Open Source, Model-Driven Electronic Health Records with Interactive Graphics

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Health Records at the Mayo Clinic, 1907

The use of properly organised patient records, or case notes, has a surprisingly short history, having first been introduced at the Mayo Clinic by Dr Henry S. Plummer in 1907.

These 'patient dossiers' provided the first model for the organisation of patient information and key features of that model can still be seen in today's electronic records.

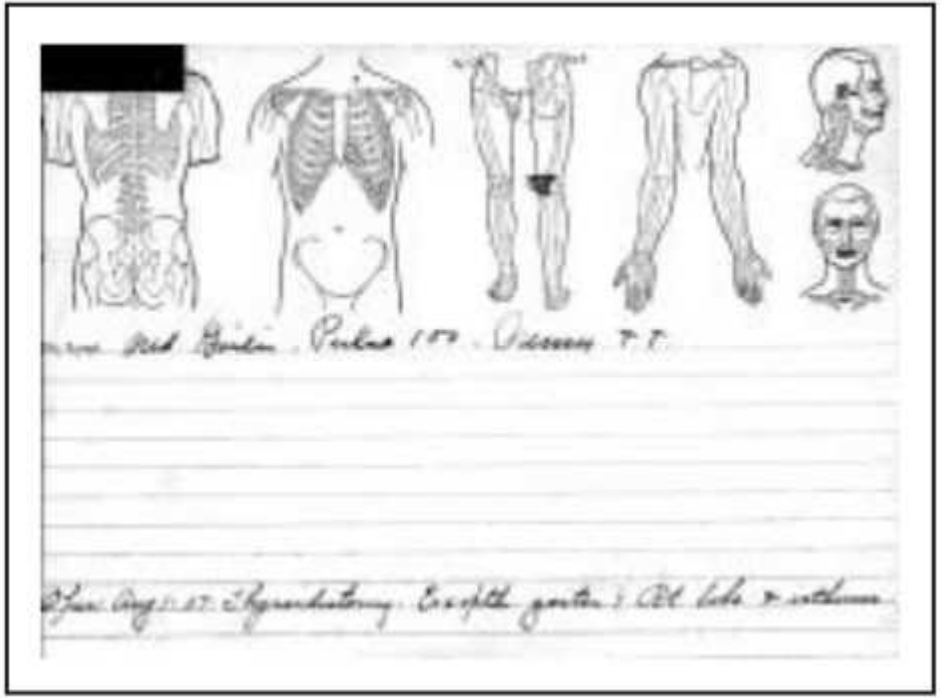
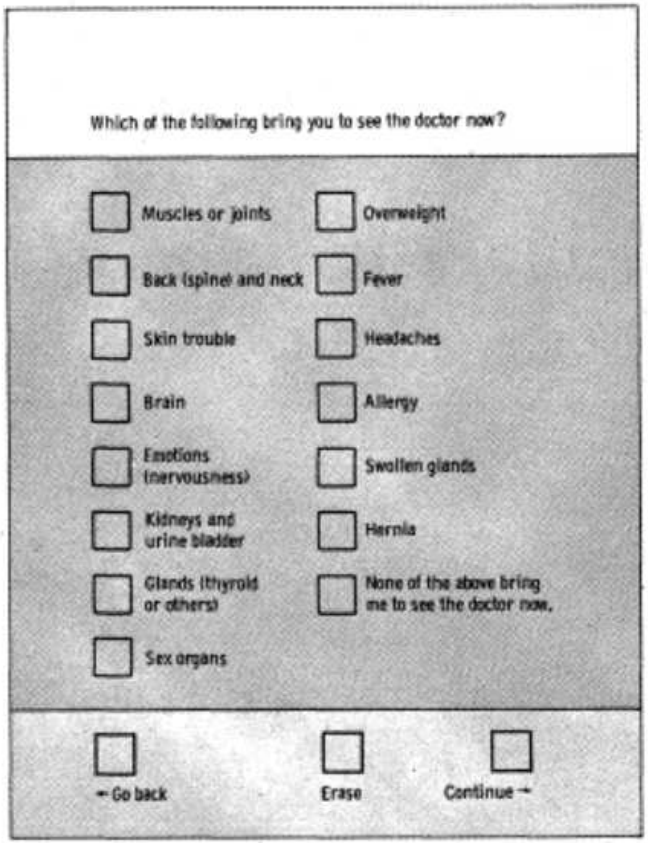


FIGURE 2. Back of 1907 patient chart documenting objective symptoms and operative note.

Camp, C.L., Smoot, R.L., Kolettis, T.N., Groenewald, C.B., Greenlee, S.M. and Farley, D.R., 2008, December. Patient records at Mayo Clinic: lessons learned from the first 100 patients in Dr Henry S. Plummer's dossier model. In Mayo Clinic Proceedings (Vol. 83, No. 12, pp. 1396-1399). Elsevier.

Mayo Clinic, 1968



Experiments with electronic health records at the Mayo Clinic in the 1960's.

Patients completed questionnaires as they waited for the consultation with their physician.

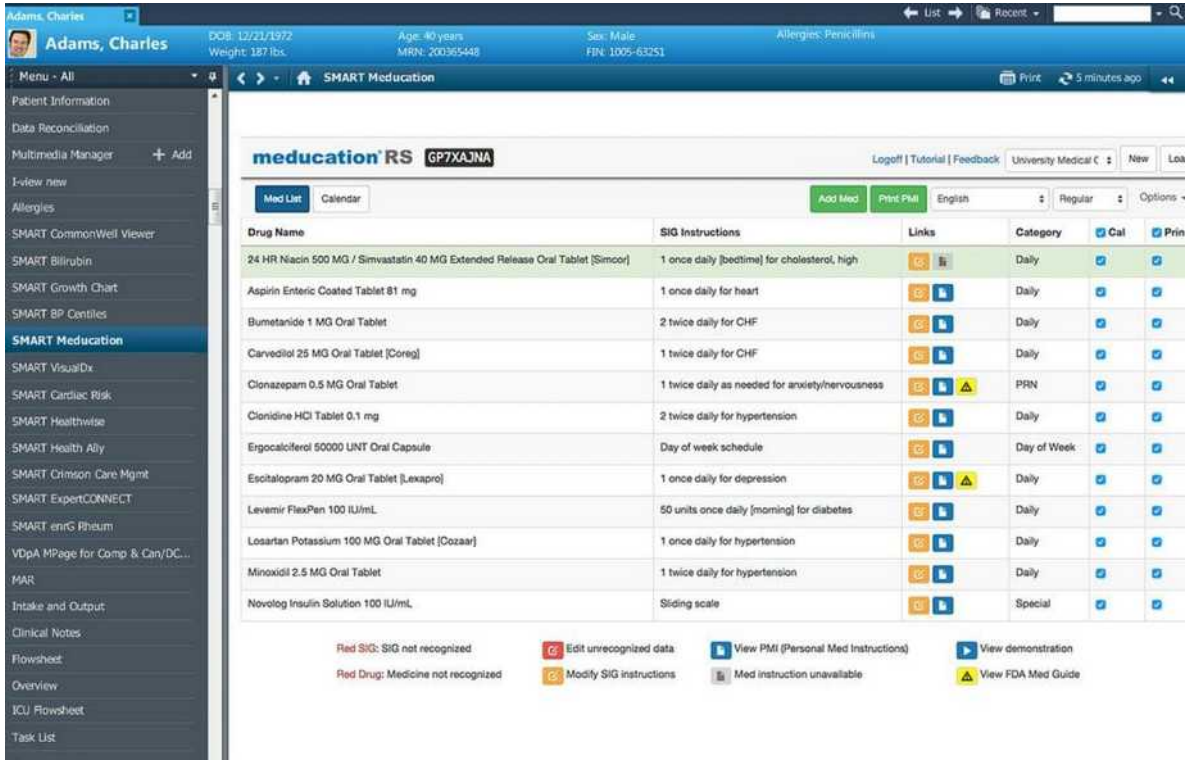
Their answers were made using a light pen and recorded electronically.

The physician was able to view the electronic responses during the clinic consultation.

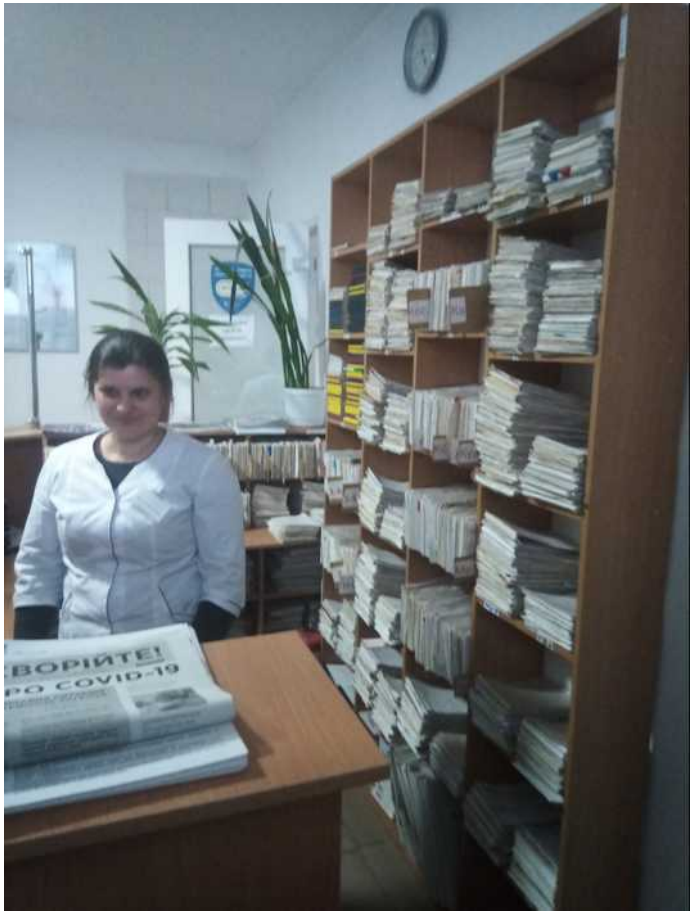
Weksel, W., Sholtz, P.N. and Mayne, J.G., 1968, December. The automated medical history. In Proceedings of the December 9-11, 1968, fall joint computer conference, part I (pp. 371-379).

