FHIR Deep Dive

AMIA Fall Symposium
Workshop 07
November 3, 2018
Agenda

• The basics: resources and references
• Structured and Coded Data
• Profiling
• Ecosystem
Benefits to Clinicians

- Clinicians can get involved in system design
- Tooling available
- Improved access to more complete, higher quality patient information incl. genomics
- Greater choice and variety of applications and devices to support clinical workflow
- Increased IT development speed – solving business problems faster in innovative ways
- Improving Decision Support
  - E.g. Immunization protocol
- Saving time
Benefits to Consumers

- Prospect of improved patient engagement apps, enabled through FHIR APIs to clinical systems
  - Can engage more deeply
- Clinician has access to a more complete patient record and improved decision making tools, leading to:
  - Better decision making
  - More efficient diagnosis and treatment
  - Higher quality care
- Overall improved patient experience – reducing wasted time
Benefits to Health Care Organisations

• Most vendors are committed to FHIR
• Should lead to:
  • faster deployments
  • lower cost interoperability
  • reduced vendor lock in as FHIR is adopted by source systems
• Standards based APIs to support internal application development
• Capture data for
  • Analytics and Decision Support
  • Population Management
BASICS OF FHIR
Overview of FHIR

- Fast Healthcare Interoperability Resources (FHIR)
- Consistent, simple to use content model (resources)
  - Controlled extensibility
- Supports all paradigms of exchange
  - Real-time APIs
  - Documents, Messages & Operations
- Designed with implementers in mind
- Freely available
- Detailed on-line, hyperlinked specification
- Freely available tooling, servers, libraries
- Strong endorsement and support from vendors, providers and regulatory community (e.g. NHS, INTEROpen, Project Argonaut)
- Massive supporting community
Related to other healthcare Standards

- HL7
  - Version 2
  - Version 3
  - CDA
- openEHR
- CIMI
- IHE
- DICOM
- Terminologies
  - SNOMED
  - ICD
The specification

http://hl7.org/fhir/index.html
Resources: What are they?

- The Content model
- The Thing that is exchanged
  - Via REST (FHIR Restful API), Messages, Documents
- Informed by much past work inside & outside of HL7
  - HL7: version 2, version 3 (RIM), CDA
  - Other SDO: openEHR, CIMI, ISO 13606, IHE, DICOM
<table>
<thead>
<tr>
<th>General:</th>
<th>Care Provision:</th>
<th>Medication &amp; Immunization:</th>
<th>Diagnostics:</th>
</tr>
</thead>
<tbody>
<tr>
<td>AllergyIntolerance</td>
<td>CarePlan</td>
<td>Medication</td>
<td>Observation</td>
</tr>
<tr>
<td>Condition (Problem)</td>
<td>CareTeam</td>
<td>MedicationOrder</td>
<td>DiagnosticReport</td>
</tr>
<tr>
<td>Procedure</td>
<td>Goal</td>
<td>MedicationAdministration</td>
<td>DiagnosticOrder</td>
</tr>
<tr>
<td>ClinicalImpression</td>
<td>ReferralRequest</td>
<td>MedicationDispense</td>
<td>Specimen</td>
</tr>
<tr>
<td>FamilyMemberHistory</td>
<td>ProcedureRequest</td>
<td>MedicationStatement</td>
<td>BodySite</td>
</tr>
<tr>
<td>RiskAssessment</td>
<td>NutritionOrder</td>
<td>Immunization</td>
<td>ImagingStudy</td>
</tr>
<tr>
<td>DetectedIssue</td>
<td>VisionPrescription</td>
<td>ImmunizationRecommendation</td>
<td>ImagingObjectSelection</td>
</tr>
</tbody>
</table>

**Maturity Model**
Resource example

XML and JSON

Resource Identity & Metadata

Human Readable Summary

Extension with URL to definition

Standard Data:
- MRN
- Name
- Gender
- Birth Date
- Provider
References between resources

Coded Properties
- type
- bodySuite
- indication
- performer.role
- complication
- relatedItem.type

Other Properties
- identifier (Identifier)
- outcome (String)

- PATIENT
- CONDITION
- PROCEDURE
- DIAGNOSTIC REPORT
- ENCOUNTER
- PRACTITIONER

Subject
- Related Item
- Encounter
- Performer
- Report
12-year-old-boy

First consultation
Complaining of pain in the right ear for 3 days with an elevated temperature. On examination, temperature 38°C and an inflamed right eardrum with no perforation. Diagnosis Otitis Media, and prescribed Amoxicillin 250mg 3 times per day for 7 days.

