for $i in xxfi

```

Tender Joints 1

cityEHR Version Number - V1.5 User: cityEHR Administrator / cityEHR Feature Demo Logged on: 11:26:01 on Tuesday, 1st August 2017 Last logged on: 12:29:58 on Friday, 28th July 2017

XML Health Record



Quit Admin

Dashboard Patient Search Patient Cohorts In-Tray Registration



03-Aug-2018 - Patient Registration * Page load time: PT1.438S



Patient Demographics

NHS Number	<input type="text" value="1078288621"/>	Hospital Number	<input type="text" value="12175731"/>	Overseas Patient	<input type="checkbox"/>	Find Demographics	<input checked="" type="checkbox"/>
Title	<input type="text" value="Mr"/>	Forename	<input type="text" value="Corin"/>	Surname	<input type="text" value="Cale"/>		
Gender	<input type="text" value="Male"/>	Date of Birth	<input type="text" value="13-1-1991"/>				
Address	<input type="text" value="13 Sandy Lane"/>		Town/City	<input type="text" value="Colchester"/>			
Postcode	<input type="text" value="CO1 9DW"/>						

GP Details

Code	<input type="text"/>	Dr	<input type="text"/>	Practice	<input type="text"/>	Find GP	<input type="checkbox"/>
Address	<input type="text"/>		Town/City	<input type="text"/>		Postcode	<input type="text"/>

XML Health Record

```
<?xml version="1.0" encoding="UTF-8"?>
<ClinicalDocument xmlns:cityEHR="http://openhealthinformatics.org/ehr" xmlns:cda="urn:hl7-org:v3" xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:mif="urn:hl7-org:v3/mif" xmlns:cityEHRFunction="http://openhealthinformatics.org/ehr/functions" xmlns="urn:hl7-org:v3"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <typeId root="#CityEHR:Form" extension="#CityEHR:Form:BaseRegistration"/>
  <templateId root="#ISO-13606:EHR_Extract:cityEHR" extension="#ISO-13606:Folder:FeatureDemo"/>
  <id root="cityEHR" extension="07-01-57.374*01-00-2017-02-23T08-15-25.865Z-CityEHR-Form-BaseRegistration-admin"/>
  <code code="134436002" codeSystem="2.16.840.1.113883.2.1.3.2.4.15" codeSystemName="SNOMED" displayName="Patient Registration"/>
  <effectiveTime value="2017-02-23T08:15:25.865Z"/>
  <recordTarget>
    <patientRole>
      <id extension="A47375107030" root="2.16.840.1.113883.2.1.4.1"/>
      <patient>
        <name>
          <prefix/>
          <given>Leicester</given>
          <family>Jameson</family>
        </name>
        <administrativeGenderCode code="Male" codeSystem="" displayName="Male"/>
        <birthTime value="1980-02-04"/>
      </patient>
      <providerOrganization>
        <id extension="NHS Hospital Code" root="#ISO-13606:EHR_Extract:cityEHR"/>
        <name/>
      </providerOrganization>
    </patientRole>
  </recordTarget>
```

XML Health Record

```
<structuredBody>
  <component>
    <section cityEHR:layout="Ranked" cityEHR:labelWidth="17">
      <id root="cityEHR" extension="#ISO-13606:Section:Demographics"/>
      <title>Patient Demographics</title>
      <entry cityEHR:layout="Ranked" cityEHR:rendition="#CityEHR:EntryProperty:Form"
        cityEHR:initialValue="#CityEHR:EntryProperty:Pre-filled" cityEHR:labelWidth="17"
        cityEHR:entryScope="#CityEHR:EntryProperty:Defined" cityEHR:CRUD="#CityEHR:EntryProperty:UL"
        cityEHR:sortCriteria="#ISO-13606:Element:LookUpKey">
        <observation>
          <typeId root="cityEHR" extension="#HL7-CDA:Observation"/>
          <id root="#ISO-13606:Entry:Demographics" extension="#ISO-13606:Entry:Demographics" cityEHR:origin=""/>
          <code code="" codeSystem="cityEHR" displayName=""/>
          <value code="" codeSystem="" displayName="" root="#ISO-13606:Cluster:PatientIdentifiers" [28 lines]
          <value code="" codeSystem="" displayName="" root="#ISO-13606:Cluster:BasicDemographics" [16 lines]
          <value code="" codeSystem="" displayName="" root="#ISO-13606:Cluster:AgeAndGender"
            extension="#ISO-13606:Cluster:AgeAndGender" cityEHR:elementDisplayName="">