Needs met by Major EPR Vendors

www.epic.com
www.nextgen.com
www.cerner.com
www.allscripts.com
www.eclinicalworks.com



Paper Based Health Records

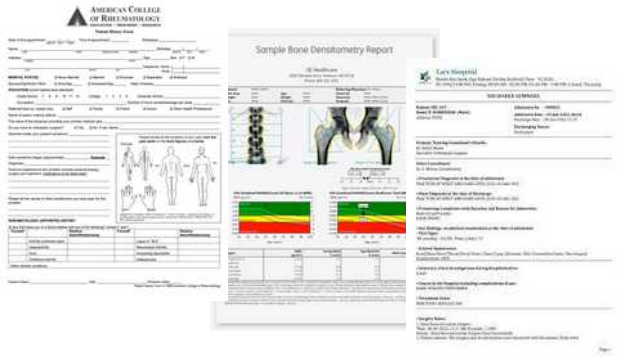


Ambulatory Center, Rivne Oblast, Ukraine

Health records stored in filing cabinet

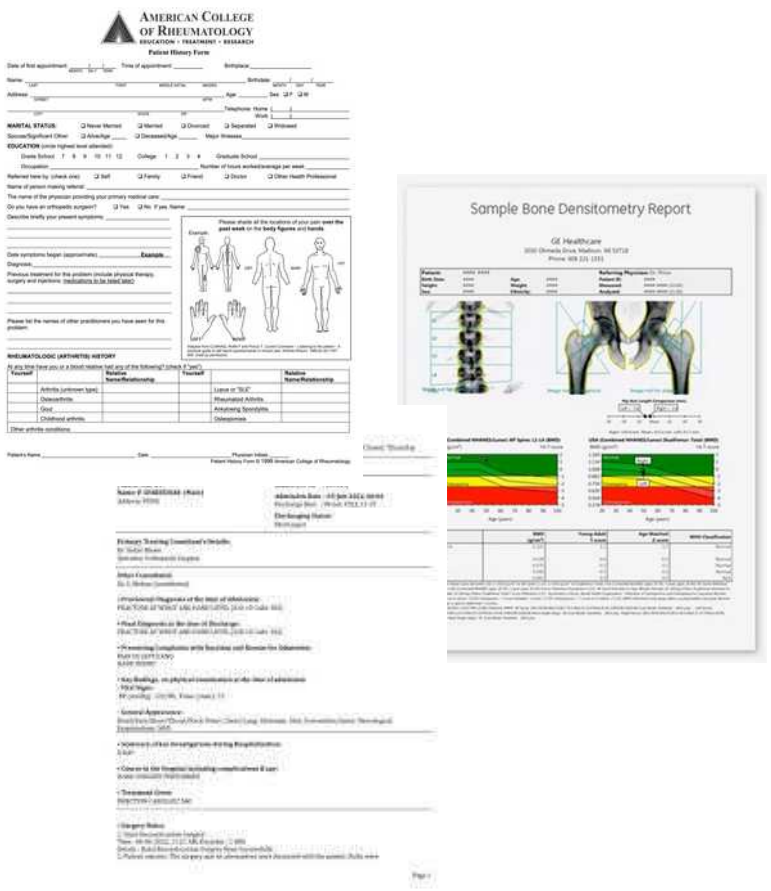
Each patient record in a suspension file

Each record a set of documents, sorted into folders



The folders contain the patient record as a set of documents

Clinical Documents



The information in the health record is held as a set of documents.

Typically, documents are organised into different sections, to make then easier to read.

Specific observations or findings are then recorded as entries within the sections

Two international standards use the concept of document-based Electronic Heath Records

- HL7 CDA – Clinical Document
- ISO 13606 – Composition

ISO 13606 Reference Model

EHR_EXTRACT - The electronic health record for one person

FOLDER - High-level organisation of the EHR e.g. per episode, per clinical specialty

COMPOSITION - A clinical care session, encounter or document e.g. test result, letter

SECTION - Clinical headings reflecting the workflow and consultation process

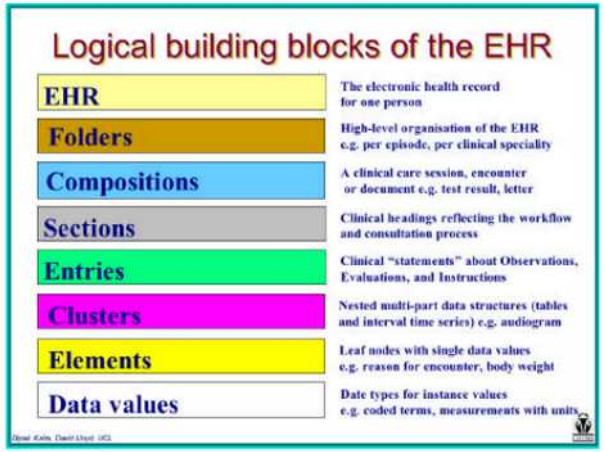
ENTRY - Clinical statements about Observations, Evaluations and Instructions

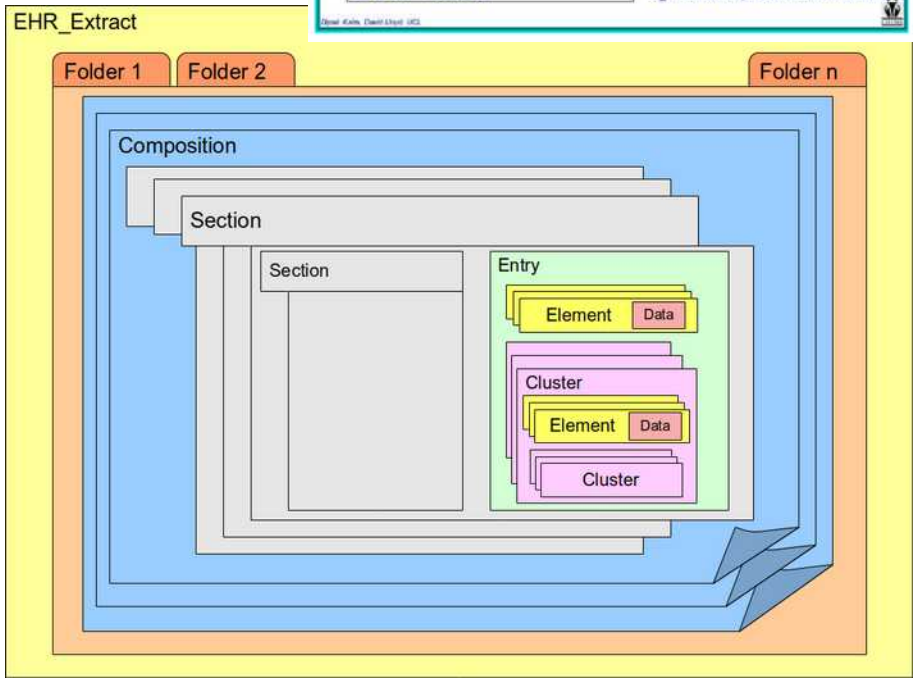
CLUSTER - Nested multi-part data structures (tables and interval time series) e.g. audiogram

ELEMENT - nodes with single data values e.g. reason for encounter, body weight

DATA - Data types for instance values e.g. coded terms, measurements with units

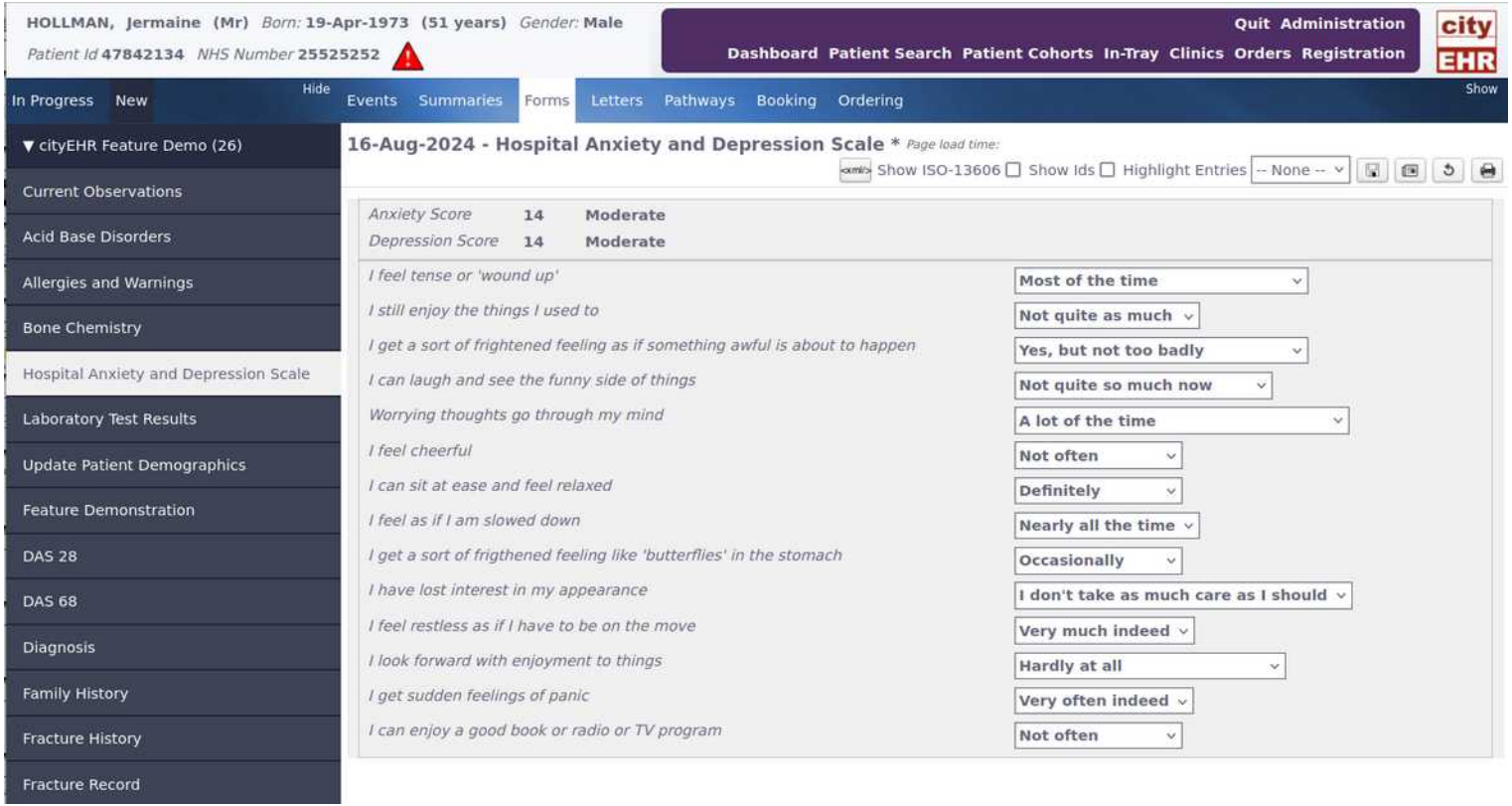
Kalra, D., 2006. Electronic health record standards. Yearbook of medical informatics, 15(01), pp.136-144.





