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 Thing that is exchanged
  - Via REST (FHIR Restful API), Messages, Documents
- The Content model
  - Small logically discrete units of exchange
  - Defined behaviour and meaning
  - Known identity / location
  - Smallest unit of transaction
  - “of interest” to healthcare
- Informed by much past work inside & outside of HL7
  - HL7: version 2, version 3 (RIM), CDA
  - V2: Sort of like Segments
  - V3: Sort of like CMETs
  - Other SDO: openEHR, CIMI, ISO 13606, IHE, DICOM

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## Resources

### General:
- AllergyIntolerance
- Condition (Problem)
- Procedure
- ClinicalImpression
- FamilyMemberHistory
- RiskAssessment
- DetectedIssue

### Care Provision:
- CarePlan
- CareTeam
- Goal
- ReferralRequest
- ProcedureRequest
- NutritionOrder
- VisionPrescription

### Medication & Immunization:
- Medication
- MedicationOrder
- MedicationAdministration
- MedicationDispense
- MedicationStatement
- Immunization
- ImmunizationRecommendation

### Diagnostics:
- Observation
- DiagnosticReport
- DiagnosticOrder
- Specimen
- BodySite
- ImagingStudy
- ImagingObjectSelection

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FHHR the basics | Resource example

- Resource Identity & Metadata
- Human Readable Summary
- Extension with URL to definition
- Standard Data:
  - MRN
  - Name
  - Gender
  - Birth Date
  - Provider

XML and JSON
FHIR the basics | References between resources

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

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

Subject
- PATIENT

Related Item
- CONDITION
- PROCEDURE
- DIAGNOSTIC REPORT

Report
- ENCOUNTER
- PRACTITIONER

Encounter
- PERFORMER
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.
Pain right ear 3 days
Elevated temperature
Temperature 38°C
Inflamed right drum
Otitis media
Amoxicillin 250mg
Itchy skin rash
No breathing difficulties
Urticarial Rash
Penicillin Allergy
Erythromycin 250mg
Penicillin Allergy
Amoxicillin 250mg
Erythromycin 250mg
Urticarial Rash
Penicillin Allergy
Itchy skin rash
No breathing difficulties
Inflamed right drum
Otitis media
Elevated temperature
Pain right ear 3 days
Patient
Practitioner
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
Clinical Scenario

5 year old boy

First consultation

- Complaining of pain in the r) ear for 3 days with an elevated temperature. On examination, temperature 38.5 degrees and an inflamed r) ear drum with no perforation. Diagnosis Otitis Media, and prescribed Amoxil 250mg TDS for 5 days.

Follow up consultation

- 5 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 and advised not to take penicillin in the future.
Lists of things

- **Examples**
  - Medication list
  - Problem List (Conditions)
  - Allergies
  - Past Medical History
  - Past Social History
  - Social History
  - ‘Organizer’ in Document

- **Manage ‘points in time’ and changes**
- **Explicit ‘none known’**
Scheduling patients

- Appointment / AppointmentResponse
- Availability
- Slot
- HealthCareService
- Recalls (care plan)
- Alerts

“We’re running a little behind, so I’d like each of you to ask yourself, ‘Am I really that sick, or would I just be wasting the doctor’s valuable time?’”
Resource example

XML and JSON

```
<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:lang="en">
      <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/mrnsystem"/>
    <value value="123456"/>
  </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 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>- identifier</td>
<td>Σ</td>
<td>0..*</td>
<td>Identifier</td>
<td>Elements defined in Ancestors: id, meta, implicitRules, language, text, content</td>
</tr>
<tr>
<td>- active</td>
<td>?!Σ</td>
<td>0..1</td>
<td>boolean</td>
<td>An identifier for this patient</td>
</tr>
<tr>
<td>- name</td>
<td>Σ</td>
<td>0..*</td>
<td>HumanName</td>
<td>Whether this patient's record is in active use</td>
</tr>
<tr>
<td>- telecom</td>
<td>Σ</td>
<td>0..*</td>
<td>ContactPoint</td>
<td>A name associated with the patient</td>
</tr>
<tr>
<td>- gender</td>
<td>Σ</td>
<td>0..1</td>
<td>code</td>
<td>A contact detail for the individual</td>
</tr>
<tr>
<td>- birthDate</td>
<td>Σ</td>
<td>0..1</td>
<td>date</td>
<td>The date of birth for the individual</td>
</tr>
<tr>
<td>- deceased[x]</td>
<td>?!Σ</td>
<td>0..1</td>
<td>date</td>
<td>Indicates if the individual is deceased or not</td>
</tr>
<tr>
<td>- deceased</td>
<td></td>
<td></td>
<td>date</td>
<td></td>
</tr>
<tr>
<td>- deceasedBoolean</td>
<td></td>
<td></td>
<td>boolean</td>
<td></td>
</tr>
<tr>
<td>- deceasedDateTime</td>
<td></td>
<td></td>
<td>dateTime</td>
<td></td>
</tr>
<tr>
<td>- address</td>
<td>Σ</td>
<td>0..*</td>
<td>Address</td>
<td>Addresses for the individual</td>
</tr>
<tr>
<td>- maritalStatus</td>
<td></td>
<td>0..1</td>
<td>CodeableConcept</td>
<td>Marital (civil) status of a patient</td>
</tr>
<tr>
<td>- multipleBirth[x]</td>
<td></td>
<td>0..1</td>
<td>CodeableConcept</td>
<td>Whether patient is part of a multiple birth</td>
</tr>
<tr>
<td>- multipleBirth</td>
<td></td>
<td></td>
<td>boolean</td>
<td></td>
</tr>
<tr>
<td>- multipleBirthInteger</td>
<td></td>
<td></td>
<td>integer</td>
<td></td>
</tr>
<tr>
<td>- photo</td>
<td></td>
<td>0..*</td>
<td>Attachment</td>
<td>Image of the patient</td>
</tr>
<tr>
<td>- contact</td>
<td>I</td>
<td>0..*</td>
<td>BackboneElement</td>
<td>A contact party (e.g. guardian, partner, friend) for the patient</td>
</tr>
<tr>
<td>- relationship</td>
<td></td>
<td>0..*</td>
<td>CodeableConcept</td>
<td>The kind of relationship</td>
</tr>
</tbody>
</table>

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Terminology Sub-system

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

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

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

Element: code/Coding/CodeableConcept

Selects

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 />
<Observation />
<Patient />
<Device />

(Bundle>
<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
Security

• 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
Freely available

- Unencumbered – free for use, no membership required
- [http://hl7.org/fhir](http://hl7.org/fhir)

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FHIR plain English license:

- FHIR is © HL7. The right to maintain FHIR remains vested in HL7
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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/