            <value root="#ISO-13606:Element:Gender" extension="#ISO-13606:Element:Gender" xsi:type="xs:string" value="Male"
              units="" code="#CityEHR:Value:Gender3AMale" codeSystem="cityEHR" displayName="Male"
              cityEHR:elementDisplayName="Gender" cityEHR:elementType="#CityEHR:ElementProperty:enumeratedValue"
              cityEHR:valueRequired="#CityEHR:ElementProperty:Optional" cityEHR:elementScope="#CityEHR:ElementProperty:Defined"/>
            <value root="#ISO-13606:Element:DateOfBirth" extension="#ISO-13606:Element:DateOfBirth" xsi:type="xs:date"
              value="1980-02-04" units="" code="" codeSystem="" displayName="" cityEHR:elementDisplayName="Date of Birth"
              cityEHR:elementType="#CityEHR:ElementProperty:simpleType"
              cityEHR:valueRequired="#CityEHR:ElementProperty:Optional" cityEHR:elementScope="#CityEHR:ElementProperty:Defined"
            />
            </value>
          <value code="" codeSystem="" displayName="" root="#ISO-13606:Cluster:AddressDetails" [15 lines]
        </observation>
      </entry>
    </section>
  </component>
</structuredBody>
```

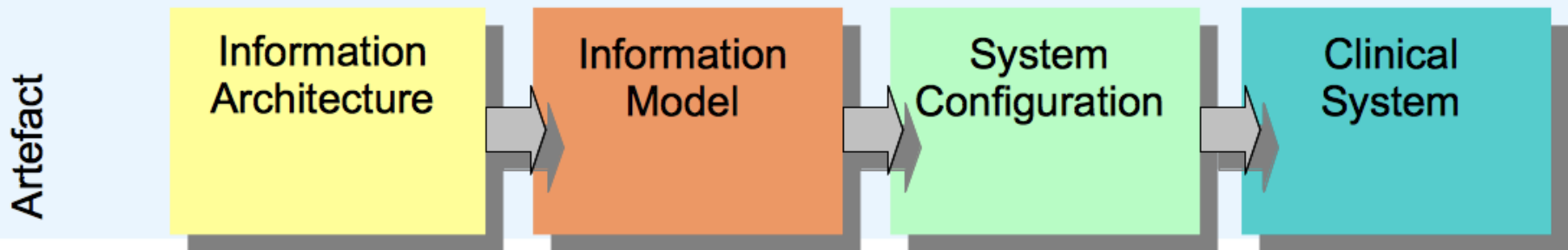


Open Source, Model-Driven, XML Health Records



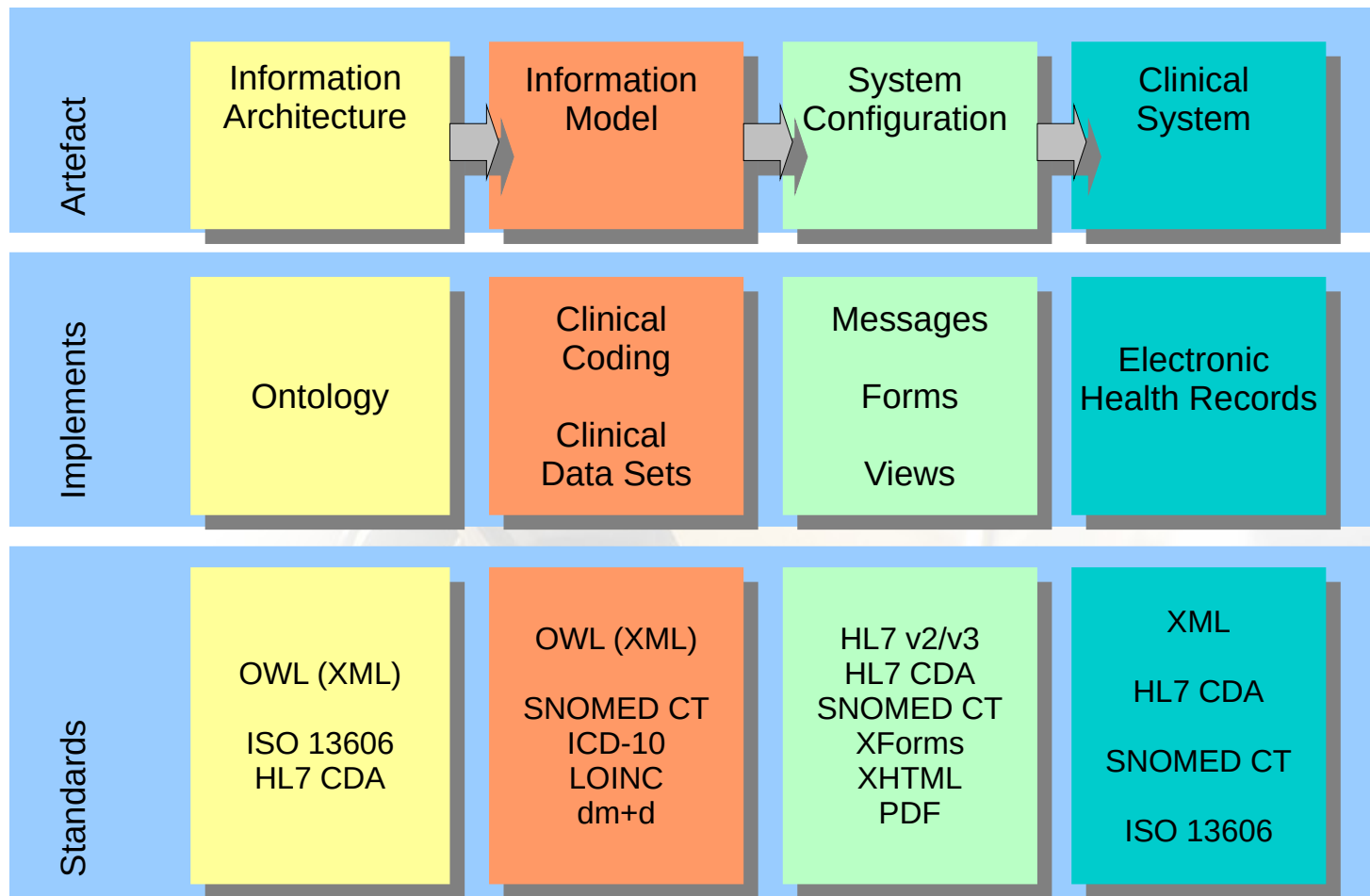
Model-Driven EHR

- A base Information Architecture provides the building blocks
- Clinicians create clinical Information Models for their own systems
- The System Configuration is generated from the Information Model
- The runtime EHR system operates using the System Configuration
 - views of the patient record
 - search criteria
 - data collection forms
 - clinical messages
 - (pathways, orders, prescriptions)



Standards/Clinician/Ontology-Driven EHR

- Standards based
- Clinician led
- Ontology models



EHR Ontology Model

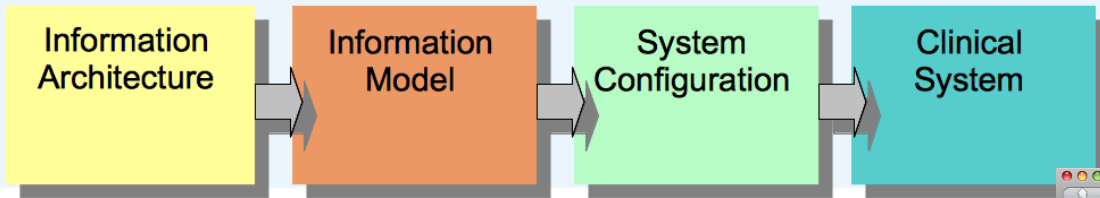
```
<Declaration>
  <Class IRI="#ISO-13606:Entry"/>
</Declaration>
<Declaration>
  <NamedIndividual IRI="#ISO-13606:Entry:BMDData"/>
</Declaration>
<ClassAssertion>
  <Class IRI="#ISO-13606:Entry"/>
  <NamedIndividual IRI="#ISO-13606:Entry:BMDData"/>
</ClassAssertion>
<DataPropertyAssertion>
  <DataProperty IRI="#hasDisplayName"/>
  <NamedIndividual IRI="#ISO-13606:Entry:BMDData"/>
  <Literal xml:lang="en-gb">DXAScanResults</Literal>
</DataPropertyAssertion>
```

```
<ObjectPropertyAssertion>
  <ObjectProperty IRI="#hasContent"/>
  <NamedIndividual IRI="#ISO-13606:Entry:BMDData"/>
  <NamedIndividual IRI="#ISO-13606:Element:BMDDMeasurement"/>
</ObjectPropertyAssertion>
<ObjectPropertyAssertion>
  <ObjectProperty IRI="#hasContent"/>
  <NamedIndividual IRI="#ISO-13606:Entry:BMDData"/>
  <NamedIndividual IRI="#ISO-13606:Element:TScore"/>
</ObjectPropertyAssertion>
<ObjectPropertyAssertion>
  <ObjectProperty IRI="#hasContent"/>
  <NamedIndividual IRI="#ISO-13606:Entry:BMDData"/>
  <NamedIndividual IRI="#ISO-13606:Element:ZScore"/>
</ObjectPropertyAssertion>
```

cityEHR - Clinician-led Development

- Clinicians create clinical models for their own systems
- Using the cityEHR architectural model

Artefact



ABERNATHY, Timothy Born 28-Mar-1979 (34 years) Gender Male
K1476889 NHS Number 100001356

Dashboard Patient Search Clinic Lists Pati

Show Patient Record Summaries Forms Care Setting: [Rheumatology]

15-Jul-2013 - Fracture Record

Fractures

Fracture Site	Type	Trauma level
01-7-2013 Left Shaft Humerus	-- Select --	-- Select --
01-7-2013 Left Maxilla	-- Select --	-- Select --
01-7-2013 Right Phalanges (hand)	-- Select --	-- Select --

ORCID iD V0.98 User: cityEHR User Logged on: 14:11:52 on Monday, 15th July 2013 Last logged on: 02:57:03 on Monday, 15th July 2013

document-247.pdf (page 2 of 2)

Previous Next Zoom Move Text Select Sidebar Search

Patient ID: 1234567892

What are my choices to reduce fracture risk?