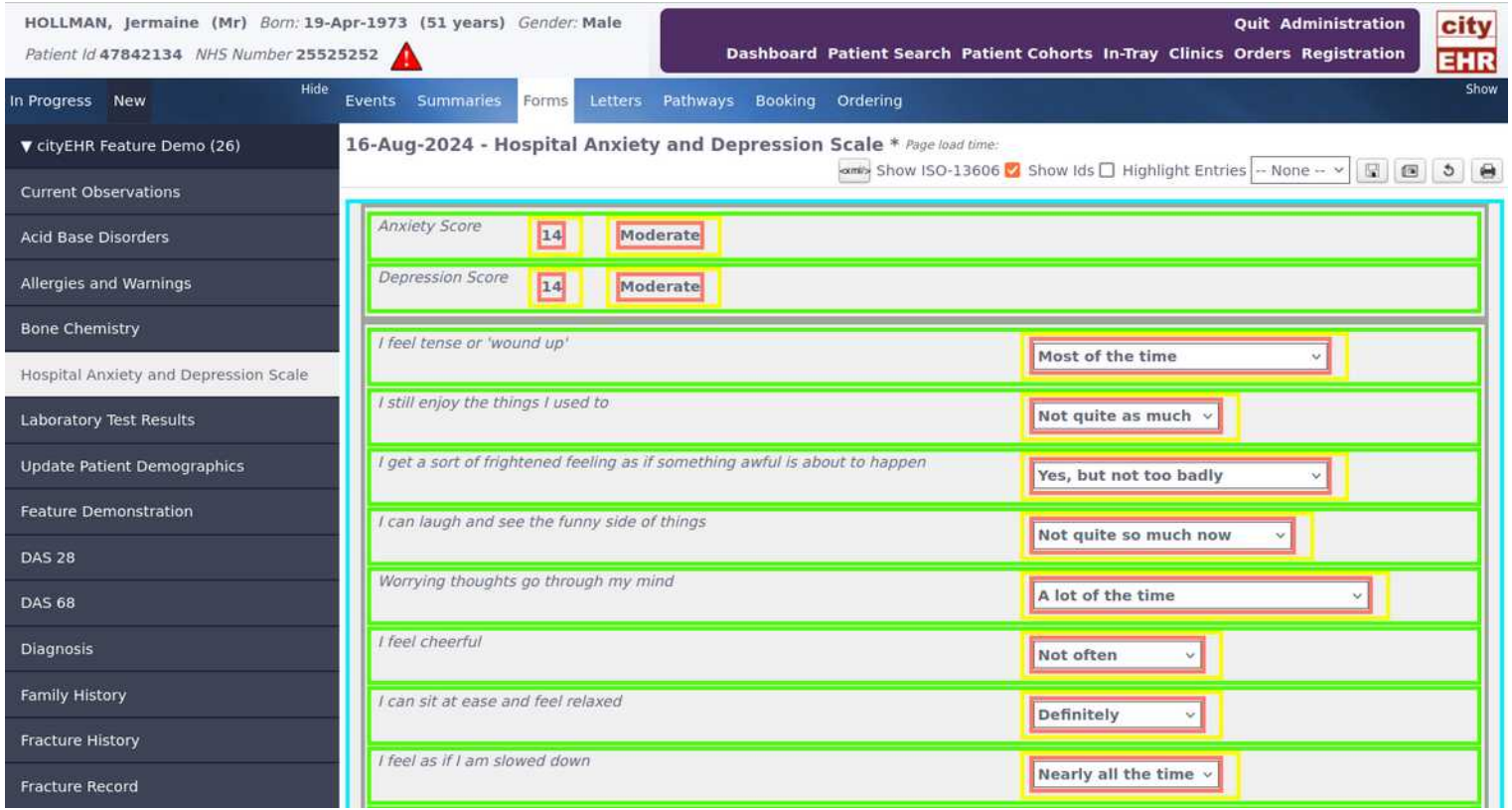
Open Source, Open Standards

cityEHR is an open source Electronic Health Record, built using open standards



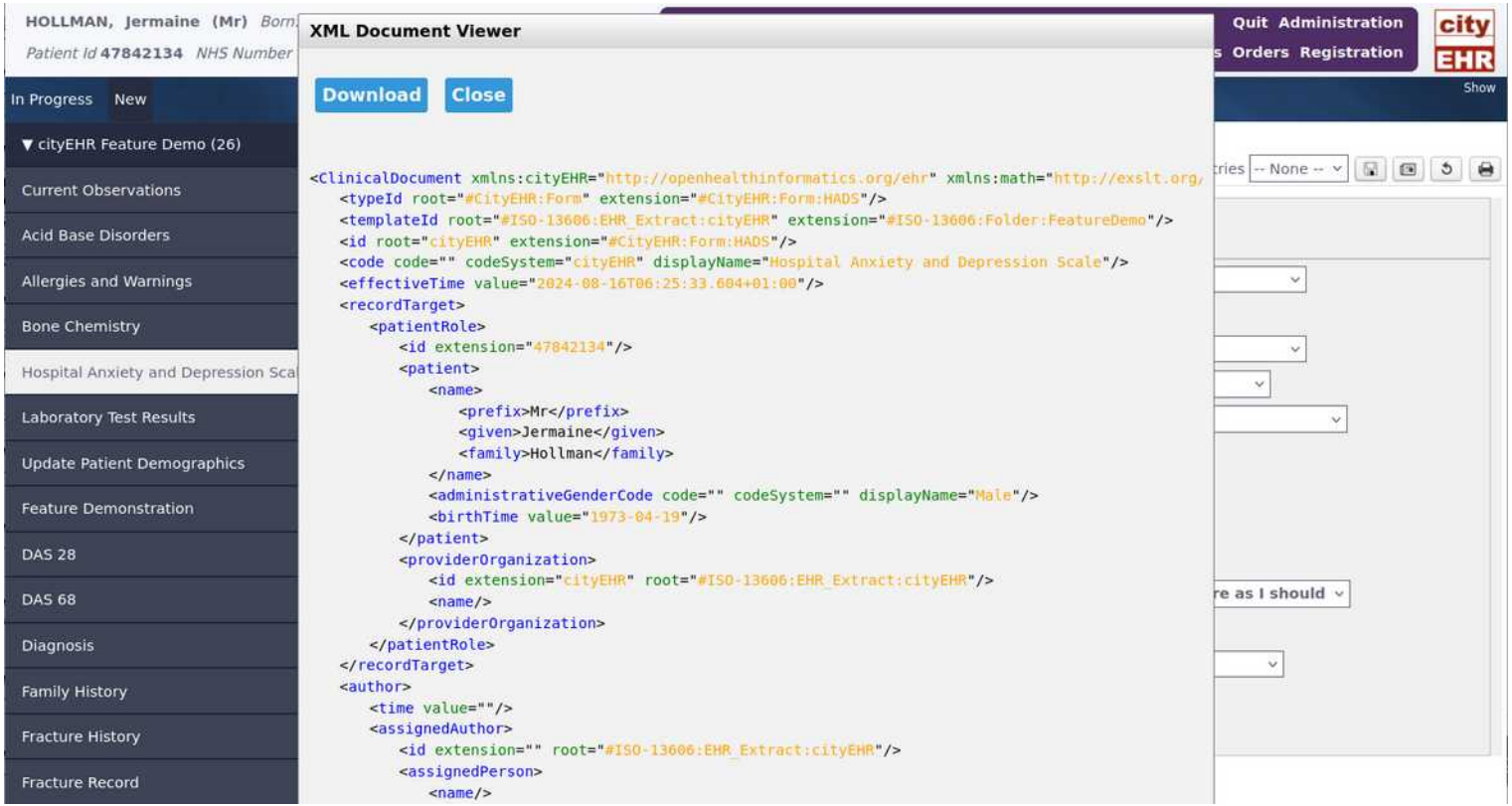
Document-Based Using ISO 13606

cityEHR uses the reference model of EHR defined by the ISO 13606 standard



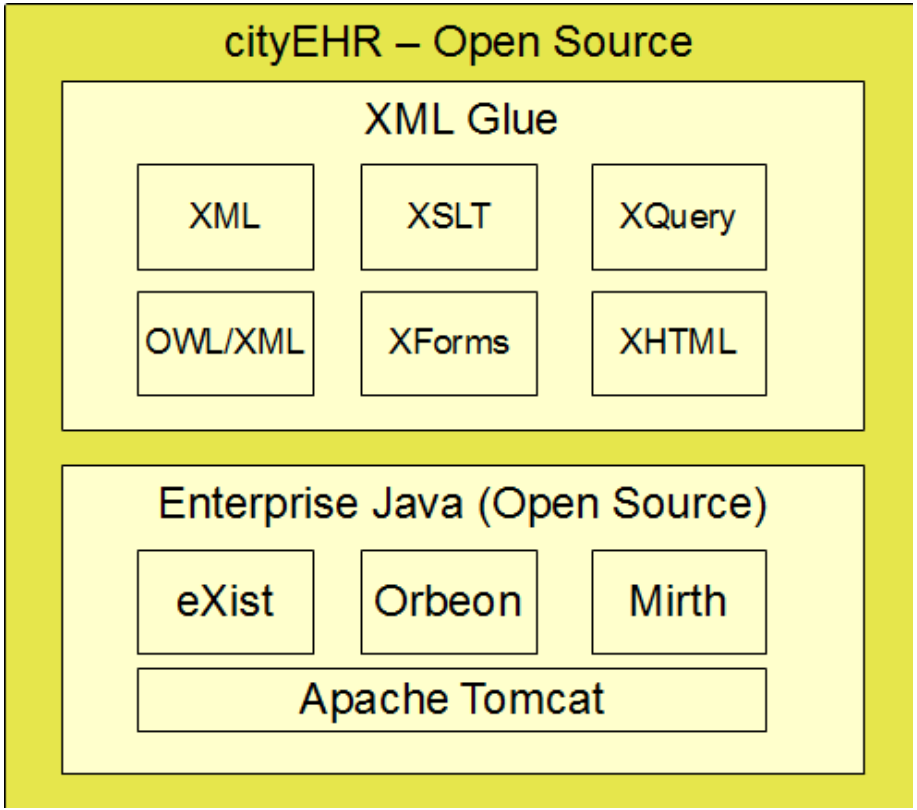
Document-Based Using HL7 CDA

cityEHR stores the health record as XML documents using the HL7 CDA standard

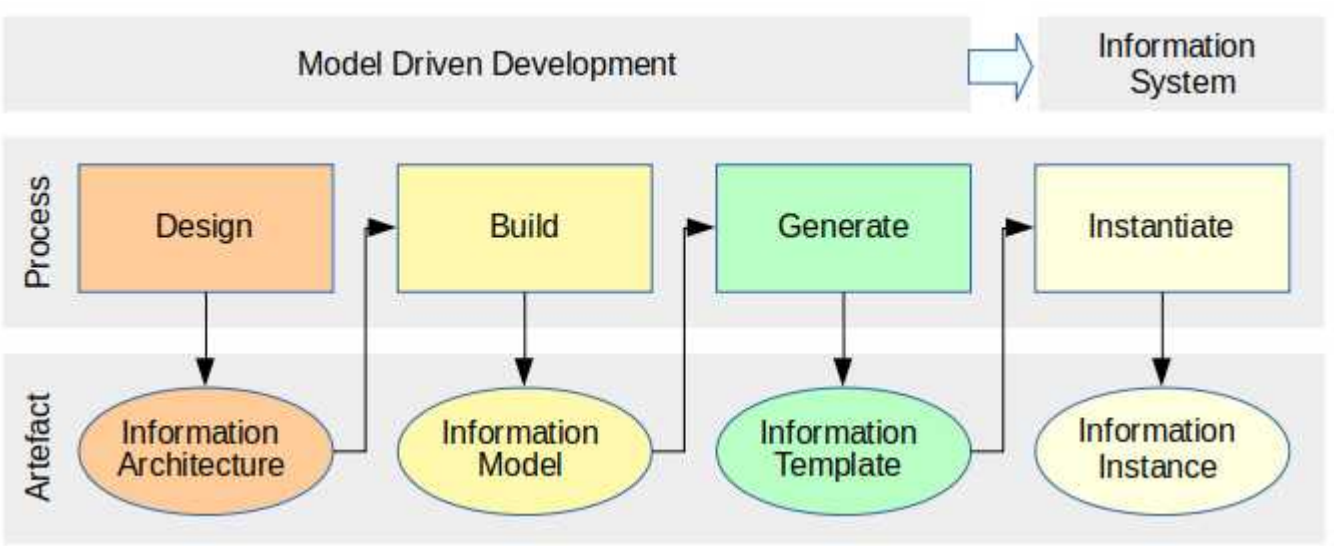


Open Source for cityEHR

- cityEHR is built using open source software
- An enterprise-scale health records system
- An XRX application – XForms – REST – XQuery
- Initial research at City University, London
- Distributed under the LGPL license



Architecture and Models



Agreement (national) on the Design of a Clinical Information Architecture allows for...

