FHIR Overview

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A bit of Standards history

At the beginning (1987) there was V2

- A delimiter based message system exemplified with part of complete blood count message below ..... 

  OBX|2|NM|789-8^RBC^LN|4.9|10^6/uL|4.0-5.4|N
  OBX|3|NM|718-7^HGB^LN|12.4|g/dL|12.0 5.0|N
  OBX|4|NM|20570-8^HCT^LN|50|%|35-49|H
  OBX|5|NM|30428-7^MCV^LN|81|fL|80-94|N

V2 continues to dominate

- Then there was V3 – an XML based message/document system – which was never successful

- Then CDA, based on V3 as a document system, which is in use but challenging

- V2 continues to be mainstay (20-40 billion messages/year)
Now we have FHIR—which is the future

- It parallels much of V2’s organization. V2 has separate segments for the patient, orders, medications, and observations
- FHIR does too, but has more
- V2 had data types, like structured names (last^First^middle^Suffix^title, etc) coded data
- FHIR does too, but goes further and with more precision
- FHIR is an API, but can implement a message paradigm like V2 AND a document paradigm like V3
Overview – of FHIR
What is it?

- A set of data structured and designed to store and deliver everything of interest to clinical care and associated activities - billing, research, etc.
- Foundation is a set of more than a 100 “tables” (objects) called resources
- Each table contains multiple fields/attributes
- Fields have an associated data types – like decimal, text, range, address, coded entry, person name
- Some data types are complicated and made up of other smaller data types (e.g. names, addresses, code entry)
- It also has profiles and extensions which I will leave to Lloyd to define
What makes it attractive

- It is very malleable
  - It does not specify any particular database technology. Just defines how it should behave
  - The structured (resources) can be represented in XML, JSON, or RDF triples (maybe even CSV)
- It dodges the effort of defining *one standard* enterprise model (can’t be done) by limiting attention to the key elements (80:20) and allowing users to add things of their choosing as extensions but in a formal and controlled way
- Encourages the use of specific coding systems like LOINC and UCUM but does not require them
Why attractive more

- Available FHIR servers also include hordes of relevant coding systems built in.
- Has strong buy in from industry and growing support from Federal agencies. ONC is on board. CMS and FDA are feeling the pull.
- It is accumulating the functions of a full-fledged health system.
- Provides a great ecosystem for developing special tools and applications without having to do it yourself.
- Apple Health is built on FHIR (as well as the Meaningful Use coding systems – LOINC, RxNorm and SNOMED CT) and so is the emerging Sync For Science and All of Us research projects.
Still more

- Free, test servers (For those who want to play)
  http://hapifhir.io/docindex.html

- SMART on FHIR – an set of FHIR tools and application designed to pull data out of commercial EMRs and do interesting things
  https://apps.smarthealthit.org/apps/featured/page/2
  - Including one of our own tools

LHC-Forms on FHIR
Lister Hill National Center for Biomedical Communications (LHNCBC)
Widget that creates input forms for Web-based medical applications or to integrate into electronic health records.

Support: Web  Designed for: Clinicians & Patients
Even more

- Balloted under ANSI rules as a formal HL7 standard
- All available at no cost
- Emerged on a relative shoestring
- Gorgeous and consistent documentation immediately available online
- Will explain it further through that documentation
A walk through the FHIR documentation garden

If you want to walk it yourself here is the URL for the active development version (https://build.fhir.org/index.html)
It will take you to a page. It has interesting information but too little to start. First, take a look at the resources and dig in one or two. Click on the 'Resources' button and in orange
There are more than 100 resources (think of them as tables with special powers) Check out the terminology resources.

https://build.fhir.org/resourcelist.html
Further down the same page we see other resources – note especially those in the Left most column