The most important choices for you are:

- #ORCID:Class.Drug:reduce drug therapy for 3 years.
This medication is taken with a large glass of tap water once a week after fasting overnight at least half an hour before any food, drink or other medication. You must also remain upright or standing for this half hour. Please read the information leaflet carefully as it is important you follow the instructions exactly to get benefit from your treatment.
- You need calcium to make sure your medication works to strengthen your bones.
No specific recommendations for you.
- Vitamin D is needed for your medication to work to strengthen your bones.
Your level is low and we will provide you with high strength Vitamin D tablets that you need to take as per the instructions on the bottle. We have given you one year supply. If you have been recommended Calcium and Vitamin D tablets, continue them in addition to these new tablets.
- No specific recommendations for you.
- No specific recommendations for you.
- No specific recommendations for you.

Page 2 | 2



Information Model – Spreadsheet Input

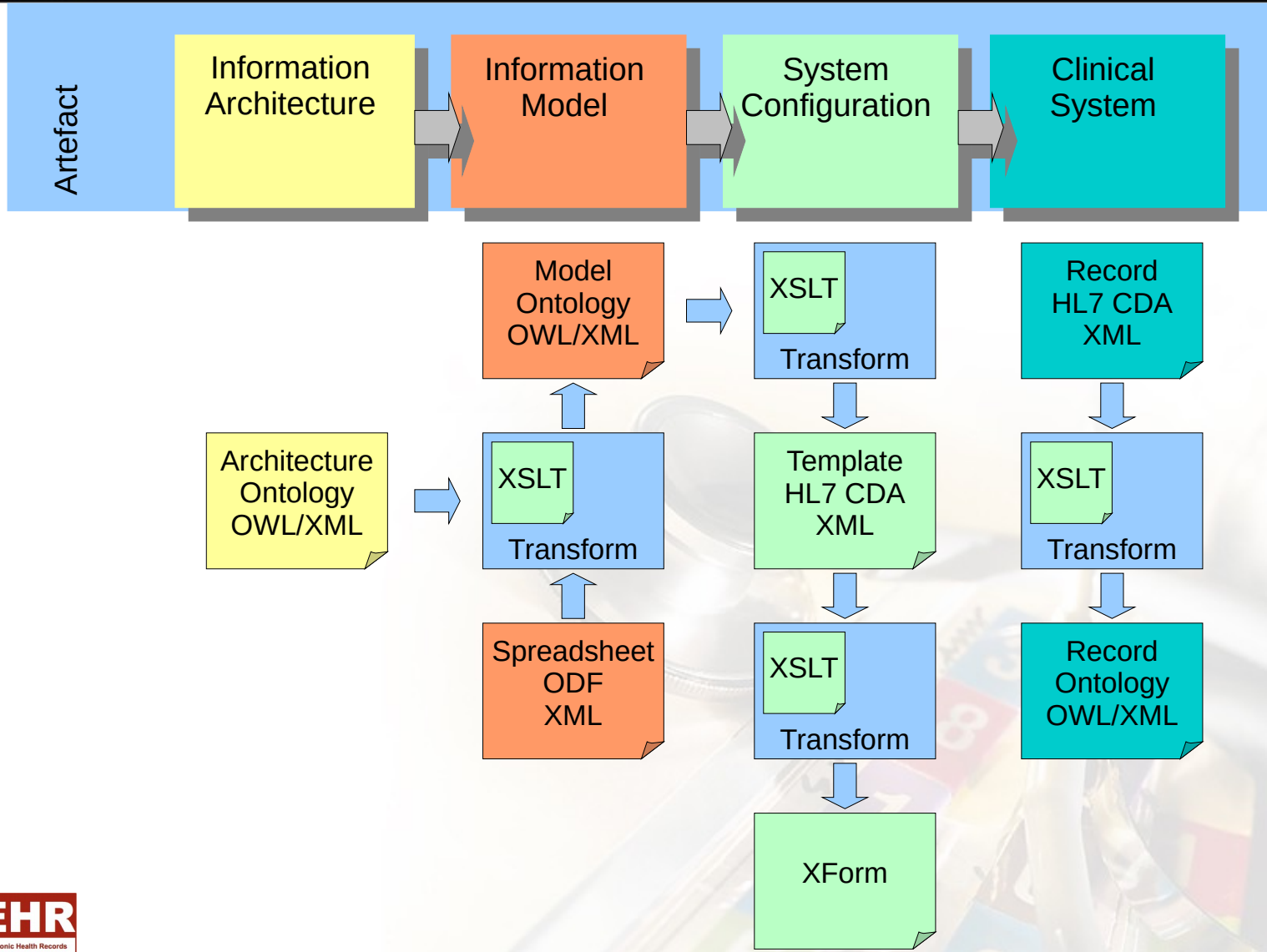
Clinicians can create their own information models using a spreadsheet

Converted to an OWL/XML ontology when imported to cityEHR

cityEHR - Specialty - Feature Demo 163.ods - OpenOffice Calc

Identifier	EntryType	CRUD	Occurrence	InitialValue	Layout	SortOrder	SortCriteria	Categorization
ClinicDetails	Observation	L	Single	Pre-filled	Ranked			
BMDData	Observation	CRU	MultipleEntry	Pre-filled	Unranked			
BMDDataClustered	Observation	CRU	MultipleEntry	Pre-filled	Unranked			
ScanDate	Observation	CRU	Single	Empty	Unranked			
HasFracture	Observation	CRU	Single	Pre-filled	Unranked			
FractureSite	Observation	CRU	MultipleEntry	Default	Unranked	Ascending		
QmileWalk	Observation	CRU	Single	Default	Unranked			
10StepWalk	Observation	CRU	Single	Default	Unranked			
