Agenda & Structure

• House rules, intro, agenda (5’)

• 1: Case Reporting scoping (5’)
  • Lifelong vs time window

• 2: FHIR Fundamentals (15’)
  • Resources, Data types, terminology
  • Profiles
  • FHIR Operations, Capability Statement, REST/Documents
  • FHIR Implementation Guide development process - logical model + profiles, terminology, others (operations, etc)

• 3: Case Reporting purposes (10’)
  • Lifelong vs time window
  • Population / clinical
  • Q&A: Your context / Challenges / ideas?

• 4: Case Reporting Architecture (30)
  • Architectural pattern(s)
  • Data objects and data flow

• 5: FHIR Questionnaires (5-10)

• 6: FHIR Structured Data Capture (15)

• 7: Implementation intro (5)
  • Layered specification
  • Tooling
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Goals

1. Understand use of terminologies in FHIR
   • how coded data is represented and exchanged in FHIR resources
   • how code systems and value sets in FHIR are defined, identified and used
   • how to specify and use bindings in FHIR models (resources and profiles)

2. Understand Terminology searching and services
   • FHIR terminology-based search capabilities
   • FHIR Terminology Service capabilities
Part 1
Scoping
Scope

1. Case Reporting: Data exchange mechanisms for acquiring, maintaining and using data about a patient’s case – evolution, treatment...

- Chronic conditions
- Infectious diseases
- Treatments
- ...any other...
FHIR Applicability
Basic architecture
Scoping factors

- Purpose: Patient vs Population
- Lifelong vs time window
- Condition-focused vs comprehensive
- Facility-specific vs nationwide / global

- Discussion – your ideas?
Part 1
FHIR Fundamentals (Review)
Main topics

• Resources, Data types, terminology

• Profiles

• FHIR Operations, Capability Statement, REST/Documents

• FHIR Implementation Guide development process - logical model + profiles, terminology, others (operations, etc)
The HL7® FHIR® standard

Source: HL7 Belgium
FHIR Resource

### 8.1.2 Resource Content

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**See the Profiles & Extensions and the alternate definitions: Master Definition XML, JSON, XML Schema/Schematron, JSON Schema, SNOMED, SNIF for Turtle, see the extensions & the expanded analysis.**
Data types

http://build.fhir.org/datatypes.html
Primitive types

**integer**
A signed integer in the range -3,2768 / 3,2767 (32-bit), for larger values, use decimals

**string**
A sequence of printable characters.

Note: that string values are NOT NULL. The string length of a string value is the number of printable characters (including NUL, which is the value for an empty string). A string value that contains non-printable characters is invalid in XML, although it may be stored within an XML element.

**XML representation**
- `integer`:
  - Base 10 signed integer
- `string`:
  - Base 0 (null) or base 10 (valid characters)

**JavaScript representation**
- `integer`:
  - Number
  - Must be signed
- `string`:
  - No special syntax

**Use cases**
- Leading and trailing spaces are allowed.
- Leading and trailing whitespace is allowed, but should be removed before using the XML format. This is because spaces (including tabs) are not considered whitespace content.

**Plain text**
- String values are NOT NULL. Although they may be stored within an XML element.

**Example**
```xml
<integer>123</integer>
<string>This is a string</string>
```

**Additional information**
- String values are NOT NULL. Although they may be stored within an XML element.

**Constraints**
- Leading and trailing spaces are allowed.
- Leading and trailing whitespace is allowed, but should be removed before using the XML format. This is because spaces (including tabs) are not considered whitespace content.
Data types in instances

```json
{
  "resourceType": "Patient",
  "id": "43961584-bf55-4ddf-9462-a37465fe4440",
  "identifier": [
    {
      "type": {
        "coding": [
          {
            "system": "http://terminology.hl7.org/CodeSystem/v2-0203/",
            "code": "MR",
            "display": "Medical record number"
          }
        ]
      },
      "system": "http://myhospital.org/identifiers/patients",
      "value": "P0000001"
    }
  ],
  "name": [
    {
      "family": "Doe",
      "given": ["John"
    ]
  }
  ],
  "gender": "male",
  "birthDate": "1971-04-28T00:20:00Z"
}
```
FHIR “special” resource types

- Foundational resources: used to define fundamental aspects of FHIR (resources, maps, operations, capabilities)

http://hl7.org/fhir/resourcelist.html
Exchange paradigms

FHIR supports four paradigms

- RESTful API [hl7.org/fhir/http.html](http://hl7.org/fhir/http.html)
- Documents (like CDA) [hl7.org/fhir/documents.html](http://hl7.org/fhir/documents.html)
- Services (SOA techniques) [hl7.org/fhir/services.html](http://hl7.org/fhir/services.html)
- Messages [hl7.org/fhir/messaging.html](http://hl7.org/fhir/messaging.html)
- Subscriptions [hl7.org/fhir/subscription.html](http://hl7.org/fhir/subscription.html)
REST