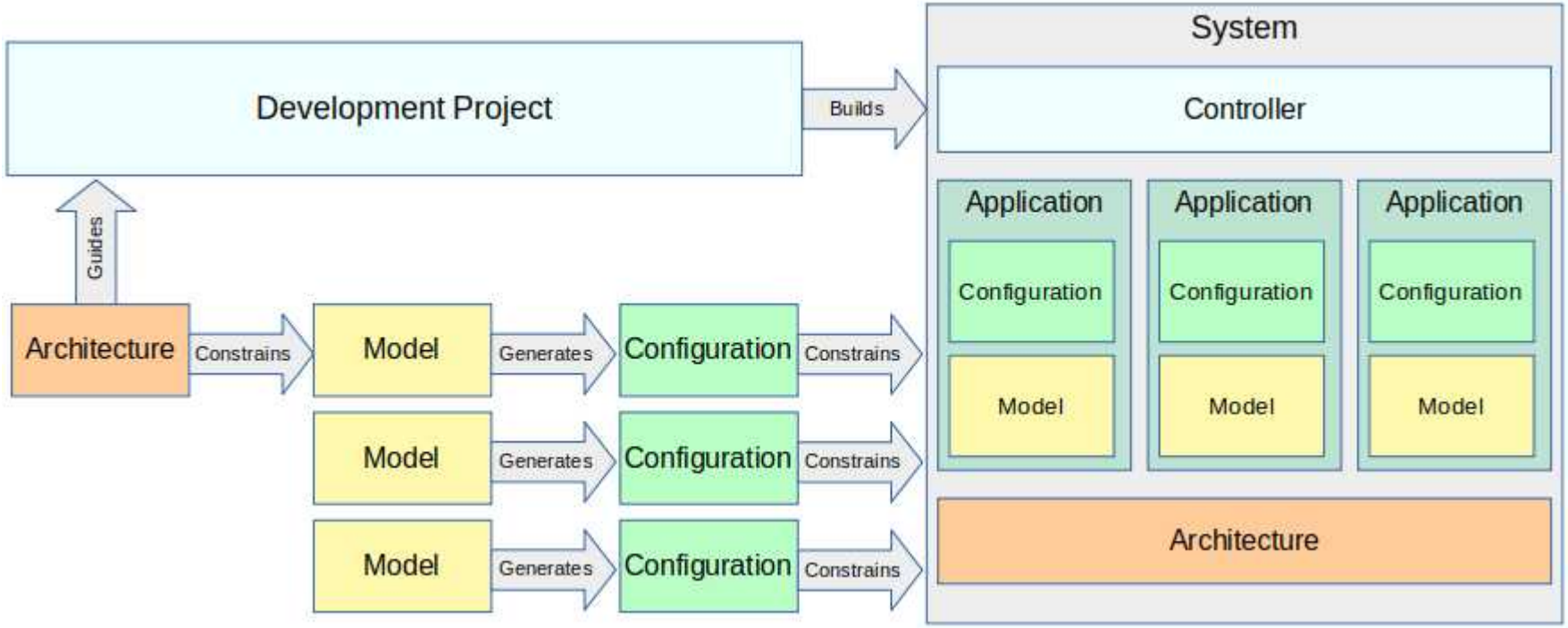
Information Models to be developed locally, which then generate the templates used to...

instantiate the Clinical Information gathered and used for clinical care and research

Model-Driven Clinical Systems

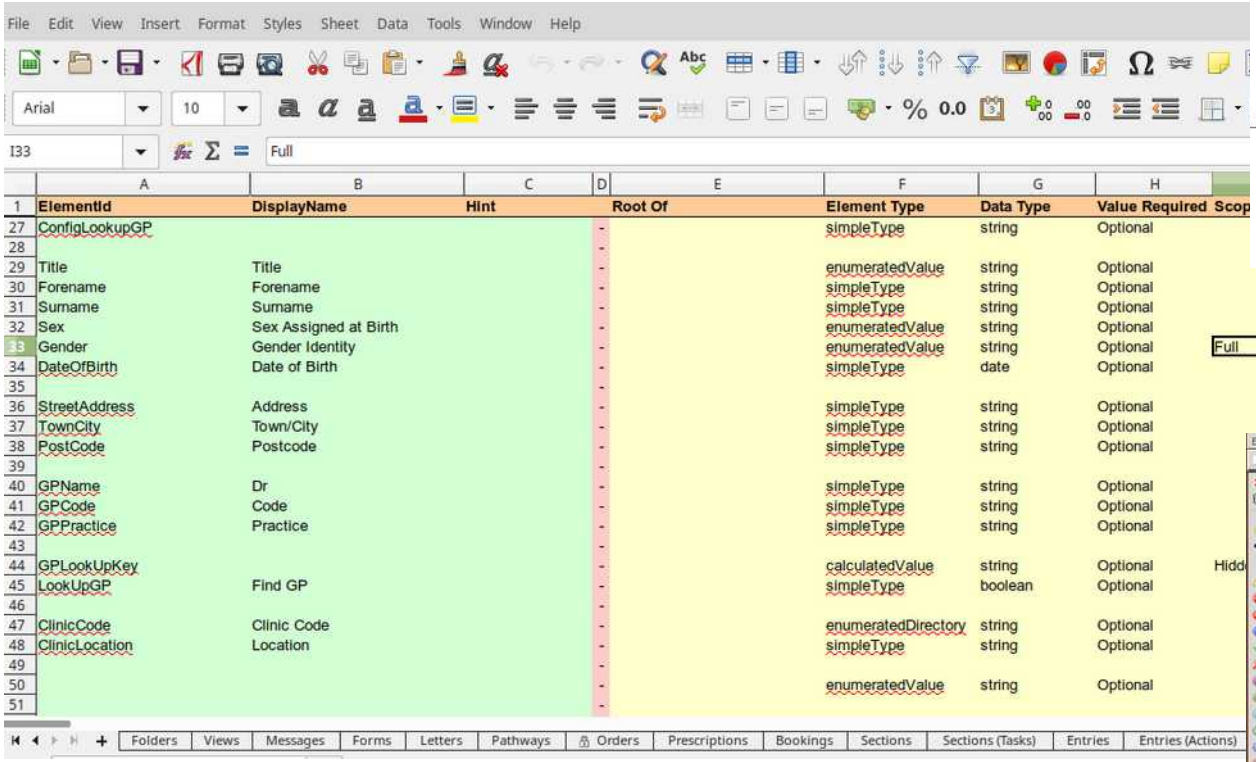
Using the EHR framework, clinicians can develop their own clinical information models.

Then deploy them as enterprise-scale EHR, conforming to the architectural standards

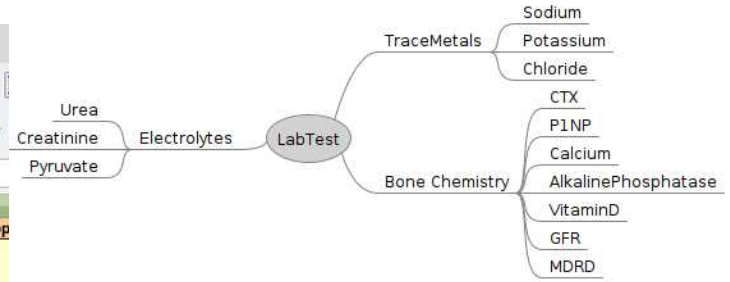


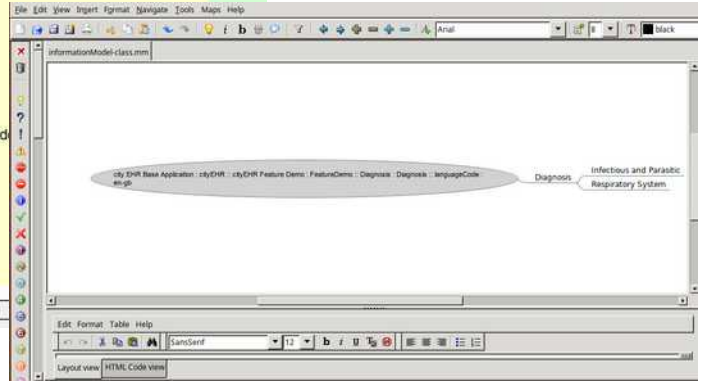
Clinical Information Models Created by Clinicians

Clinicians use familiar tools to create information models that meet their needs



	ElementId	DisplayName	Hint	Root Of	Element Type	Data Type	Value Required	Scop
27	ConfigLookupGP				simpleType	string	Optional	
28								
29	Title	Title			enumeratedValue	string	Optional	
30	Forename	Forename			simpleType	string	Optional	
31	Surname	Surname			simpleType	string	Optional	
32	Sex	Sex Assigned at Birth			enumeratedValue	string	Optional	
33	Gender	Gender Identity			enumeratedValue	string	Optional	Full
34	DateOfBirth	Date of Birth			simpleType	date	Optional	
35								
36	StreetAddress	Address			simpleType	string	Optional	
37	TownCity	Town/City			simpleType	string	Optional	
38	PostCode	Postcode			simpleType	string	Optional	
39								
40	GPName	Dr			simpleType	string	Optional	
41	GPCode	Code			simpleType	string	Optional	
42	GPPractice	Practice			simpleType	string	Optional	
43								
44	GPLookUpKey				calculatedValue	string	Optional	Hidd
45	LookUpGP	Find GP			simpleType	boolean	Optional	
46								
47	ClinicCode	Clinic Code			enumeratedDirectory	string	Optional	
48	ClinicLocation	Location			simpleType	string	Optional	
49								
50					enumeratedValue	string	Optional	
51								