StoopCrouchKneel	Observation	CRU	Single	Default	Unranked			
DoingChores	Observation	CRU	Single	Default	Unranked			
RoomWalk	Observation	CRU	Single	Default	Unranked			
InOutBed	Observation	CRU	Single	Default	Unranked			
SmokingHabits	Observation	CRU	Single	Pre-filled	Unranked			
CigarettesPerDay	Observation	CRU	Single	Default	Unranked			

Generating XForms



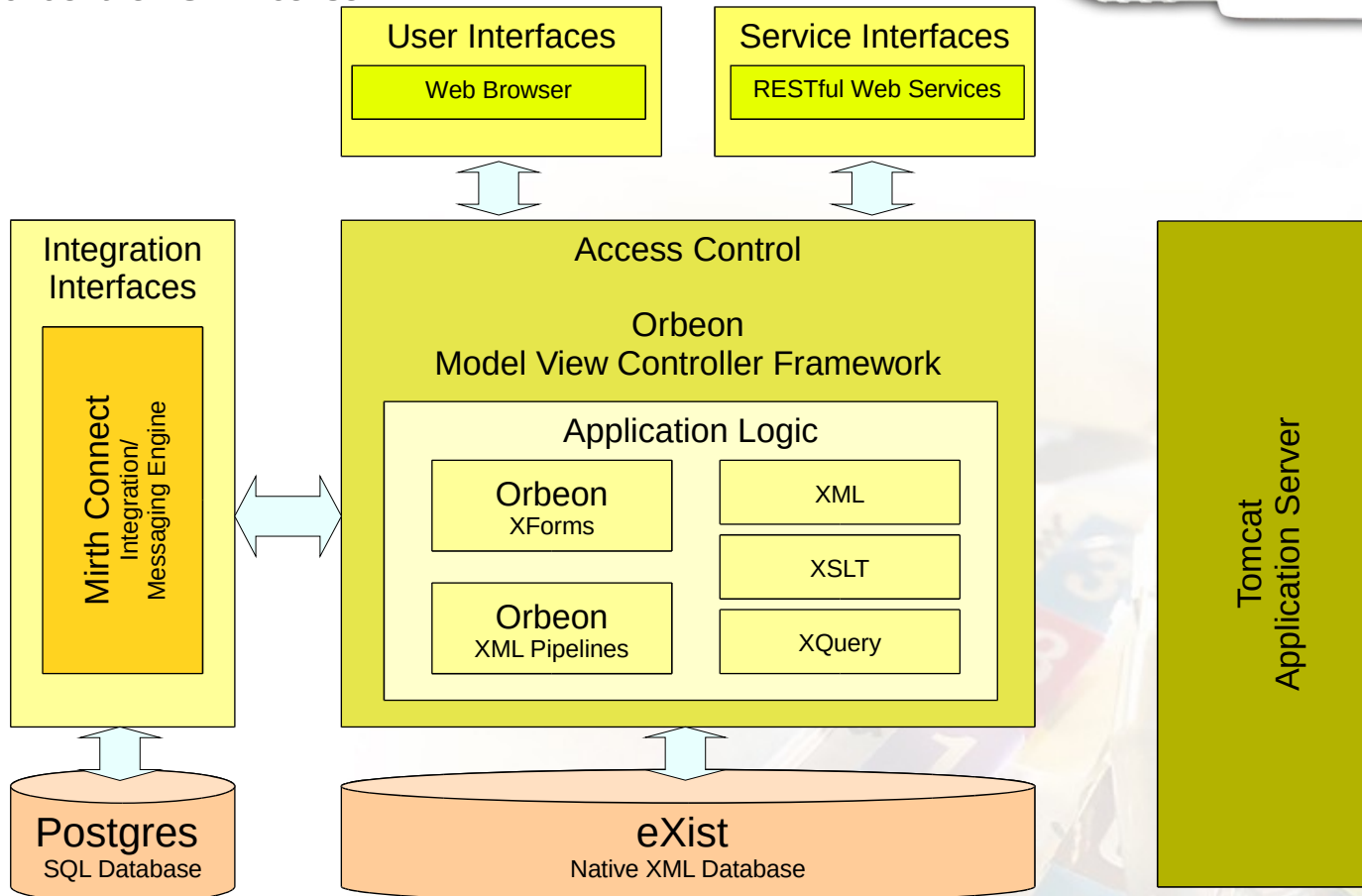


XML Health Records Using XForms



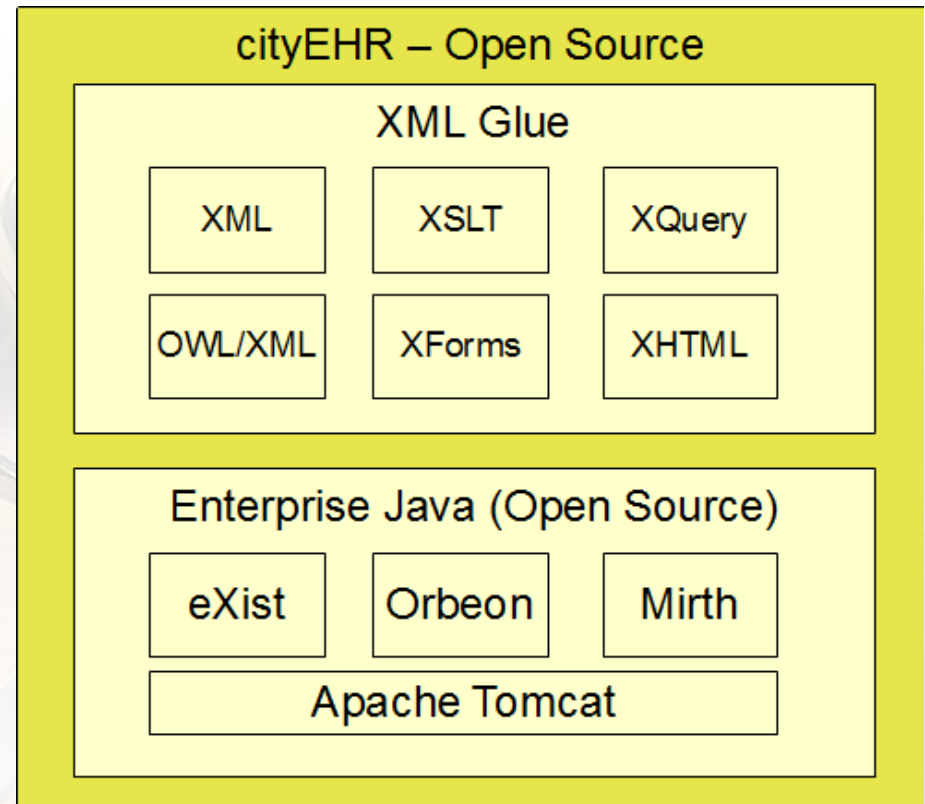
cityEHR Platform

- cityEHR is built using open source software
- An enterprise-scale health records system
- Following research at City University, London
- Distributed under the LGPL license



XForms – REST – XQuery

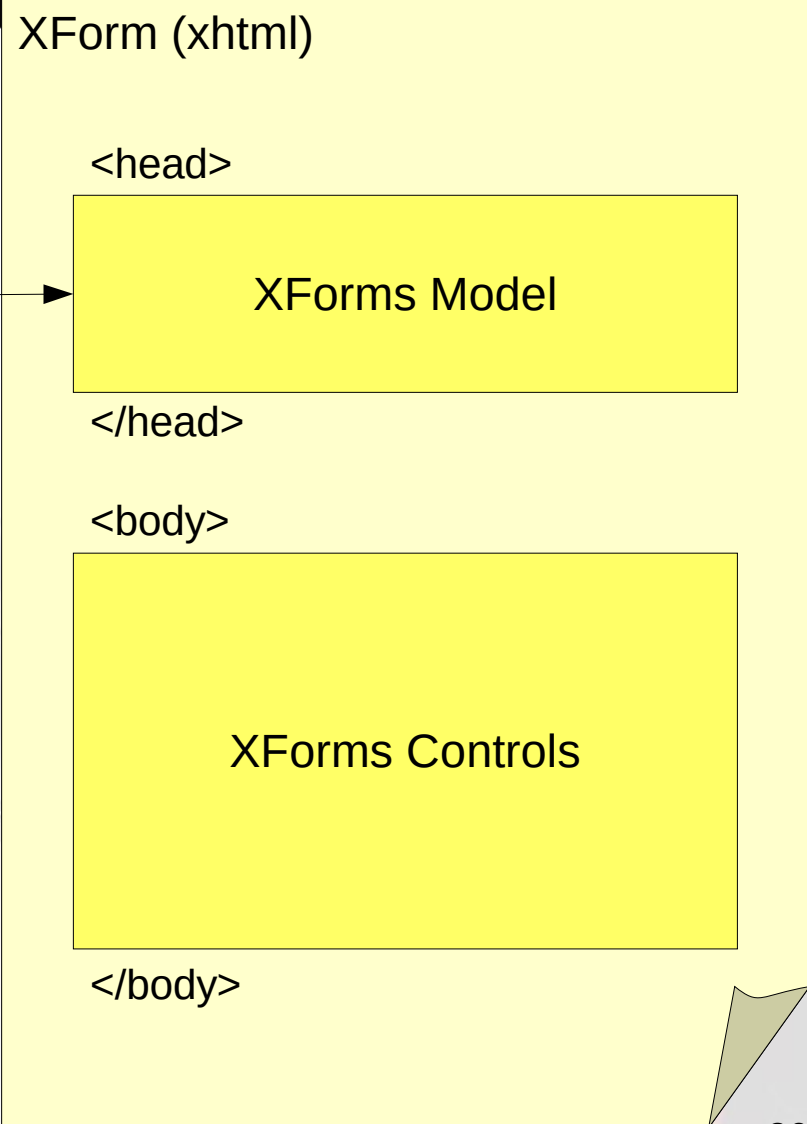
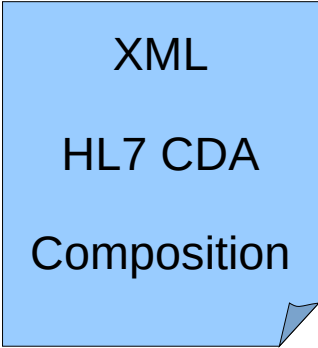
- An XRX application – XForms – REST – XQuery
- Open source, Enterprise Java
- But no Java code
- 100% Declarative Application





Dynamic XForms User Interface

Instance



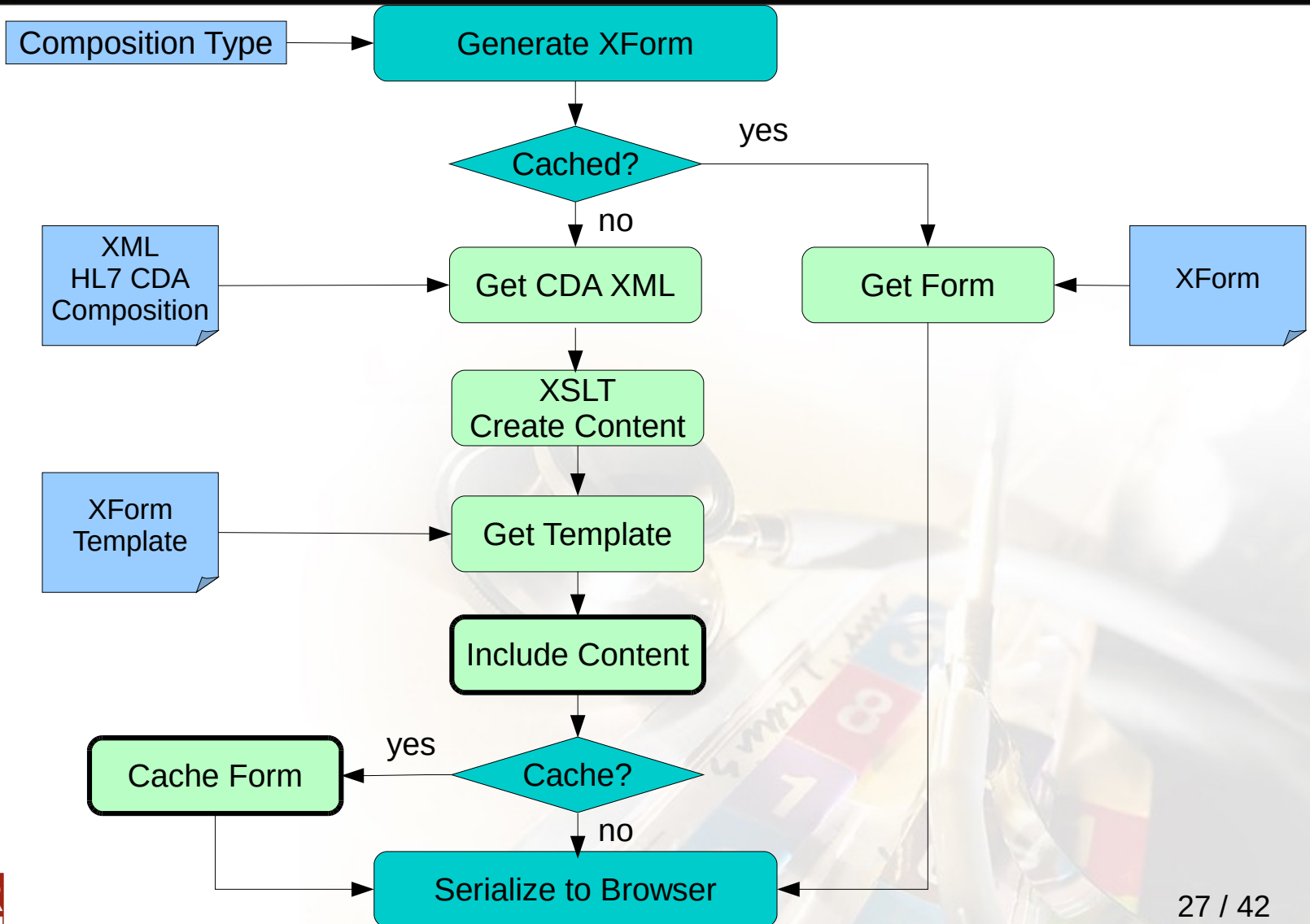
Controls depend on the XML instance

Can create directly in XForms

But cannot support arbitrary levels of nesting (for sections and clusters)



Generating XForms in a Pipeline





cityEHR

Electronic Health Records System

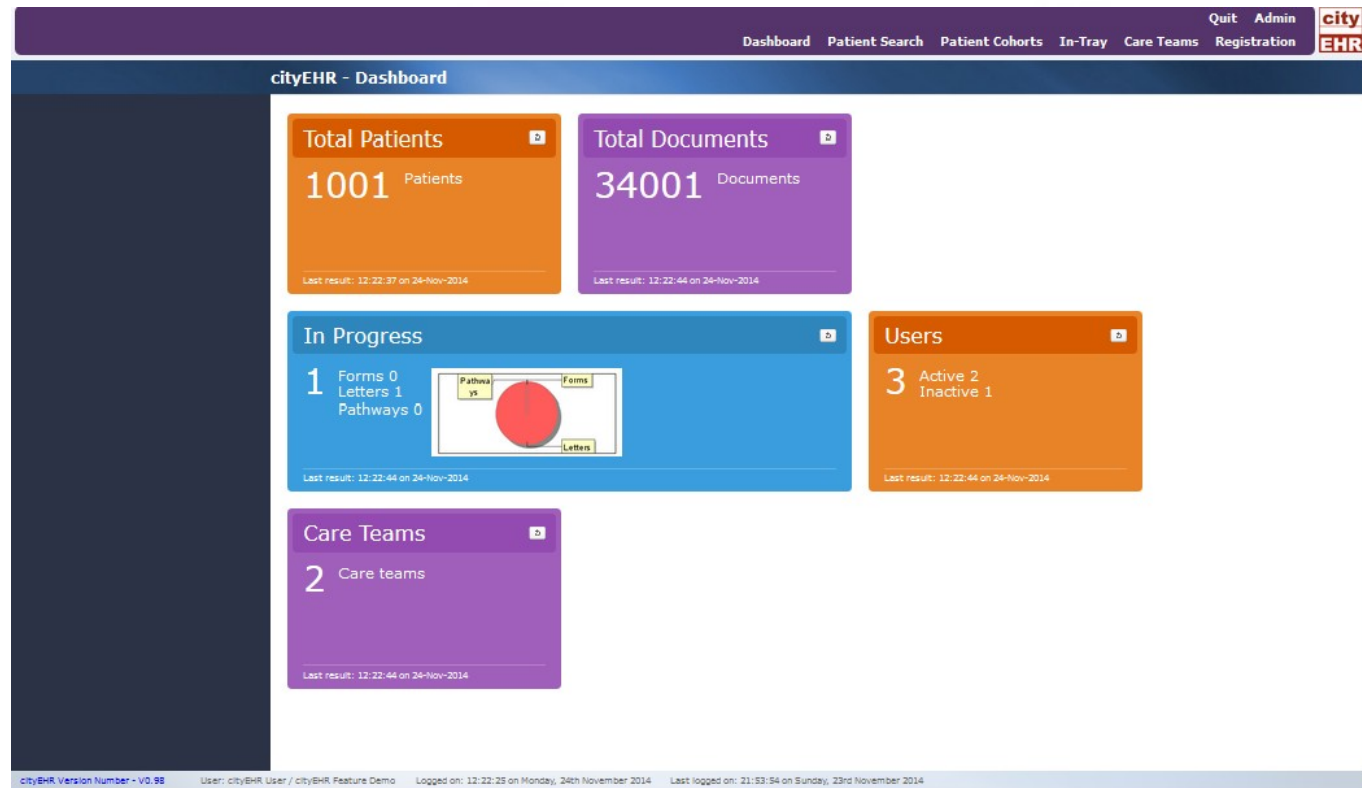
- Web-based EHR
- Open standards
- Clinician led
- One click deployment
- Enterprise scale

cityEHR Electronic Health Record
© 2013 cityEHR Limited
Open Health Informatics Research Programme
City University, London
ORCHID classification scheme, © 2013 NUH NHS Trust
✓ ✕ ← → ▶ ◀ ▶ ▲ ■ ■

cityEHR No user authenticated for this session.

Dashboard – Cross Patient Information

- Execute any database query (configurable)
- Summary of results
- Charts (Bar, Pie, Dial)



Finding Patients

- Patient search
- Linked to entries in designated CDA registration documents
- Completely configurable