• Most common approach
• GET (the “read” verb)
  • GET a single resource: GET Patient/43961584
  • GET a set of resources GET Patient (??…)
    • Response is a resource (a Patient, or a Bundle, or an OperationOutcome)
• POST (create)
• PUT (update)
• DELETE (delete)
Documents

- A Bundle with
  - Type = document
  - 1st Entry is a Composition
  - N entries referenced by Composition
  - Signature and Provenance

- Used for
  - Persistence
  - Stewardship
  - Authentication
  - Context
  - Integrity
  - Human Readability

http://build.fhir.org/documents
Layered FHIR specifications

- Different levels of specification
  - Look for already existing guidance…
  - …or help build it

- A specification can add constraints and extensions to the specification it depends on
FHIR specifications – Implementation Guides

- Define the use cases
- Define the data
  - Functionally – Logical models
  - Technically – FHIR profiles
  - terminology
Case Reporting Architecture
Case Reporting requirements

• Observe how a patient’s condition evolves

• Track chronic / epidemic diseases...

• ... or short-term episodes
Case Reporting Architecture components
Data Sourcing

• What data is there? What can be acquired?
  • Patient episode data (treatment, medication, visit report...)
  • EHR existing data
  • Legacy data
  • (Other data)

• When is it acquired?
  • Each event / visit
  • History
Data Pool

- Data objects – can be FHIR native or not
- **Data functions**
  - Data processing/reconciliation
  - De-identification

- Storage format – not end format
Data Acquisition

• Data acquisition getting data into the **Storage format**
• Depends on how data is to be acquired
  • User entry e.g. Patient, nurse...
  • From existing systems e.g. EHRs
Data Usage

• Population data / analytics
  • Dedicated architecture
  • Existing specification

• Surveillance / trigger events
  • Can use e.g. FHIR Subscriptions
Data Structures
Data Objects

• Data input
  • Patient episode
  • Patient history
  • EHR data
  • Legacy data
  • (Other data e.g. product data)
Data objects

- Case reports could be presented as FHIR resources
  - Even better packed in a Bundle per Event / per Patient

- However, sometimes what we have is other data...
  - Some previously captured data – CSV/others
  - Standardized data (CDA,...)

- ...or we need to capture it
Why use forms?

• AllergyIntolerance
• Condition
• Encounter
• FamilyMemberHistory
• MedicationStatement
• Observation
• Patient
• 100+ other resources

or

• QuestionnaireResponse
Forms for display
Forms provide:

• Tight control over user experience:
  • How questions are phrased
  • What answer choices are permitted
  • What gets asked when (and in what order)
  • User interface ‘appearance’
  • i.e. Consistency in data capture

• Full flexibility in what data is captured and how

• Very simple data model
Anatomy of a Question

Prefix

Text

5.a) What pizza toppings would you like?

(choose at least 1)

- Cheese
- Ham
- Mushrooms
- Other

(please specify): ____________

Child “display” item

(implies required = true, repeats = true)

Option or options

Nested “question” item

(enableWhen tied to “Other” answer)
Linking Questionnaire to QuestionnaireResponse

**Questionnaire**

```
<item>
  <linkId value="Q1"/>
  <text value="Test questions"/>
  <type value="group"/>
  <repeats value="true"/>
  <item>
    <linkId value="Q1"/>
    <text value="What is your name?"/>
    <type value="string"/>
  </item>
  <item>
    <linkId value="Q2"/>
    <text value="What is your quest?"/>
    <type value="string"/>
  </item>
  <item>
    <linkId value="Q3"/>
    <text value="What is your favorite colour?"/>
    <type value="string"/>
  </item>
</item>
```

**QuestionnaireResponse**

```
<item>
  <linkId value="Q1"/>
  <text value="Test questions"/>
  <item>
    <linkId value="Q1"/>
    <text value="What is your name?"/>
    <answer>
      <valueString value="Sir Lancelot of Camelot"/>
    </answer>
  </item>
  <item>
    <linkId value="Q2"/>
    <text value="What is your quest?"/>
    <type value="string"/>
  </item>
  <item>
    <linkId value="Q3"/>
    <text value="What is your favorite colour?"/>
    <type value="string"/>
  </item>
</item>
```
Structured Data Capture (SDC)
What is Structured Data Capture (SDC)?