<table>
<thead>
<tr>
<th>Individuals</th>
<th>Entities</th>
<th>Workflow</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 5</td>
<td>Organization 3</td>
<td>Task 2</td>
<td>Encounter 2</td>
</tr>
<tr>
<td>Practitioner 3</td>
<td>OrganizationRole 0</td>
<td>Appointment 3</td>
<td>EpisodeOfCare 2</td>
</tr>
<tr>
<td>PractitionerRole 2</td>
<td>HealthcareService 2</td>
<td>AppointmentResponse 3</td>
<td>Flag 1</td>
</tr>
<tr>
<td>Patient 2</td>
<td>Endpoint 2</td>
<td>Schedule 3</td>
<td>List 1</td>
</tr>
<tr>
<td>Person 2</td>
<td>Location 3</td>
<td>Slot 3</td>
<td>Library 2</td>
</tr>
<tr>
<td>Group 1</td>
<td>Substance 2</td>
<td>ProcessRequest 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BiologicallyDerivedProduct 0</td>
<td>ProcessResponse 2</td>
<td></td>
</tr>
</tbody>
</table>
Finally the resources that constitute the guts of the clinical record 
(I highlighted a few - note that observation is the most mature)
What you will see in diagnostic report and observations are test and measurements such as the following: [https://build.fhir.org/resourcelist.html](https://build.fhir.org/resourcelist.html)

<table>
<thead>
<tr>
<th>Concept</th>
<th>Example</th>
<th>Where to find</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical Findings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory Results</td>
<td>Blood panels such as CBC with Differential, Liver Panel, etc.</td>
<td>DiagnosticReport with Observations</td>
</tr>
<tr>
<td>Imaging Study Findings</td>
<td>CT Scans, MRI, Plain Radiographs, Ultrasounds)</td>
<td>DiagnosticReport (some with Observations)</td>
</tr>
<tr>
<td>Diagnostic Test Results</td>
<td>EKG, pulmonary function test, EEG</td>
<td>Observations (and maybe a DiagnosticReport)</td>
</tr>
<tr>
<td>Vital Signs</td>
<td>Temperature, Blood Pressure, Heart Rate, Respiratory Rate</td>
<td>Observation</td>
</tr>
<tr>
<td>Other Physical Exam Findings</td>
<td>Auscultation findings</td>
<td>Observation</td>
</tr>
<tr>
<td>Pulmonary Artery Catheter readings</td>
<td>Pulmonary artery pressure</td>
<td>Observation</td>
</tr>
</tbody>
</table>
Click on Observations to learn how to explore any resource. Note the five tabs. ([https://build.fhir.org/observation.html](https://build.fhir.org/observation.html))

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**10.1 Resource Observation - Content**

Orders and Observations Work Group  | Maturity Level: 5 | Normative | Compartments: Device, Encounter, Patient, Practice
--- | --- | --- | ---

Normative Candidate Note: This page is candidate normative content for R4 in the Observation Package. Once normative, it will lose its Candidate status and no longer be made.

Measurements and simple assertions made about a patient, device or other subject.

**Note to balloters** The Orders and Observations work-group wants to draw the attention of reviewers and implementers to the following resource:

1. The guidance on using code value pairs to represent observations in FHIR
Content tab – a good one

This one includes lots of narrative descriptions and a structured hierarchy of the fields (attributes) of in the file. Read the text but don’t wrestle with the hierarchy on the first pass.

The example tab shows JASON and XML examples of real observations. Depending on the resource examples and the examples may rich in number and variety or not. Don’t start there

Observation-example-f001-glucose

<table>
<thead>
<tr>
<th>Orders and Observations Work Group</th>
<th>Maturity Level: N/A</th>
<th>Ballot Status: Informative</th>
<th>Compartments: Device, Encounter, Patient, Practitioner, RelatedPerson</th>
</tr>
</thead>
</table>

This is the narrative for the resource. See also the XML or JSON format. This example conforms to the profile Observation.

Generated Narrative with Details

id: f001

identifier: 6323 (OFFICIAL)

status: final


subject: P. van de Heuvel

effective: Apr 2, 2013 9:30:10 AM --> (ongoing)
Resource Observation

http://hl7.org/fhir/observation.html

Resource Observation - Content

Observations Work Group | Maturity Level: 5 | Trial Use | Compartments: Device, Encounter, Patient, Practitioner, RelatedPerson

Observations and simple assertions made about a patient, device or other subject.