- Recently accessed (from audit log)
- From clinic lists
- From in-patient lists

cityEHR

Dashboard Patient Search Patient Cohorts In-Tray Care Teams Registration

Quit Admin

Recent In-patients

K1473055 - Abernathy
K5954065 - Abernathy
M6152131 - Chumley-Warren
M4426572 - Jones
L4868424 - Hart
M9830530 - Harmon

Patient Search Jones/lars : Search time: PTO.3445 / PTO.115 | Inpatients Only Order by Surname

Patient Id Surname jones Forename lars

Gender -- Select Value --

Day of Birth -- Select Value -- Month -- Select Value -- Year Date

Consultant

Displaying 1 to 1 of 1 patients

Hospital Number	Forename	Surname	Gender	DoB
L3726574	Lars	Jones	Male	28-Jun-1975

cityEHR Version Number - V0.98 User: cityEHR User / cityEHR Feature Demo Logged on: 12:39:23 on Monday, 24th November 2014 Last logged on: 12:22:25 on Monday, 24th November 2014

cityEHR
Open Health Informatics for Electronic Health Records

Full Historic Record

- Full list of stored CDA documents
- From migrated data
- From messages
- Or from input data

ABERNATHY, Timothy (Dr) Born 08-Feb-1979 (34 years) Gender Male
Hospital Number NHS Number 1000001356

Quit Admin **cityEHR**

Dashboard Patient Search Patient Cohorts In-Tray Care Teams Registration

Events **Events** Summaries Letters Forms Pathways Care Setting: cityEHR Feature Demo Show

- ▶ Rheumatoid Arthritis Clinic (4)
- ▶ Risk Factors (1)
- ▶ Update Patient Demographics (9)
- ▶ Feature Demonstration (17)
- ▼ Hospital Anxiety and Depression Scale (8)
 - 08-Feb-2013 Hospital Anxiety and Depression Scale
 - 01-Feb-2013 Hospital Anxiety and Depression Scale
 - 29-Jan-2013 Hospital Anxiety and Depression Scale
 - 15-Jan-2013 Hospital Anxiety and Depression Scale
 - 07-Nov-2012 Hospital Anxiety and Depression Scale
 - 20-Oct-2012 Hospital Anxiety and Depression Scale
 - 15-Aug-2012 Hospital Anxiety and Depression Scale