Follow up consultation
2 days later returned with an itchy skin rash. No breathing difficulties. On examination, urticarial rash on both arms. No evidence meningitis. Diagnosis of penicillin allergy. Antibiotics changes to Erythromycin 250mg 4 times per day for 10 days.
As linked resources...
clinFHIR: Server roles

- Specific server roles (according to clinFHIR)
  - **Data/patient** – patient related (clinical) and ‘reference’ (Practitioner, Organization)
  - **Conformance** – profile, extensionDefinition (both StructureDefinition)
  - **Terminology** – ValueSet & Terminology operations
- Important to be STU consistent!
STRUCTURED AND CODED DATA
Why have structured / coded data

- Structured vs Coded
- Coded:
  - Improves UI possibilities
  - Improves exchange
  - ‘Secondary’ uses
    - Allows Decision Support
    - Population health
Resource example

```xml
<Patient xmlns="http://hl7.org/fhir">
  <id value="glossy"/>
  <meta>
    <lastUpdated value="2014-11-13T11:41:00+11:00"/>
  </meta>

  <text>
    <status value="generated"/>
    <div xml:base="http://www.w3.org/1999/xhtml"
        xml:lang="en-US">
      <p>Henry Levin the 7th</p>
      <p>MRN: 123456. Male, 24-Sept 1932</p>
    </div>
  </text>

  <extension url="http://example.org/consent#trials">
    <valueCode value="renal"/>
  </extension>

  <identifier>
    <use value="usual"/>
    <label value="MRN"/>
    <system value="http://www.goodhealth.org/identifiers/mrns/">
      <value value="123456"/>
    </system>
  </identifier>

  <name>
    <family value="Levin"/>
    <given value="Henry"/>
    <suffix value="The 7th"/>
  </name>

  <gender value="male"/>
  <birthDate value="1932-09-24"/>
  <careProvider>
    <reference value="Organization/3"/>
    <display value="Good Health Clinic"/>
  </careProvider>
  <active value="true"/>
</Patient>
```

- **Resource Identity & Metadata**
- **Human Readable Summary**
- **Extension with URL to definition**

**Standard Data:**
- MRN
- Name
- Gender
- Birth Date
- Provider

XML and JSON
## Resource structure

<table>
<thead>
<tr>
<th>Name</th>
<th>Flags</th>
<th>Card.</th>
<th>Type</th>
<th>Description &amp; Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td>⌂</td>
<td></td>
<td>DomainResource</td>
<td>Information about an individual or animal receiving health care services</td>
</tr>
<tr>
<td></td>
<td>Σ</td>
<td>0..*</td>
<td>Identifier</td>
<td>Elements defined in Ancestors: <code>id</code>, <code>meta</code>, <code>implicitRules</code>, <code>language</code>, <code>text</code>, <code>content</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>An identifier for this patient</td>
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<tr>
<td>identifier</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>active</td>
<td>?! Σ</td>
<td>0..1</td>
<td>boolean</td>
<td>Whether this patient’s record is in active use</td>
</tr>
<tr>
<td>name</td>
<td>Σ</td>
<td>0..*</td>
<td>HumanName</td>
<td>A name associated with the patient</td>
</tr>
<tr>
<td>telecom</td>
<td>Σ</td>
<td>0..*</td>
<td>ContactPoint</td>
<td>A contact detail for the individual</td>
</tr>
<tr>
<td>gender</td>
<td>Σ</td>
<td>0..1</td>
<td>code</td>
<td><code>male</code></td>
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<td></td>
<td></td>
<td></td>
<td>AdministrativeGender</td>
<td>The date of birth for the individual</td>
</tr>
<tr>
<td>birthDate</td>
<td>Σ</td>
<td>0..1</td>
<td>date</td>
<td></td>
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<tr>
<td>deceased[x]</td>
<td></td>
<td></td>
<td>boolean</td>
<td>Indicates if the individual is deceased or not</td>
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<td>?! Σ</td>
<td>0..1</td>
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Terminology Sub-system