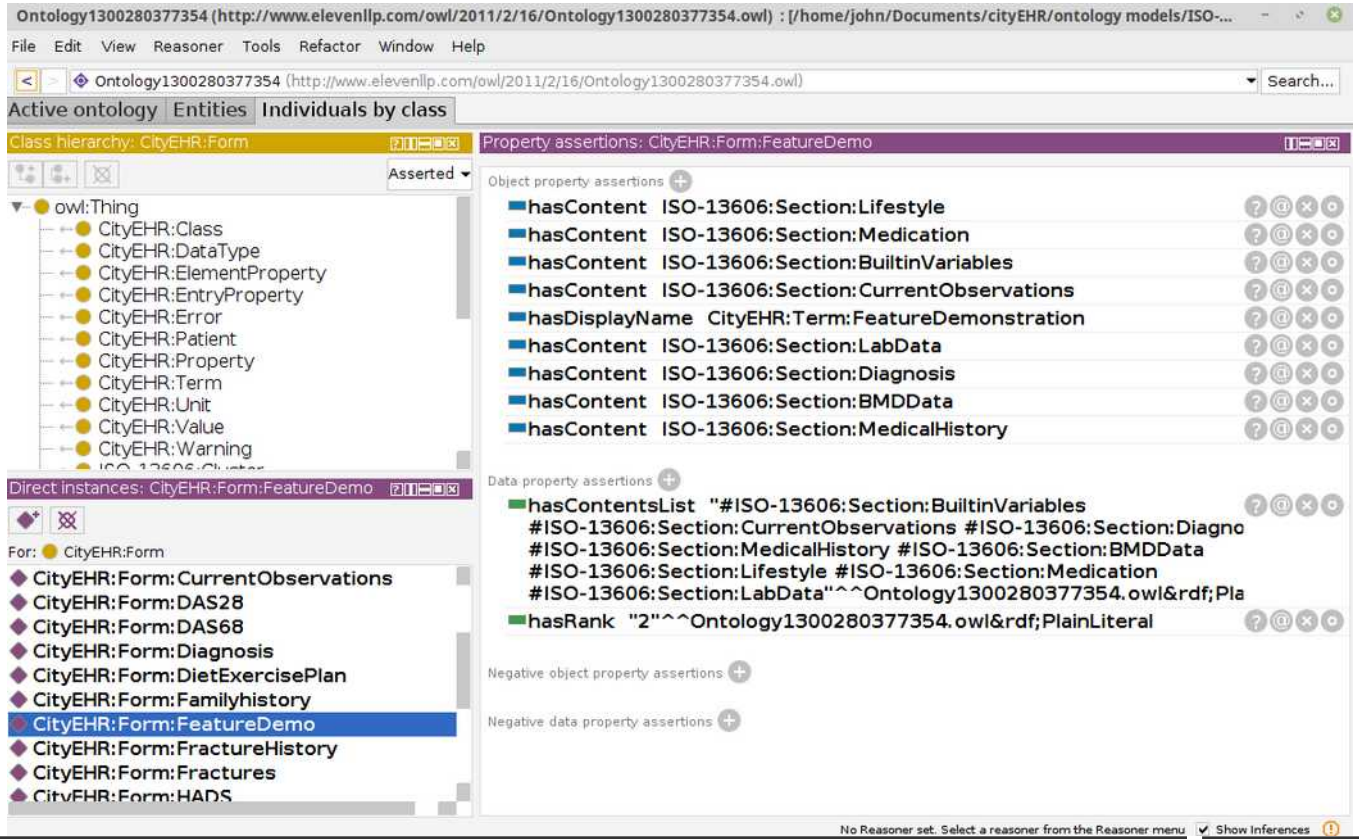


Ontology Models to Feed Artificial Intelligence

The underlying models are represented as ontologies, using the OWL/XML standard

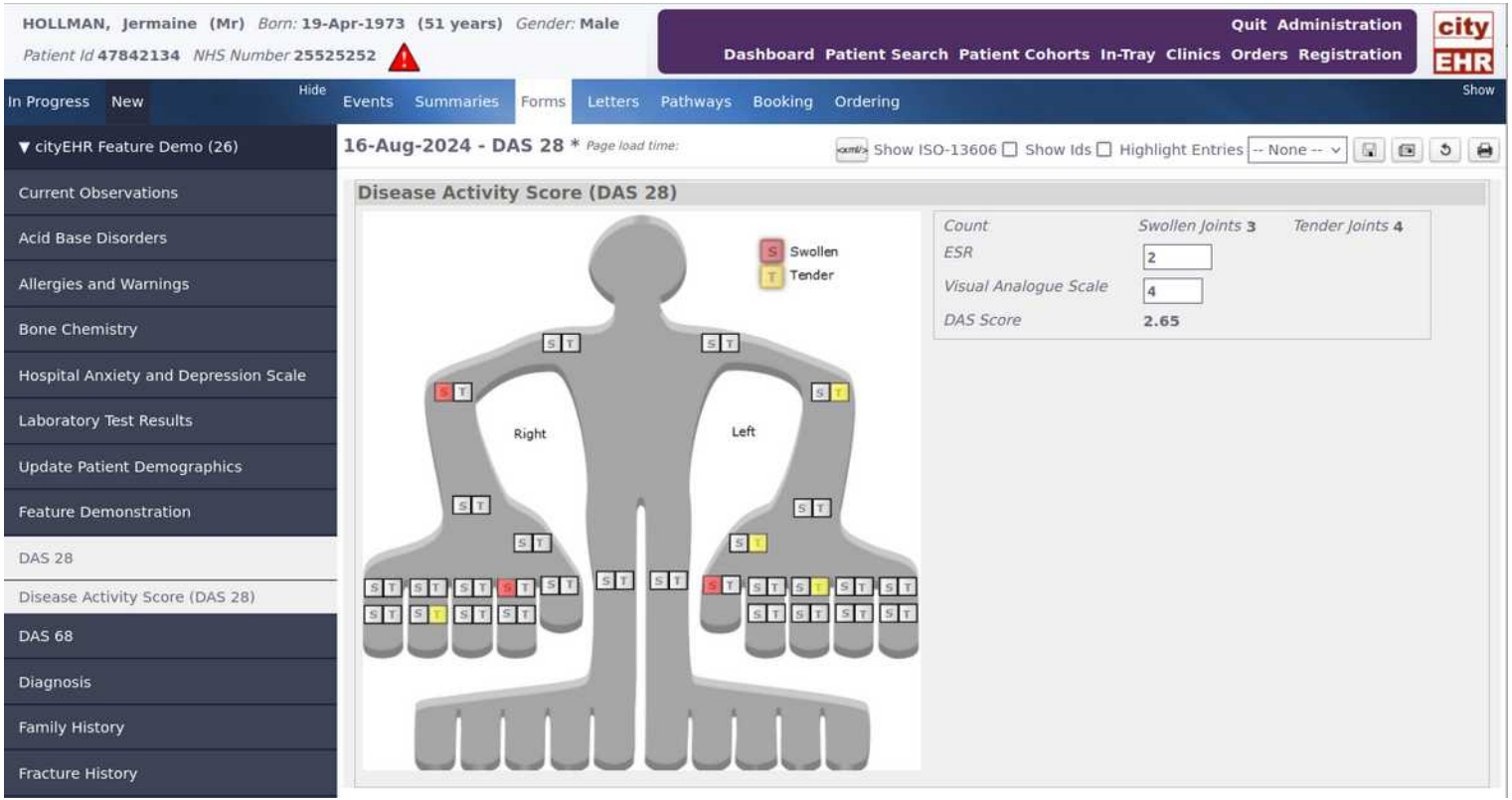
Ontology models are a one of the foundational models for Artificial Intelligence

Enabling AI tools such as Description Logic Reasoners to mine data for clinical research



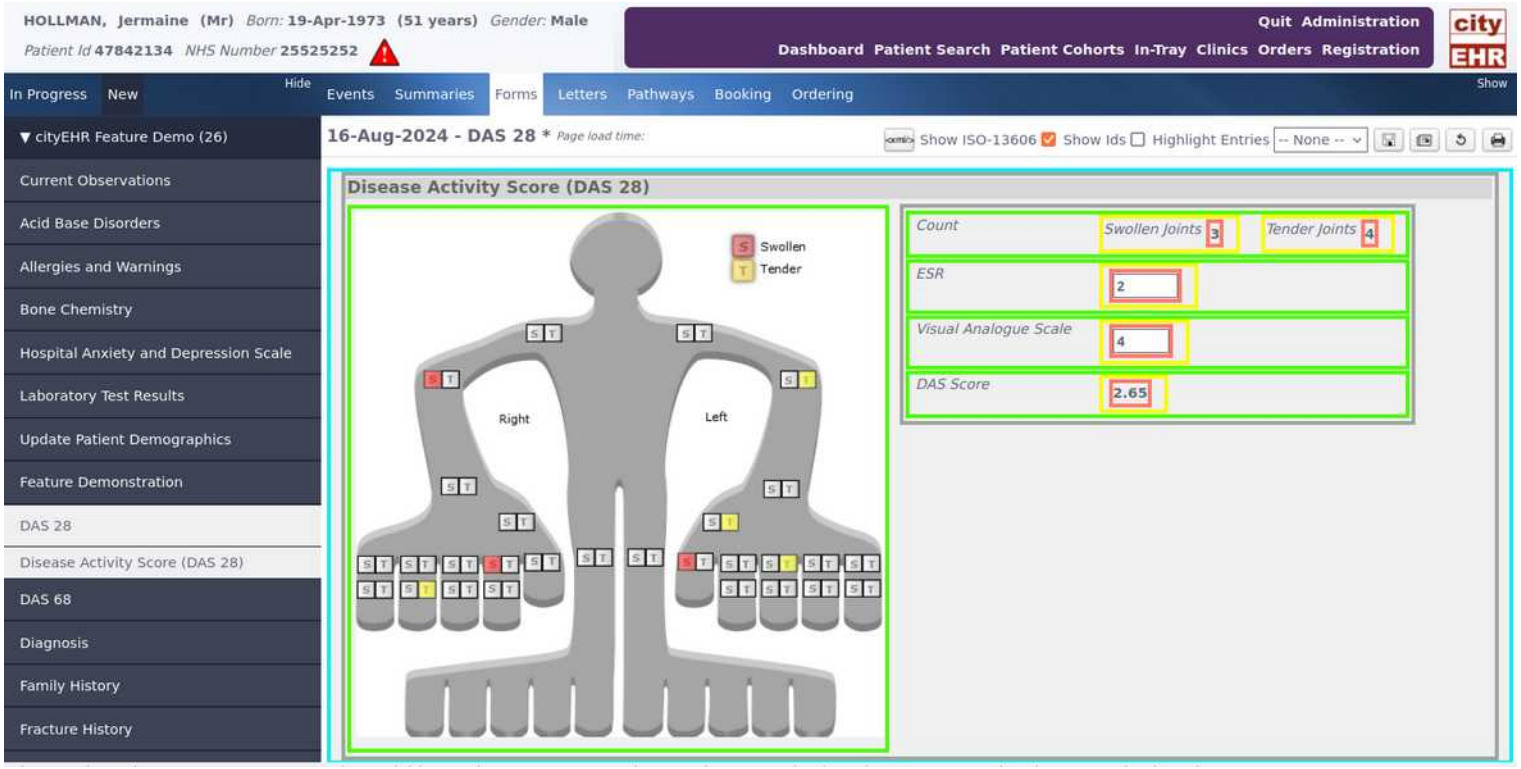
Interactive Graphical Data Entry

Support for graphical data entry



SVG Graphics Linked to the Information Model

Any SVG (XML Scalable Vector Graphics) can be linked to the information model



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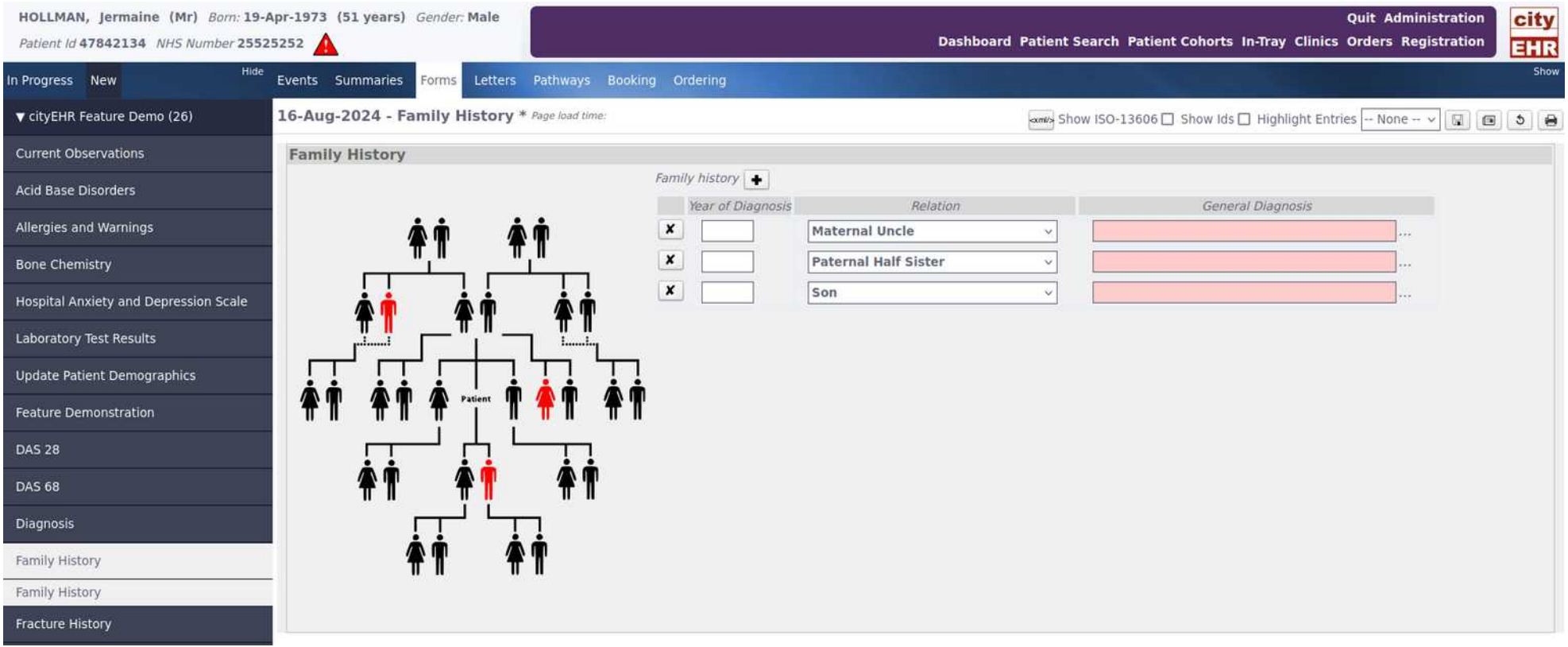