 - 07-Mar-2012 HADS
 - ▶ DAS 28 (1)

08-Feb-2013 - Hospital Anxiety and Depression Scale

Anxiety Score
15 Moderate

Depression Score
17 Severe

I feel tense or 'wound up'
Most of the time

I still enjoy the things I used to
Not quite as much

I get a sort of frightened feeling as if something awful is about to happen
Yes, but not too badly

I can laugh and see the funny side of things
Not at all

Worrying thoughts go through my mind
A great deal of the time

I feel cheerful
Not often

I can sit at ease and feel relaxed
Usually

I feel as if I am slowed down
Very often

I get a sort of frightened feeling like 'butterflies' in the stomach
Not at all

I have lost interest in my appearance
Definitely

I feel restless as if I have to be on the move
Very much indeed

I look forward with enjoyment to things

cityEHR V0.98 User: cityEHR User Logged on: 07:08:39 on Friday, 22nd November 2013 Last logged on: 21:40:07 on Wednesday, 20th November 2013

Annotating the Historic Record

- Add annotations to historic data
- Configurable structure of annotations
- Stored as HL7 CDA
- Linked to subject document
- With notification to InTray

The screenshot displays the cityEHR interface for patient Timothy Dr. ABERNATHY, born 08-Feb-1979 (34 years), Male. The interface includes a navigation menu with options like Dashboard, Patient Search, Patient Cohorts, In-Tray, Care Teams, and Registration. The main content area shows a list of events on the left and a detailed view of a 'Hospital Anxiety and Depression Scale' event from 08-Feb-2013. An annotation is added to this event, stating 'This patient is severely depressed please handle with care' with an 'Alert' type and a 'Nurse' notification role. Below the annotation, the scale results are shown: Anxiety Score 15 (Moderate) and Depression Score 17 (Severe). The scale items and their responses are listed below.