- Standardize/enhance capabilities of FHIR Questionnaires:
  - Workflow
  - Complex form rendering - [https://build.fhir.org/ig/HL7/sdc/rendering.html](https://build.fhir.org/ig/HL7/sdc/rendering.html)
  - Complex form behavior - [https://build.fhir.org/ig/HL7/sdc/behavior.html](https://build.fhir.org/ig/HL7/sdc/behavior.html)
  - Automatically populating forms - [https://build.fhir.org/ig/HL7/sdc/behavior.html](https://build.fhir.org/ig/HL7/sdc/behavior.html)
  - Automatically extracting form data - [https://build.fhir.org/ig/HL7/sdc/extraction.html](https://build.fhir.org/ig/HL7/sdc/extraction.html)
  - Adaptive forms - [https://build.fhir.org/ig/HL7/sdc/adaptive.html](https://build.fhir.org/ig/HL7/sdc/adaptive.html)
  - Form composition - [https://build.fhir.org/ig/HL7/sdc/modular.html](https://build.fhir.org/ig/HL7/sdc/modular.html)
Questionnaire (complex) workflow and actors

• How do you find a form?
• How do you retrieve allowed values?
• How do you manage form completion?
• How do you submit a form?
• How do you ask someone to complete a form?
• How do you track whether they’ve filled it out?
• How do you derive one form from another?
SDC as enabler of standard tools

• [https://confluence.hl7.org/display/FHIRI/SDC+Implementations](https://confluence.hl7.org/display/FHIRI/SDC+Implementations)

Data Extraction
Data extraction

3 mechanisms to be explored later

• Observation-based extraction
• Definition-based extraction
• Structure-map based extraction
  • $extract operation
Structure-map extraction

• Uses FHIR mapping language -
  • https://www.hl7.org/fhir/mapping-language.html

• Easily gets rather complex
  • we’re working on making it more accessible
Structure-map extraction

• Uses FHIR mapping language -
  • [https://www.hl7.org/fhir/mapping-language.html](https://www.hl7.org/fhir/mapping-language.html)

• Easily gets rather complex
  • we’re working on making it more accessible
Mapping

map "http://hl7belgium.org/matchbox/fml/extractfindrisc" = "extractfindrisc"

uses "http://hl7.org/fhir/StructureDefinition/QuestionnaireResponse" alias QuestionnaireResponse as source
uses "http://hl7.org/fhir/StructureDefinition/Observation" alias Observation as target

group QuestionnaireResponse(source src : QuestionnaireResponse, target tgt : Observation) {
    src.item as item where linkId.value in ('findriscScore') -> tgt as scoreresult then item(item, scoreresult) "r1";
    src.item as item where linkId.value in ('findriscScore') -> tgt as scoreresult then patient(item, scoreresult) "r2";
}

group item(source src, target tgt : Observation) {
    src -> tgt.code as code then itemcoding(src, code) "x1";
    src -> tgt.status = "final" "x2";
    src -> tgt.value = (src.answer.valueDecimal) "x3";
}

group patient(source src, target tgt : Observation) {
    src -> tgt.subject as patref then patientid(src, patref) "x4";
}

group patientid(source src, target tgt : Reference) {
    src -> tgt.id as patid then idvalue(src, patid) "x5";
}

group idvalue(source src, target tgt : Identifier) {
    src -> tgt.value = (src.answer.valueDecimal) "x6";
}

group itemcoding(source src, target tgt : CodeableConcept) {
    src -> tgt.coding as y then codingcode(src,y) "x7";
}

group codingcode(source src, target tgt : Coding) {
    src -> tgt.code = "763117005" "x8";
    src -> tgt.system = "http://snomed.info/sct" "x9";
    src -> tgt.display = 'FINDRISC (Finnish Diabetes Risk Score) score' "x10";
}
HIV Mapping

• + Wrapped in a Document
Implementation

Introduction
Tooling

• Implementation Guide
• LHCForms
• HAPI
• Matchbox
Layered FHIR specifications

• Different levels of specification
  • Look for already existing guidance…
  • …or help build it

• A specification can add constraints and extensions to the specification it depends on
Q&A, ideas
Get in touch, be active

• Check with others (at chat.fhir.org or community.fhir.org)
• Create (or ask someone to create) a change request
• Join a FHIR® event like DevDays (devdays.com), discuss
• Join a FHIR® connectathon, test and provide feedback
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Demo and hands-on

- http://ui.hl7.beda.software
- http://smartqedit4.azurewebsites.net