Scope and Usage

An observation is an event resource from a FHIR workflow perspective - see Workflow.

Observations are a central element in healthcare, used to support diagnosis, monitor progress, determine baselines and patterns and even capture demographic characteristics. Observations are simple name/value pair assertions with some metadata, but some observations group other observations together logically, or even are multi-component. Note that the DiagnosticReport resource provides a clinical or workflow context for a set of observations and the Observation resource is referenced by the report to represent lab, imaging, and other clinical and diagnostic data to form a complete report.

Observation resource include:

- Measurements such as body weight, blood pressure, and temperature
- Laboratory Data like blood glucose, or an estimated GFR
- Results like bone density or fetal measurements
- Measurements such as EKG data or Pulse Oximetry data
- Assessment tools such as APGAR or a Glasgow Coma Score
- Characteristics: such as eye-color
- History like tobacco use, family support, or cognitive status
- Characteristics like pregnancy status, or a death assertion
Detailed descriptions tab ([https://build.fhir.org/observation-definitions.html](https://build.fhir.org/observation-definitions.html))

For learning about a given observation, this is the best tab to dwell on. It lists each field by name, gives its data type and explains what it contains. Once you have negotiated a given resource, the pattern will be the same for all other resources – Nice thing about FHIR
Some observation fields

**Observation.code**
- **Definition**: Observation.code
- **Description**: Describes what was observed. Sometimes this is called the observation "name".

**Observation.subject**
- **Definition**: Observation.subject
- **Description**: The patient, or group of patients, location, or device whose characteristics (direct or indirect) are described by the observation and into whose record the observation is placed. Comments: Indirect characteristics may be those of a specimen, fetus, donor, other observer (for example a relative or EMT), or any observation made about the subject.

**Observation.focus**
- **Definition**: Observation.focus
- **Description**: This element has a standards status of "Trial Use" which is different to the status of the whole resource.

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Identifies the observation

Subject usually the patient
The value of the observation – the data of the observation. See possibilities in list.

Reason why a value might be missing
FHIR Data types (https://build.fhir.org/datatypes.html)

- Primitive data types
Complex FHIR data types

Complex Types

- Ratio
- Period
- Range
- Attachment
- Identifier
- Timing
- Coding
- Signature
- CodeableConcept
- Quantity
- SimpleQuantity
- Duration
- Count
- Money
- HumanName
- Annotation
- Address
- ContactPoint

Element
We (LHNCBC) have been developing specifications for reporting genetic test results in a structured fashion. The first was for V2 and approved by ballot late 2017 as part of the general Laboratory Result Interface – along with Newborn screening, also born in LHNCBC.

Now we are working in the FHIR workgroup to create a parallel specification in FHIR.

Lloyd, who is the lead on this project, has created UML diagrams to show the relationships between specific observations needed to support FHIR reporting of structured genetic reports. These distinct observations are all defined by LOINC terms. This UML diagram is a nice way to see the relationships, and you may see them associated with other resources. Will show just one of the pages of the UML diagram ([link](https://docs.google.com/document/d/1juWEnjyXV34yYmPq3FDpLAiJlM0Hiv0FyNBfvPD6enM/edit#heading=h.fk5kmv4ghxne))
Why I like FHIR – a Contrast

cda Obligation Policy Security Observation

[Observation: templateId 2.16.840.1.113883.3.445.14]

This template is constrains the Security Observation to specify a "obligation policy code". This template reuses the SecurityObservation implementing the HL7 Healthcare Security Classification (HCS) standard.