Date	Type	Comments	Action	Notify
12:21:01 on 22-Nov-2013	Alert	This patient is severely depressed please handle with care	Notify Role	Nurse

Anxiety Score
15 Moderate

Depression Score
17 Severe

I feel tense or 'wound up'
Most of the time

I still enjoy the things I used to
Not quite as much

I get a sort of frightened feeling as if something awful is about to happen
Yes, but not too badly

I can laugh and see the funny side of things
Not at all

Worrying thoughts go through my mind
A great deal of the time

I feel cheerful
Not often

I can sit at ease and feel relaxed
Usually

I feel as if I am slowed down
Very often

I get a sort of frighened feeling like 'butterflies' in the stomach
Not at all

cityEHR V0.98 User: cityEHR User Logged on: 07:08:39 on Friday, 22nd November 2013 Last logged on: 21:40:07 on Wednesday, 20th November 2013

Clinical Data Entry

- All data relationships and behaviour are defined in the information model
- Conditional sections, entries, clusters, elements
- Calculated values (elements)
- Multiple entries
- Pre-filled entries
- Default values
- Constraints
- Hints
- Supporting information
- Required values
- Layout
- Rendition
- Reference data look-up

ABERNATHY, Timothy Born 28-Mar-1979 (34 years) Gender Male
K1476889 NHS Number 1000001356

Dashboard Patient Search Clinic Lists Patient Cohorts

Quit Admin

In Progress New Hide Patient Record Summaries Forms Care Setting: Rheumatology

▼ Rheumatology (26)

15-Jul-2013 - HADS

Hospital Anxiety and Depression Scale

Anxiety Score 14 Moderate
Depression Score 9 Mild

I feel tense or 'wound up'	Most of the time
I still enjoy the things I used to enjoy	Not quite as much
I get a sort of frightened feeling as if something awful is about to happen	Yes, but not too badly
I can laugh and see the funny side of things	Not quite so much now
Worrying thoughts go through my mind	From time to time, but not too often
I feel cheerful	Most of the time
I can sit at ease and feel relaxed	Usually
I feel as if I am slowed down	Very often
I get a sort of frightened feeling like 'butterflies' in the stomach	Occasionally
I have lost interest in my appearance	I don't take as much care as I should
I feel restless as I have to be on the move	Very much indeed
I look forward with enjoyment to things	Rather less than I used to
I get sudden feelings of panic	Very often indeed
I can enjoy a good book or radio or TV program	Not often

ORCHID V0.98 User: cityEHR User Logged on: 14:11:52 on Monday, 15th July 2013 Last logged on: 02:57:03 on Monday, 15th July 2013

Graphical Input of ISO-13606 Entry

- Link any image with an ISO-13606 entry
- Define an image map, linking to ISO-13606 elements
- Data input is through click on the image
- Only affects the rendition of the entry
 - All other aspects of the data are identical to form-based renditions

ABERNATHY, Timothy Born 28-Mar-1979 (34 years) Gender Male
K1476889 NHS Number 1000001356

Dashboard Patient Search Clinic Lists Patient Cohorts

Quit Admin

In Progress New Hide Patient Record Summaries Forms Care Setting: Rheumatology

Psoriatic Arthritis Clinic
Rheumatoid Arthritis Clinic
SLE Clinic
BATH Indices
DAS 28
DAS 68
Disease Activity Score
Fracture Record
PASI
PsARC
SLEDAI
EQ-5D
HADS
HAQ
Mini Nutritional Assessment
RAND 36-Item Short Form Health Survey
RODNAN
WHOQOL-BREF

15-Jul-2013 - DAS 68

Disease Activity Score

Swollen Joints 6 Tender Joints 4

ESR 45
CRP 65
Visual Analogue Scale 3
DAS Score (ESR) 4.5
DAS Score (CRP) 4.3

ORCHID V0.98 User: cityEHR User Logged on: 14:11:52 on Monday, 15th July 2013 Last logged on: 02:57:03 on Monday, 15th July 2013

Graphical Input of Multiple Entries

- Link any image with an ISO-13606 entry
- Define an image map, linking to one ISO-13606 element
- Data input is through click on the image
- Each click adds a new entry to the record
- Only affects the rendition of the entry
 - All other aspects of the data are identical to form-based renditions

ABERNATHY, Timothy Born 28-Mar-1979 (34 years) Gender Male
K1476889 NHS Number 100001356

Dashboard Patient Search Clinic Lists Patient Cohorts

Quit Admin

Show Patient Record Summaries Forms Care Setting: Rheumatology

15-Jul-2013 - Fracture Record

Fractures

Fracture Site	Type	Trauma level
01-7-2013 Left Shaft Humerus	-- Select --	-- Select --
01-7-2013 Left Maxilla	-- Select --	-- Select --
01-7-2013 Right Phalanges (hand)	-- Select --	-- Select --

ORCID V0.98 User: cityEHR User Logged on: 14:11:52 on Monday, 15th July 2013 Last logged on: 02:57:03 on Monday, 15th July 2013

Charts of Historic Data

- Available for recognised data patterns
- For an longitudinal data sets
- Generated as SVG graphics
- As trends or interval plots
 - Laboratory test results
 - Start and stop dates for medications

The screenshot displays the 'Charting' interface in cityEHR. The patient information at the top is: **ABERNATHY, Timothy (Dr)** Born 08-F, Hospital Number, NHS Number 100000. The left sidebar shows a navigation menu with options like 'Basic Summary View', '01-Jan-2000 - Basic Patient Data', 'Basic Longitudinal Data View', 'Registration Event Summary', 'Bone Chemistry Results', 'Medication History', 'Diagnosis History', 'Laboratory Test Results', 'Patient Alerts', 'Patient Administration (1)', and 'Clinical Care (2)'. The main charting area has controls for 'Close', 'Refresh', 'Start' (18-9-2007), 'Interval' (6), 'Years', and 'Plots' (Combined). A legend identifies three data series: Calcium (green), P1NP (red), and CTX (magenta). The top graph shows Calcium (green line with triangles) and CTX (magenta line with triangles) from 2008-04-01 to 2012-02-21. The bottom graph shows P1NP (red line with triangles) over the same period. The interface also includes a top navigation bar with 'Quit Admin', 'Teams Registration', and 'cityEHR' logos, and a bottom status bar with 'cityEHR V0.98', 'User: cityEHR User', and 'Logged on: '.

Date	Calcium	P1NP	CTX
2008-04-01	2.5	75	0.5
2008-10-21	2.8	50	0.8
2009-05-12	2.5	100	1.0
2009-12-01	2.4	120	1.0
2010-06-22	2.3	140	1.1
2011-01-11	2.3	80	0.9
2011-08-02	2.4	100	0.9
2012-02-21	2.5	150	0.9

Letters – Integrated Part of the Record

- Created as CDA documents
- Using same modelling tools as other documents
- Stored as HL7 CDA
- Printed (exported) as
 - PDF
 - MS Word

The screenshot displays a patient record interface for **BREAM, Barnabus (Mr)**, born 03-Sep-2012 (12 months), Gender Male. The interface includes a navigation menu with options like "In Progress", "Add New Letter", "Patient Record", "Summaries", "Enter Patient Data", "Letters", and "Care Setting: Nuffield Orthopaedic Centre". A list of letters is shown on the left, with the most recent being "20-Aug-2013 Patient Letter". The main area shows a preview of this letter, which includes the following text:

OXFORD

Consultants: Dr M. Kassim Javaid
Clinical Assistant: Dr Sally Hope
Clinical Nurse Team: Kerri Rance, Carol W
Clinical DXA: Julie Aston; HCA: Leonora L

Mr Bream
21 Basham Street
Oxford
OX2 7HJ

Dear Mr Bream

You were recently seen by cityEHR User from fractured your Femur

This letter is a summary of your treatment plan

The right side of the screenshot shows a PDF preview of the letter, titled "document-247.pdf (page 2 of 2)". The PDF content includes:

Patient id: 1234567892

What are my choices to reduce fracture risk?