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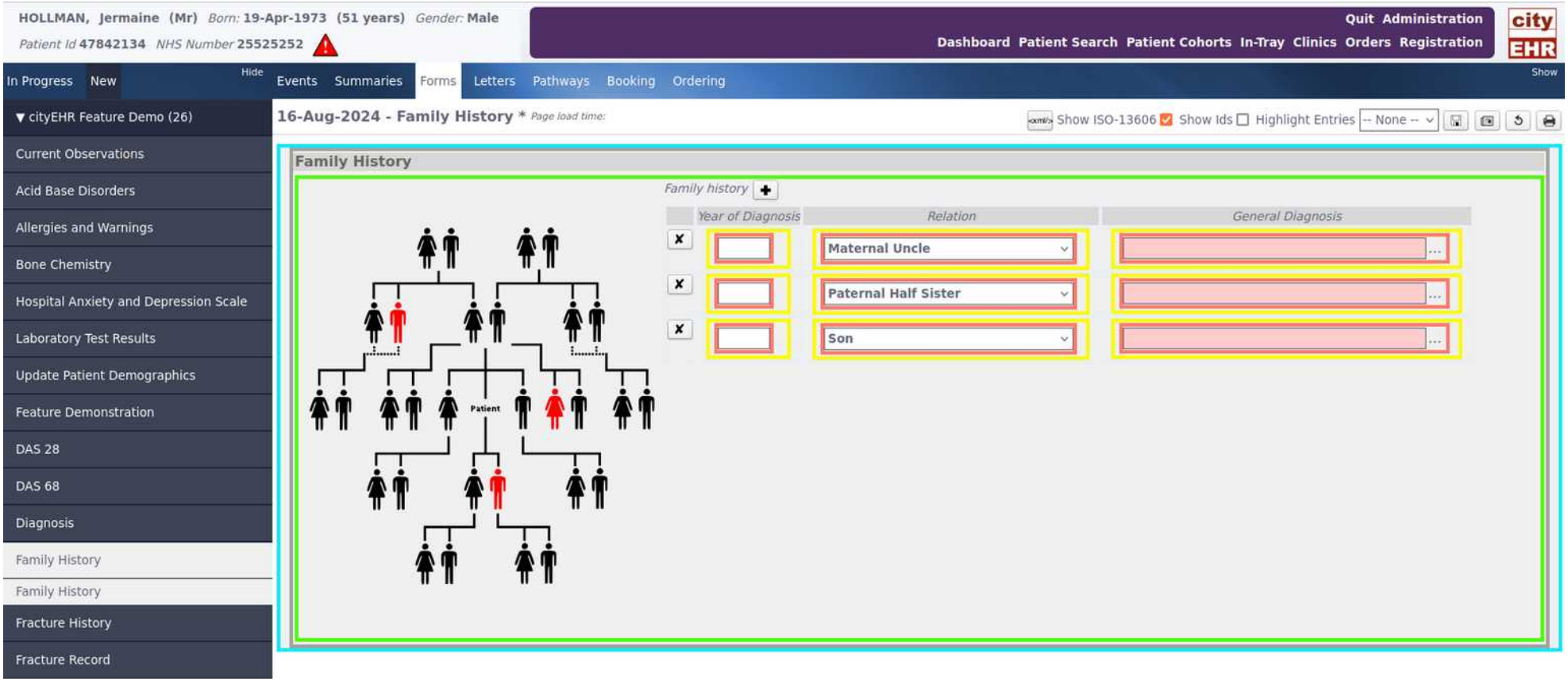


Patient-centred care

The concept of patient-centred care can be traced back to the work of influential psychologist Carl Rogers.

The patient involved in the decision making about their own healthcare

The healthcare process focussed on the needs of the patients, rather than the clinicians

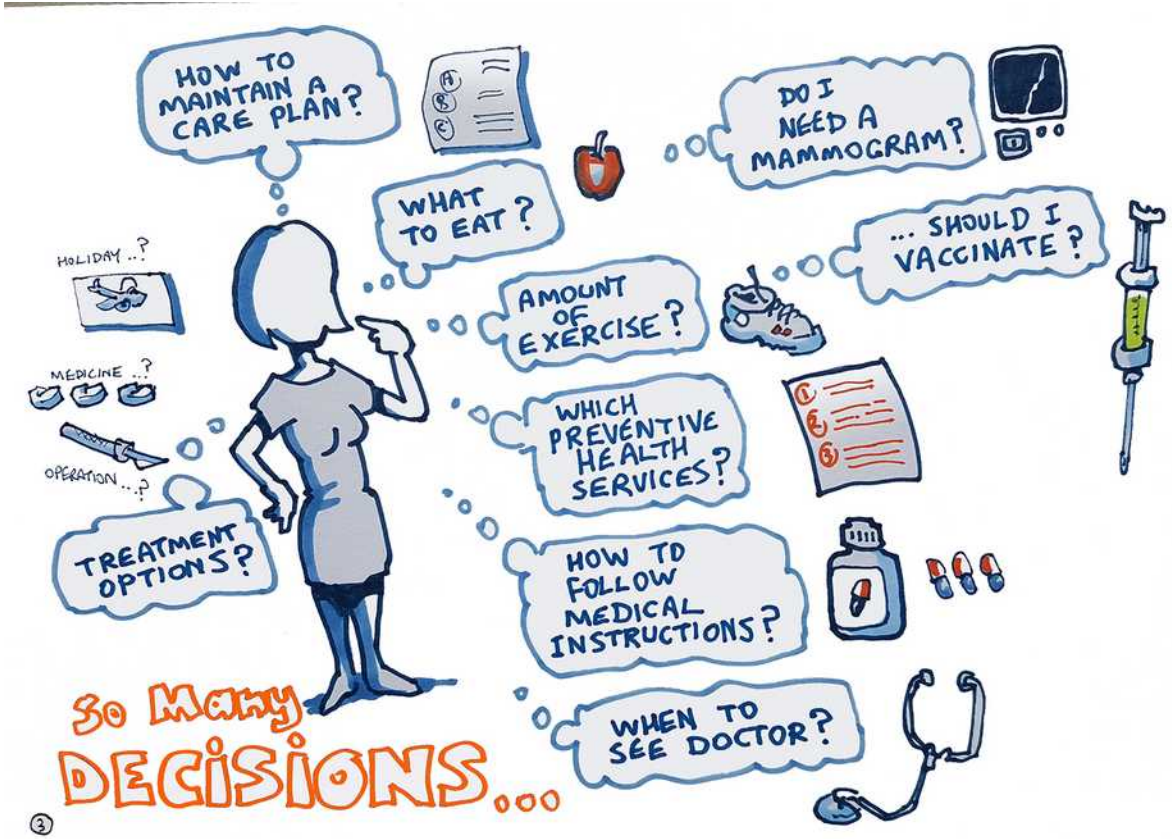
Rogers, C.R., 1959. A theory of therapy, personality, and interpersonal relationships: As developed in the client-centered framework (Vol. 3, pp. 184-256). New York: McGraw-Hill.

Health Literacy

The term “health literacy” refers to a set of skills that people need to function effectively in the health care environment.

These skills include the ability to read and understand text and to locate and interpret information in documents (print literacy); use quantitative information for tasks, such as interpreting food labels, measuring blood glucose levels, and adhering to medication regimens (numeracy); and speak and listen effectively (oral literacy).

Approximately 80 million U.S. adults are thought to have limited health literacy, which puts them at risk for poorer health outcomes. Rates of limited health literacy are higher among elderly, minority, and poor persons and those with less than a high school education.



https://www.compare-phc.unsw.edu.au

Berkman, N.D., Sheridan, S.L., Donahue, K.E., Halpern, D.J. and Crotty, K., 2011. Low health literacy and health outcomes: an updated systematic review. Annals of internal medicine, 155(2), pp.97-107.

Addressing Health Literacy Issues

A report from the Milken Institute has seven recommendations for addressing issues in health literacy, in three areas:

Lopez, C., Kim, B. and Sacks, K., 2022. Health Literacy in the United States: Enhancing Assessments and Reducing Disparities. Milken Institute. Available at SSRN 4182046.

Technology: Keep It Simple

Recommendation 3:

The sixth-grade reading level rule should apply to overall content to improve usability, readability, and accessibility of technology.

Recommendation 4:

Access to and use of technology can work hand-in-hand to improve health literacy; focusing on the patient will help tailor the information and share it.

