Clinicians Not Burned Out - but on FHIR®

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FHIR® Deep Dive

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Agenda

• The basics: resources and references
• Structured and Coded Data
• Profiling
• Ecosystem
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
- Written into latest HHS regulations
- Massive supporting community
Informed by and Related to other Healthcare Standards

• HL7
  • Version 2
  • Version 3
  • CDA
• openEHR
• CIMI
• IHE
• DICOM
• Terminologies
  • SNOMED
  • ICD

Incorporates lessons learned from prior efforts
The specification

http://hl7.org/fhir/

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Fully Documented

Currently in 4th version
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
Resources: How are they organized?

**FHIR Composition Framework**

<table>
<thead>
<tr>
<th>Layer 5</th>
<th>Resource Contextualization</th>
<th>Profiles</th>
<th>Graphs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer 4</td>
<td>Specialized Resources</td>
<td>Public Health &amp; Research</td>
<td>Definitional Artifacts</td>
</tr>
<tr>
<td>Layer 3</td>
<td>Financial Resources</td>
<td>Support</td>
<td>Billing</td>
</tr>
<tr>
<td>Layer 2</td>
<td>Clinical Resources</td>
<td>Clinical</td>
<td>Diagnostic</td>
</tr>
<tr>
<td>Layer 1</td>
<td>Base Resources</td>
<td>Individuals</td>
<td>Entities</td>
</tr>
<tr>
<td>Layer 1</td>
<td>Foundation Resources</td>
<td>Security</td>
<td>Conformance</td>
</tr>
</tbody>
</table>

**FHIR® Resources:**

- [How are they organized?](https://www.hl7.org/fhir/overview-arch.html#framework)

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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

Five Level Maturity Model Applied to Each Resource:
FHIR: 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)

PATIENT

CONDITION

PROCEDURE

DIAGNOSTIC REPORT

ENCOUNTER

PRACTITIONER
Recording a consultation

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
Clinical Scenario

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.
Organizing Resources: 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
example

Resource

Resource Identity & Metadata

Human Readable Summary

Extension with URL to definition

Standard Data:
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- Gender
- Birth Date
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XML and JSON
### Resource structure

#### Resource Elements:
- **Name**
- **Cardinality**
- **Type**
- **Description**
- **Terminology binding**
- **Other**

<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><strong>Patient</strong></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, cont</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>
</tbody>
</table>
| gender              | Σ     | 0..1  | code            | male | female | other | unknown
| birthDate           | Σ     | 0..1  | date            | The date of birth for the individual                                                   |
| deceased[x]         | ?/ Σ  | 0..1  | boolean         | Indicates if the individual is deceased or not                                          |
| deceasedBoolean     |       |       | boolean         |                                              |
| deceasedDateTime     |       |       | dateTime        |                                              |
| address             | Σ     | 0..*  | Address         | Addresses for the individual                                                           |
| maritalStatus       | 0..1  | CodeableConcept | Marital (civil) status of a patient  |
| multipleBirth[x]    | 0..1  |       | boolean         | Whether patient is part of a multiple birth                                           |
| multipleBirthBoolean|       |       | integer         |                                              |
| photo               |       | 0..*  | Attachment      | Image of the patient                                                                  |
| contact             | I     | 0..*  | BackboneElement | A contact party (e.g. guardian, partner, friend) for the patient
| relationship        |       | 0..*  | CodeableConcept | v2 Contact Role (Extensible)                                                            |
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
- Binds
- Refers to

- Conforms

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

https://www.hl7.org/fhir/terminologies.html
https://www.hl7.org/fhir/terminology-service.html
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

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
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

<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.

Wikipedia
Components
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
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/
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