The most important choices for you are:

- #ORCHID-Class:Drugs:risetromide drug therapy for 3 years.
This medication is taken with a large glass of tap water once a week after fasting overnight at least half an hour before any food, drink or other medication. You must also remain upright or standing for this half hour. Please read the information leaflet carefully as it is important you follow the instructions exactly to get benefits from your treatment.
- You need calcium to make sure your medication works to strengthen your bones.
No specific recommendations for you
- Vitamin D is needed for your medication to work to strengthen your bones.
Your level is low and we will provide you with high strength Vitamin D tablets that you need to take as per the instructions on the bottle. We have given you one years supply. If you have been recommended Calcium and Vitamin D tablets, continue them in addition to these new tablets.
- No specific recommendations for you
- No specific recommendations for you
- No specific recommendations for you

Page [2] of [2]

Secondary Uses of Clinical Data

- Cohort search using terms built from the data dictionary
- Use entry/element in clinical context
- Combine cohorts
- Export cohorts, with specified data sets
- as HL7 CDA
- as spreadsheet
- (anonymised)

The screenshot displays the cityEHR Cohort Search interface. At the top, there is a navigation bar with links for Dashboard, Patient Search, Patient Cohorts, In-Tray, Care Teams, and Registration. The main content area is titled 'Cohort Search' and includes a search configuration section. The search configuration shows 'Observation' set to 'Blood Pressure' with two criteria: 'Systolic' greater than 130 and 'Diastolic' greater than 90. Below the configuration is a table of search results.

All None	ID	Search Term	Cohort
<input type="checkbox"/>	4	(Age in Years greater than 50) AND (Gender equal to Male)	(5)
<input type="checkbox"/>	3	Age in Years greater than 50	(7)
<input type="checkbox"/>	2	Gender equal to Female	(11)
<input type="checkbox"/>	1	Gender equal to Male	(15)

At the bottom of the interface, there is a status bar with the following information: cityEHR V0.98, User: cityEHR User, Logged on: 14:34:55 on Friday, 22nd November 2013, Last logged on: 14:30:07 on Friday, 22nd November 2013.

Care Pathways as CDA Documents

- Pathways modelled as CDA documents
- Using same modelling tools as other documents
- Stored as HL7 CDA
- In progress
- and when complete
- forms part of the record

The screenshot displays the cityEHR interface for a patient named Timothy ABERNATHY (Dr), born 08-Feb-1979 (34 years), male. The patient's hospital and NHS numbers are 1000001356. The interface shows a navigation menu with options like Dashboard, Patient Search, Patient Cohorts, In-Tray, Care Teams, and Registration. The main content area is titled '22-Nov-2013 - Manage Weight In Progress'. On the left, there is a sidebar with options: Manage Weight, Enter Data, Follow Up, and Monitor Patient. The main area contains three sections for data entry:

- Enter Data:** Status: Outcome: **To be confirmed**
- Enter BMI Data:** *Only enter these data if you are sure you know what you are doing*
Role: Delay (days): Status: Outcome: **To be confirmed**
- Follow Up:** BMI is 20.2
Status: Outcome: **To be confirmed**
- Follow Up in One Year:**
Role: Delay (days): Status: Outcome: **To be confirmed**

At the bottom, the footer shows 'cityEHR V0.98', user 'cityEHR User', and login/logout timestamps for Friday, 22nd November 2013.



In-Tray – Collaboration for Care Teams

- List of notifications for the user
- Can be actions in pathways
- Or annotations on events
- Click directly through to the patient record

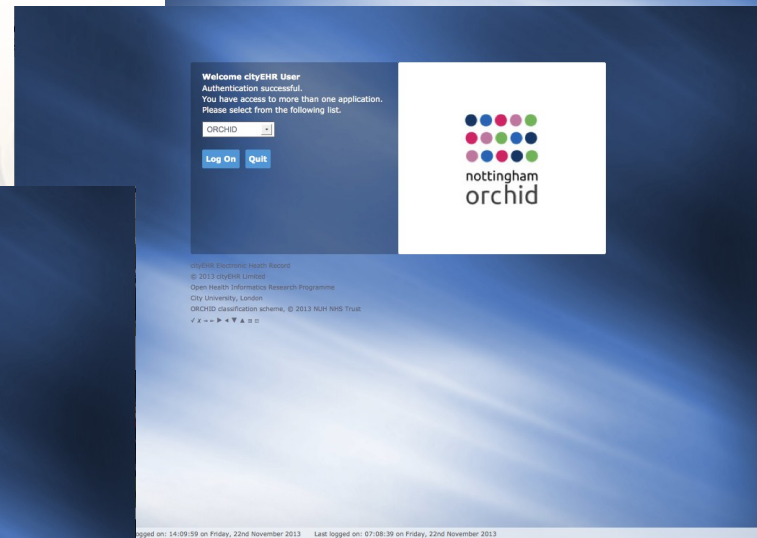
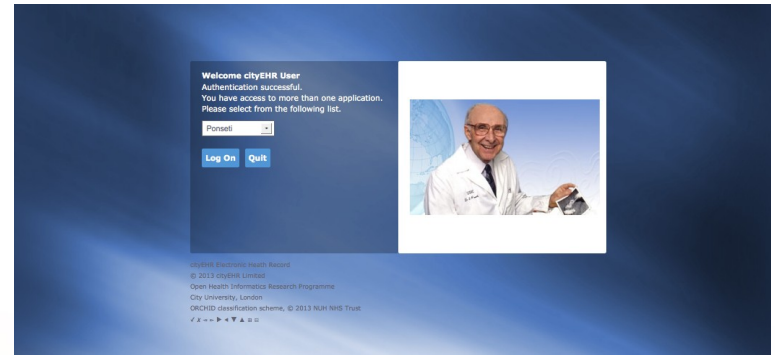
The screenshot displays the 'In-Tray' section of the cityEHR system. At the top, there is a navigation bar with links for 'Dashboard', 'Patient Search', 'Patient Cohorts', 'In-Tray', 'Care Teams', and 'Registration'. The 'In-Tray' link is highlighted. Below the navigation bar, there are tabs for 'New', 'In Progress', and 'Old', with 'In Progress' selected. A sidebar on the left contains a list of actions, each with a timestamp, date, and patient ID. The main content area shows the details for the selected action, including the patient's name, birth date, gender, hospital number, and NHS number. A red warning icon is present next to the NHS number. The footer of the interface shows the user's login information and the current date and time.

cityEHR
Open Health Informatics for Electronic Health Records

cityEHR V0.98 User: cityEHR User Logged on: 07:08:39 on Friday, 22nd November 2013 Last logged on: 21:40:07 on Wednesday, 20th November 2013

NHS Implementations

- Ponseti database – club foot clinics
 - Chelsea and Westminster
 - Manchester Children’s Hospital
- ORCHID – clinical data for biobank
 - Nottingham University Hospital
- Elfin – pathways for fracture prevention
 - Nuffield Orthopaedic Centre, Oxford





John Chelsom
Seven Informatics
john.chelsom@seveninformatics.com



13th – 18th September 2020
xmlsummerschool.com