Kiosk Systems

Self-contained hardware and (single) software application

Touch Screen

End-to-end workflow

Uncluttered user interface

Graphical, where possible

Intuitive

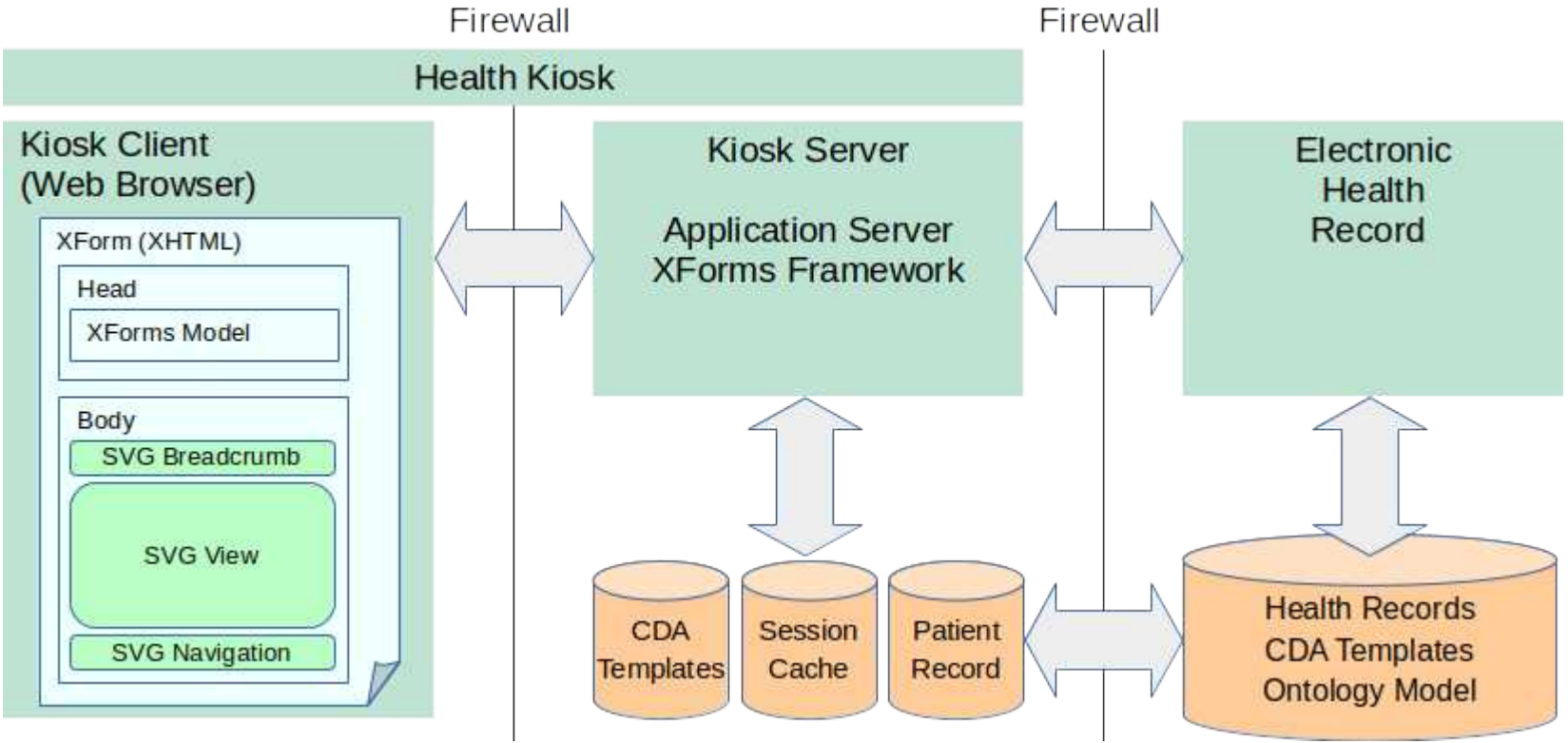
No training required

Any user, any language

https://www.businessinsider.com

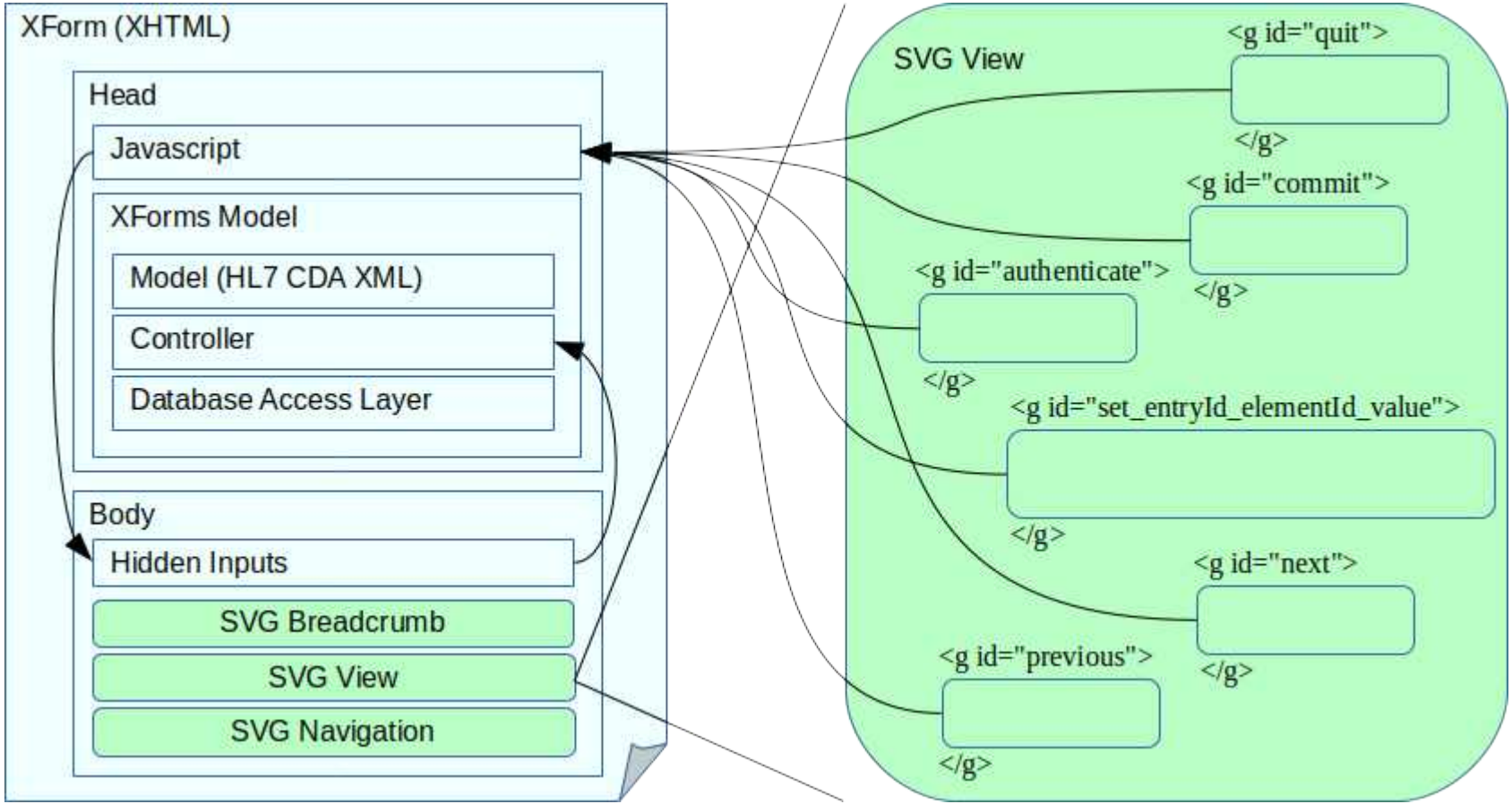
Health Kiosk Using cityEHR

Kiosk style interface for patient access to their electronic health record
The clinical information model can generate a health kiosk system.

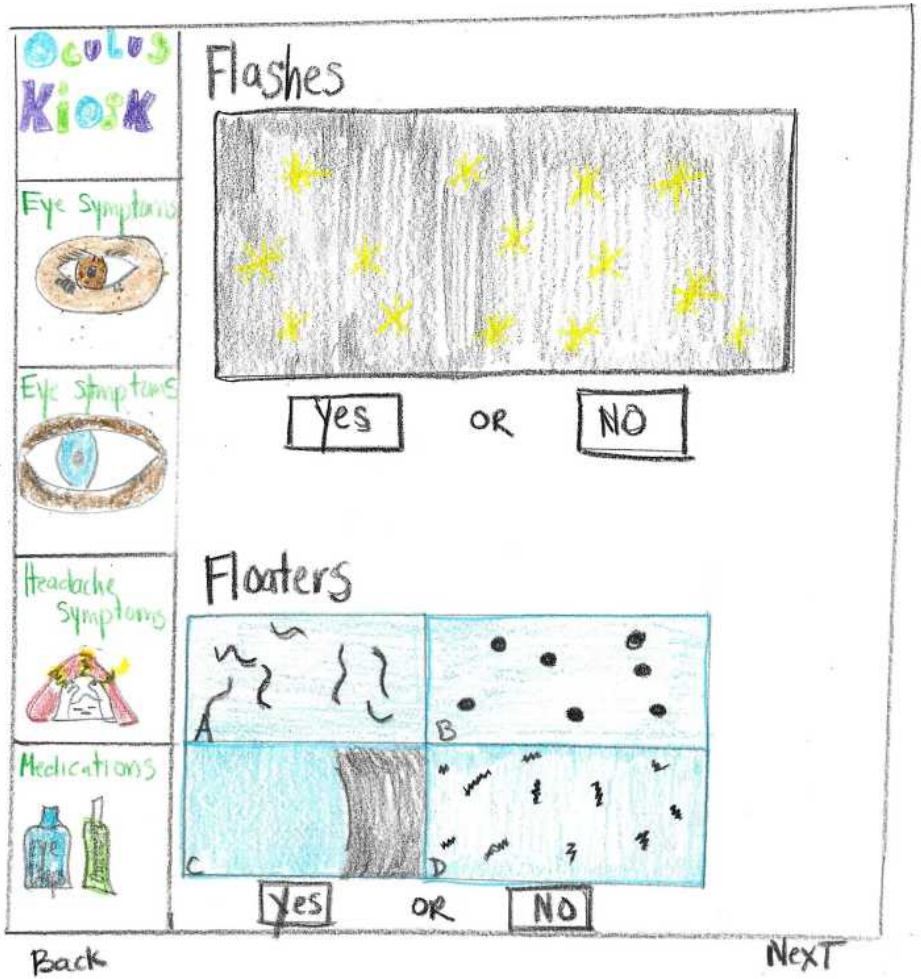


Kiosk Built Using SVG Images

Any SVG can be used as the kiosk interface, linked using a simple API



Original Prototype Using Hand Drawn Graphics



Hand drawn images made on paper

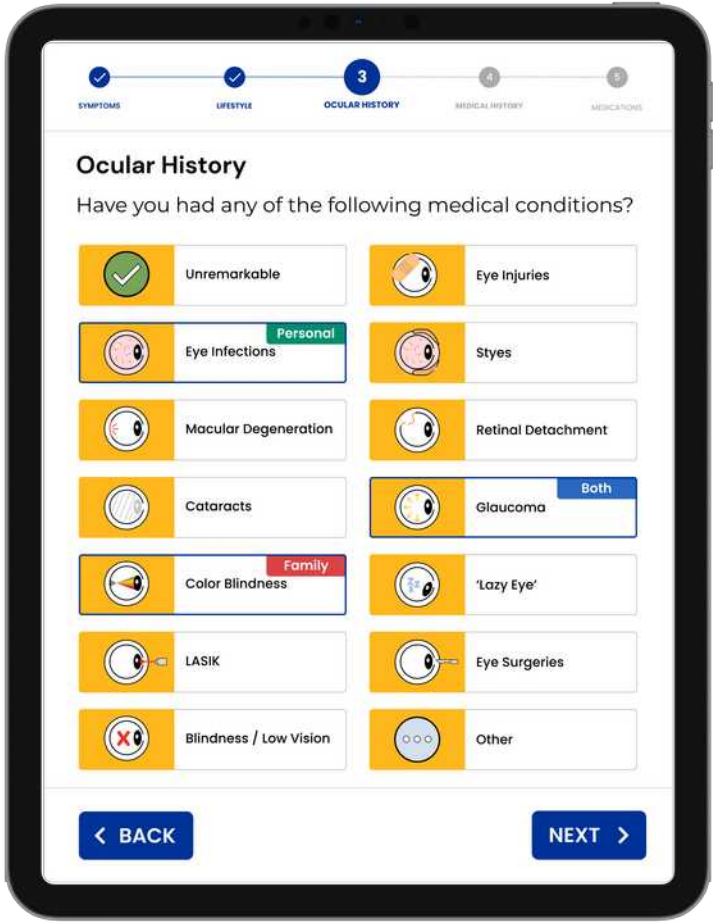
Scanned to bitmap graphic

Imported to SVG as Base64 background image

Hotspots as transparent SVG shapes

Hotspots linked to the information model

Equivalent Kiosk Using Designer Graphics



Graphic designer creates SVG of each kiosk screen

SVG shapes linked to the information model

Ongoing research project is assessing the best style of kiosk interface to address problems of low health literacy amongst patient users.