1. SHALL contain exactly one [1..1] templateId (CONF-CD-14) such that it
   a. SHALL contain exactly one [1..1] @root="2.16.840.1.113883.3.445.14"

2. SHALL conform to cda Security Observation template (templateId: 2.16.840.1.113883.3.445.21) (CONF:16828)


4. SHALL contain exactly one [1..1] value (CONF:9136), where the @code SHOULD be selected from ValueSet HL7 ObligationPolicyCode 2.16.840.1.113883.1.1.20445 STATIC (CONF:9137)
   • This attribute specifies a type of obligation policy, specifically.
cda Obligation Policy Security Observation example

```xml
<observation classCode="OBS" moodCode="EVN">
  <!-- Security Observation -->
  <templateId root="2.16.840.1.113883.3.445.21"
    assigningAuthorityName="HL7 CBCC"/>
  <!-- Obligation Policy Code template -->
  <templateId root="2.16.840.1.113883.3.445.14"
    assigningAuthorityName="HL7 CBCC"/>
  <code code="SECCONOBS"
    codeSystem="2.16.840.1.113883.1.11.20457"
    displayName="Security Classification"
    codeSystemName="HL7 SecurityObservationTypeCodeSystem"/>
  <!-- Value set constraint "2.16.840.1.113883.1.11.20445" -->
  <value xsi:type="CE" code="ENCRIPT"
    codeSystem="2.16.840.1.113883.5.1063"
    codeSystemName="SecurityObservationValueCodeSystem"
    displayName="Encrypt information">
    <originalText>Information must be encrypted</originalText>
  </value>
</observation>
```
Summary

In theory, FHIR could be used for any application, but it is tuned for healthcare and research applications. And there are miles to go to finish the healthcare side before the FHIR leaders sleep.

I have emphasized a relatively static data storage and retrieval but FHIR extends to many dynamic features from real time data collection to Structured Data Capture (SDC). (Another area where LHNCBC scientists are active in the development of the SDC specification and a variety of tools for providing support for data capture, including the generation of live SDC forms from the form definition, and autocomplete entry of data from external coding systems). (https://lhc-forms.lhc.nlm.nih.gov)
# LHC-Forms Example

## Personal Health Record

### Medical Conditions

<table>
<thead>
<tr>
<th>Medical condition</th>
<th>Status</th>
<th>Started</th>
<th>Stopped</th>
<th>Description/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest pain</td>
<td>Active</td>
<td>04/20/2016</td>
<td>MM/DD/YYYY</td>
<td>Sounds anginal. Worsen with exertion, but young and no family history</td>
</tr>
<tr>
<td>Pneumonia - bronchial</td>
<td>Inactive</td>
<td>03/17/2017</td>
<td>04/22/2016</td>
<td>Treated with Zpack on ambulatory basis</td>
</tr>
<tr>
<td>Hay fever (allergic rhinitis)</td>
<td>Active</td>
<td>03/20/2012</td>
<td>MM/DD/YYYY</td>
<td>Every spring</td>
</tr>
</tbody>
</table>

**Add another 'Medical Conditions'**

### Medications

<table>
<thead>
<tr>
<th>Medication name</th>
<th>Status</th>
<th>Strength</th>
<th>Instructions</th>
<th>Started</th>
<th>Stopped</th>
<th>Why stopped</th>
<th>Resupply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z.PAK (Pack)</td>
<td>Stopped</td>
<td>mixed Pack</td>
<td>take until gone</td>
<td>03/17/2016</td>
<td>04/22/2016</td>
<td>Finished the prescription</td>
<td>MM/DD/YYYY</td>
</tr>
<tr>
<td>Bectolmethasone (Nasal)</td>
<td>Active</td>
<td>40 mcg/puff Metered dose sp</td>
<td>1 puff twice day in season</td>
<td>03/20/2012</td>
<td>MM/DD/YYYY</td>
<td>Select one or type a value</td>
<td>MM/DD/YYYY</td>
</tr>
</tbody>
</table>

**Add another 'Medications'**

### Allergies and Other Dangerous Reactions

<table>
<thead>
<tr>
<th>Name</th>
<th>Reaction</th>
<th>Started</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen</td>
<td>Sneezing or stuffy nose</td>
<td>03/15/2017</td>
<td>Worse when maple trees bloom</td>
</tr>
<tr>
<td>Select one or type a value</td>
<td>Select one or type a value</td>
<td>MM/DD/YYYY</td>
<td>Type a value</td>
</tr>
</tbody>
</table>