Code System: Defines a set of concepts with a coherent meaning

Code Display Definition

Value Set: A selection of a set of codes for use in a particular context

Element Definition: Type and Value set reference

Element: code/Coding/CodeableConcept

Selects • SNOMED CT / LOINC / RxNORM
• ICPC, MIMS + 100s more
• ICD-X+
• A drug formulary
• Custom

Binds

Conforms

Refers to
ValueSet

- A subset of terms from a code system for a specific purpose or use case
- Promotes consistency between applications
- Key component of Terminology
  - Also CodeSystem

- Skin Tones
  - Pink
  - Ruddish
  - White
  - Gray
  - Yellow
PROFILING
Adapting FHIR to your needs: Profiling

- Many different contexts in healthcare, but want a single set of Resources
- Need to be able to describe ‘usage of FHIR’ based on context
- Allow for these usage statements to:
  - Authored in a structured manner
  - Published in a registry & Discoverable
  - Used as the basis for validation, code, report and UI generation.
- 3 main aspects:
  - Constraining a resource - remove element, change multiplicity fix values
  - Change coded element binding
  - Adding a new element (an extension)
- Profiling adapts FHIR for specific scenarios
For example...

Limit names to just 1 (instead of 0..*)

Change maritalStatus to another set of codes that extends the one from HL7 international

Require that the identifier uses the NHS number – and is required

 Doesn't support photo

Add an extension to support ethnicity

Note: Limited mandatory elements in the core spec
The ‘profile’

- Defines each element
  - Path
  - Name
  - dataType
  - Binding
  - Multiplicity
  - Mapping & much more
- Including allowable extension points
Extension Definitions

- Simple or Complex
- Definition:
  - Available on the web
  - Canonical Url
    - Resolvable or Registry
- In resource instance:
  - Reference to Url
  - Extension or ModifierExtension

- Example: US Core – Patient Resource – Extended to include race and ethnicity.
Bundles

- Container resource
- Types of Bundle
  - Searchset
  - Transaction
  - Document
  - Message
  - ...

Bundle Resource

- Observation Resource
- Device Resource
- List Resource
- Condition Resource
Messages – are bundles

<MessageHeader>
  <entry>
    <MessageHeader />
  </entry>
  <entry>
    <Observation />
  </entry>
  <entry>
    <Patient />
  </entry>
  <entry>
    <Device />
  </entry>
</Bundle>
THE ECOSYSTEM
A digital ecosystem is a distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired from natural ecosystems.
Components

- Terminology
- Decision Support
- Workflow
- Services Directory
- Provider/Patient Registry
- Authorisation
- Conformance
- Repository

FHIR API and Resources
REST (API)

• “Representational State Transfer” – an architecture for how to connect systems in real time
• Uses HTTP/S
• Simple to use
• Very commonly used outside of healthcare – especially mobile
• For simple interactions
  • Create
  • Read (& Query)
  • Update
  • Delete
• A lot of tooling / experience available
• FHIR is not a security standard
  • Leverages existing standards – for example
    • TLS
    • OAuth2
• Support in the specification
  • Security tags (metadata)
  • Specialized resources
    • Provenance
    • AuditEvent
• More detail
  • http://hl7.org/fhir/security.html
More information

From HL7
- wiki.hl7.org/index.php?title=FHIR
- http://www.fhir.org/

Community
- https://chat.fhir.org/
- List server (fhir@lists.hl7.org)
- Stack Overflow (tag FHIR)

Blogs
- https://fhirblog.com/
- https://thefhirplace.com/
- https://brianpos.com

Libraries
- Java (http://hapifhir.io/)
- C# (NuGet HL7.FHIR)

Tooling
- Forge (http://fhir.furore.com/Forge)
- http://clinfhir.com/

Test servers
- https://fhirblog.com/2016/10/19/setting-up-your-own-fhir-server-for-profiling/