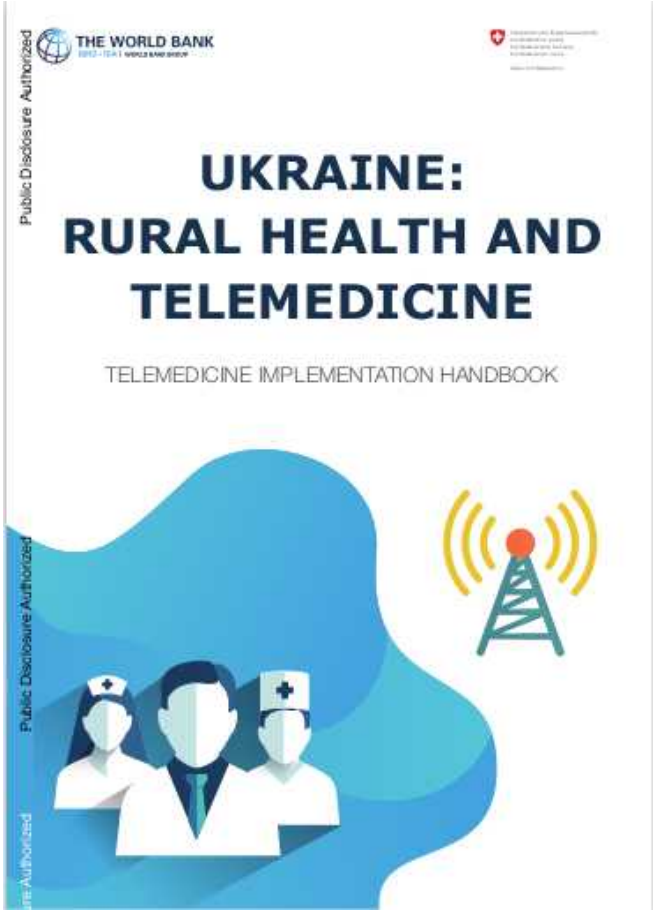
Rural Telemedicine in Ukraine

John Chelsom first visited Ukraine in 2018 to work on the World Bank's Handbook for Rural Telemedicine, published in 2020.

SUMMARY

This Handbook provides practical guidance and recommendations of best practice for the implementation of Rural Telemedicine. It covers the Technical Architecture, Functional Profiles, Standards, Infrastructure, Products (hardware and software), Implementation Procedures, Organisation, operational procedures and methods for Evaluation of Rural Telemedicine Services, with guidance for requirements at national, regional, district and local level.

This report has been tailored to the specific priorities, needs and capabilities of Ukraine and the points at which information specific to Ukraine should be considered during implementation of Telemedicine Services is shown in boxes such as this one.



World Bank. 2020. Ukraine - Rural Health and Telemedicine : Telemedicine Implementation Handbook, https://documents.banquemondiale.org/curated/fr/877101591354302267/Ukraine-Rural-Health-and-Telemedicine-Telemedicine-Implementation-Handbook

Telemedicine in Rivne Oblast

World Bank funded telemedicine in Rivne oblast, one of three pilot implementations (the others were Odesa and Poltava oblasts)

Workshops at NUWEE, Rivne

The telemedicine kits supplied by the World Bank have not been widely used, due to problems with integration with the health record systems.

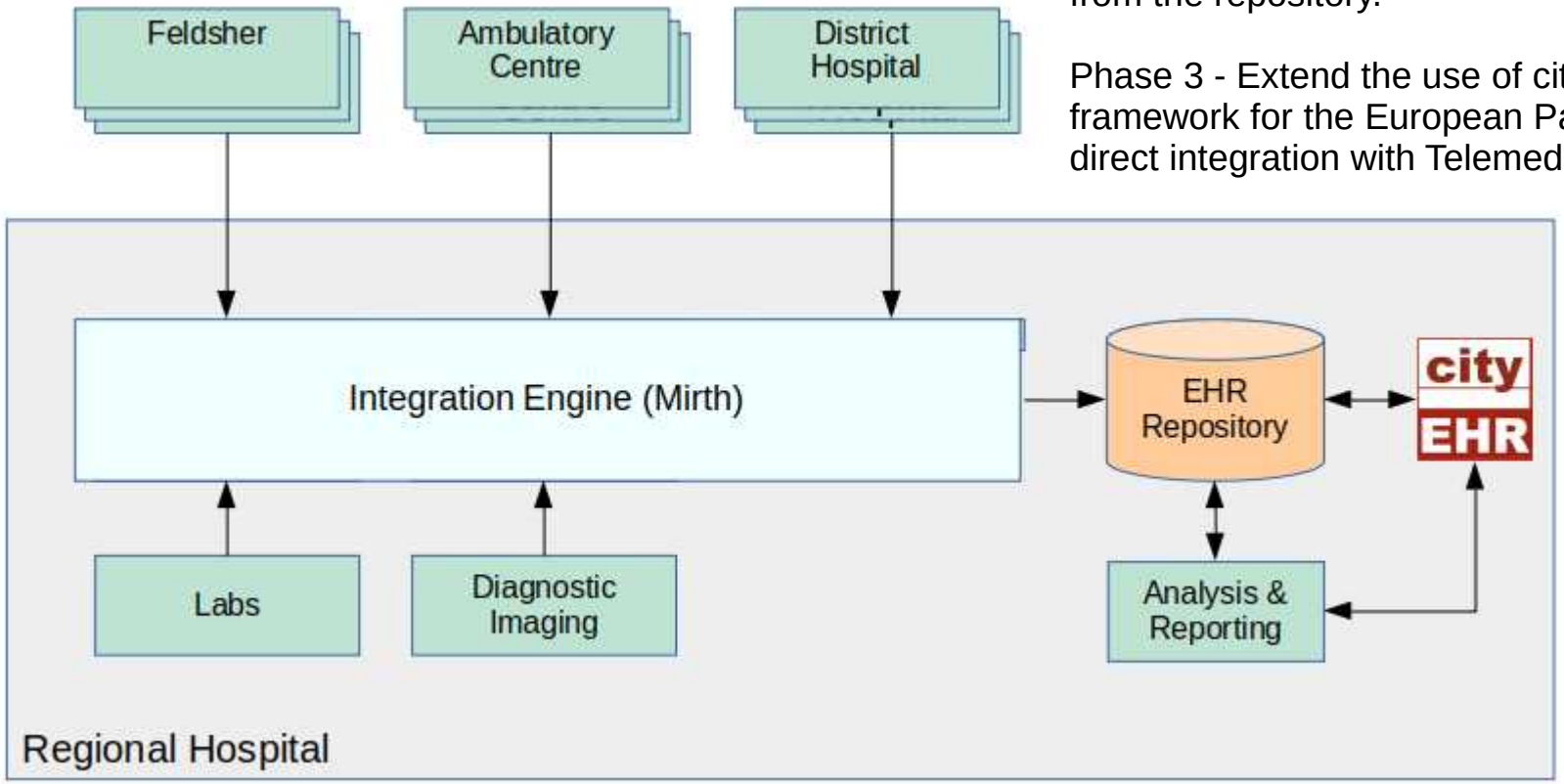
August 2024, workshop to create a pilot telemedicine integration with EHR

Project in Rivne, Ukraine

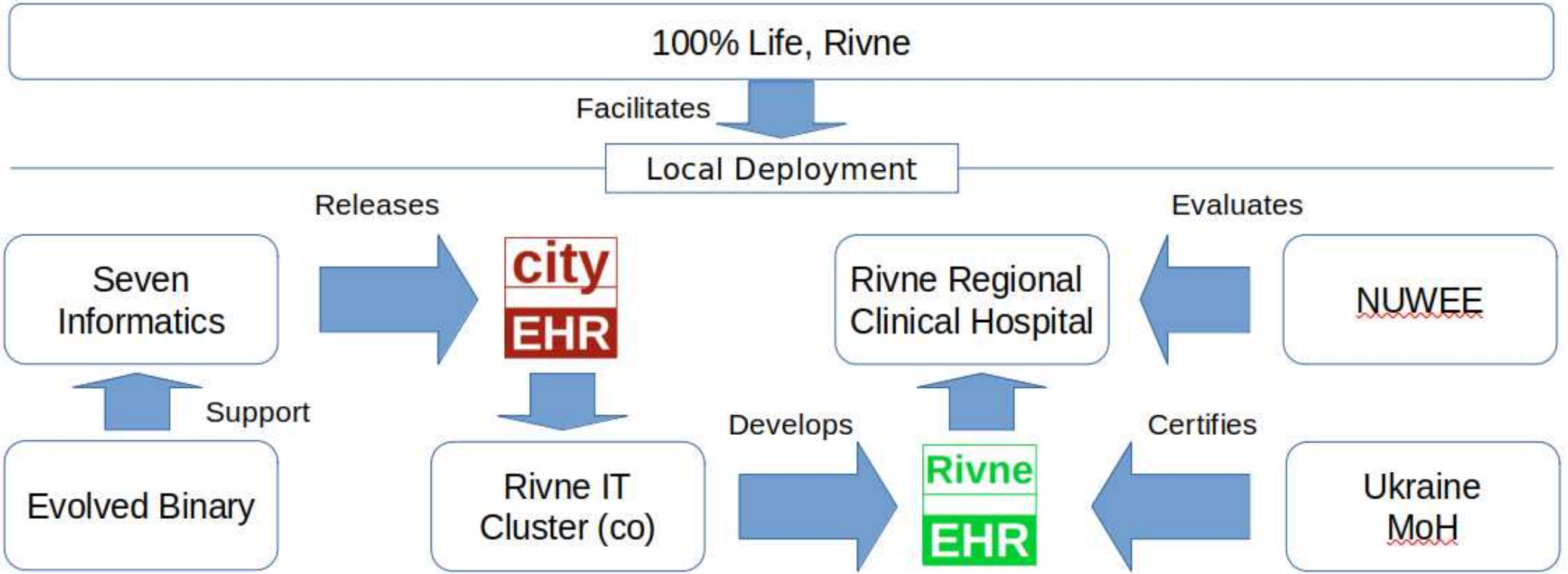
Phase 1 - Use Mirth to create an EHR repository of patient information using HL7 CDA.

Phase 2 - Use cityEHR for analysis and reporting from the repository.

Phase 3 - Extend the use of cityEHR to provide a framework for the European Patient Summary and direct integration with Telemedicine services.



Open Source Telemedicine Integration Project



Global Open Source Electronic Health Records

GOSEHR was launched the with financial support of Seven Informatics and the support for Academic Research and Education Programs from Fordham University.

Partners include leading universities in the UK, Canada, Norway and Ukraine together with the African Digital Health Research Institute.

https://gosehr.org

GOSEHR Dimensions

https://gosehr.org

Global Open Source Electronic Health Records

The objective of the Global Open Source Electronic Health Records initiative is to create a sustainable program for the deployment of open source EHR in participating countries, with the ultimate aims of improving patient outcomes and delivering better healthcare, within existing budget constraints.

The Initiative is bringing the benefits of open source, structured EHR systems to low-income countries, through engagement, education and research with local communities.

Partners include leading universities, healthcare providers, open source software developers, NGOs and local community companies.

Paths Towards GOSEHR

Education

Run by Fordham University, developing the local IT skills needed to deploy and support the installations.

Deployment

Using the open source cityEHR system through locally-based Non Government Organisations, Community Companies and Healthcare Providers.

Financial Aid

Supporting the IT infrastructure required for deployment in lower income countries.

Research

Led by Fordham University, with international collaborators, establishing needs and evaluating outcomes.

Open Health Informatics

openhealthinformatics.org

Open Standards
Open Source Software
Open Systems Interfaces
Open Development Processes

Get Involved

Register **8th – 13th September 2024, St Edmund Hall, Oxford.**

Presented by: FORDHAM UNIVERSITY

This one-week residential workshop will bring together participants from around the world, to learn how to configure and deploy an open source, model-driven, health electronic records system. We will use the open source cityEHR system, initially configured with example ontology models for a range of clinical services, which have been created by students at Fordham University, the University of Oxford and the University of Victoria, Canada.

GOSEHR Summit

An annual summit, bringing together academics, healthcare professionals, engineers and investors from around the world, presented in association with Fordham University.

Next Date: Saturday 5th April 2025, St Edmund Hall, Oxford.

Register FORDHAM UNIVERSITY