Interoperability & Healthcare Now and in the Future

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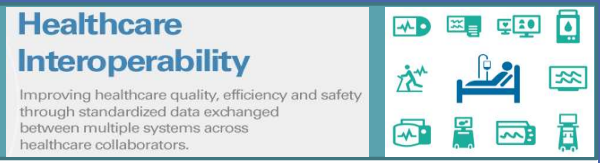
Presentation Outlines

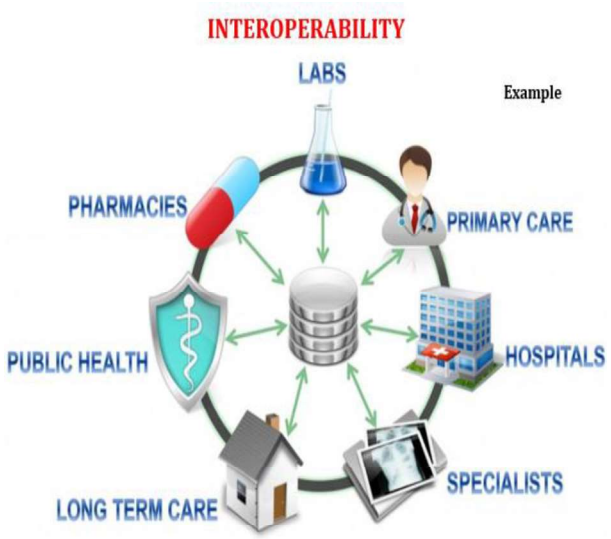


- Interoperability – What it is ?
- Level of Interoperability
- Current Standard
- Interoperability : Advantages
- Interoperability : Challenges
- Interoperability : Future
- HIS : Introduction & Issues
- My Current Activities
- Summary
- References

Interoperability – What it is ?

- "Interoperability is the ability of different information technology systems and software applications to **communicate**, to **exchange data accurately**, **effectively**, and **consistently**, and to use the information that has been exchanged [1]".

- According to the Healthcare Information and Management Systems Society (HIMSS), "*Interoperability describes the extent to which systems and devices can exchange data, and interpret that shared data. For two systems to be interoperable, they must be able to exchange data and subsequently present that data such that it can be understood by a user*."



Interoperability : Level

- Basic components of interoperability :
  - Ability of at least two or more interfaces/software/systems to exchange data. And able to use the exchanged data smoothly.

- ***Interoperability can be divided into three levels***

Level	Descriptions
Foundation	This is basic level. One EPR system receive data from another system but does not need to interpret it;
Structure	Data can be exchanged between information technology systems and interpreted at the data filed level; Format of data exchange (e.g. the message format standards); OR structural interoperability defines the syntax of the data exchange.
Semantic	It is the highest level of interoperability; where two or more systems can exchange information and exchanged information can be used;

Interoperability – Advantages

- It will reduce error and increase the efficiency.
- It will **reduce cost** (for non-integrated health care system) and quick implementation.
- This enables data sharing and data can be analysed in different ways as per the requirements.
- Improve patient safety and provide accurate information.

Interoperability – Advantages

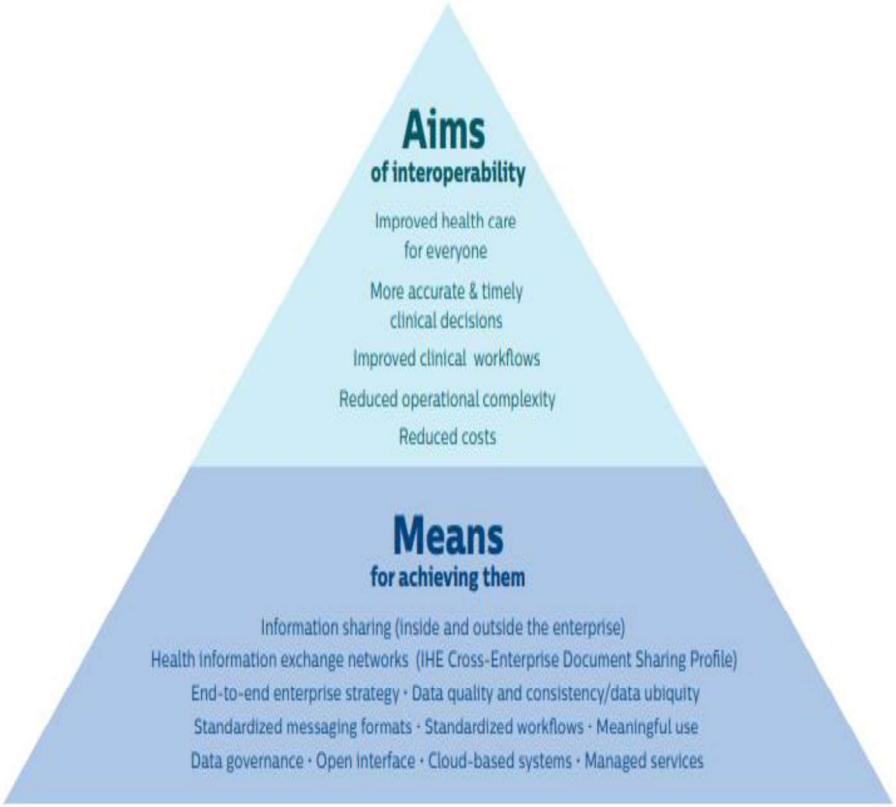
- More time to patient(s)– doctor(s) can provide more time to patient care rather than search the patients' information or data (historical and current).
- Better conversion between the doctors and other departments (e.g. Lab., Radiology, Nurse, Ward, ICU, or other stakeholders)
- Data can be shared smoothly across the *Departments*, *Hospitals*, *Clinicians* etc.

Interoperability – Standard

- **Health Level Seven (HL7)**
  - HL7v2,
  - HL7v3,
  - HL7 FHIR (**Fast Healthc**
    Interoperability Resources)

-Fast **(FHIR)** as competent standards for electr
exchange of healthcare information; developed
HL7.

-And it is **combines the good** features of **HL7 V2**
and CDA. It is design based on
RESTful web services.



https://www.healthterminologies.gov.au/docs/DH_2711_2018_Introduction_to_the_FHIR_Specification_Presentation_v1.0.pdf

Interoperability – Standard

Hammond, Bailey, Boucher, Spohr, and Whitaker, 2010 : List of common standards development Organization

TYPE OF STANDARD	EXAMPLE STANDARDS	SDO CREATING THE STANDARD
General standards	XML, TCP/IP, 802.11, Web services, security, wireless, GPS	W3C, IETF, IEEE, OMG, HL7
Data components	Reference Information Model (RIM), data elements, data types, terminology, templates, clinical statements, clinical document architecture	HL7, CEN, ISO, openEHR, IHTSDO, LOINC, RxNorm, UMLS, WHO
Data interchange	Structured and free-form documents, images	HL7, ASTM, DICOM, IEEE 1073, NCPDP, X12N, CEN, ISO
Knowledge representation	Guidelines and protocols, decision support algorithms	HL7, ASTM
Electronic health record (EHR)	Functional requirements, EHR models, Continuity of Care Record (CCR), patient summary record, personal health record	HL7, ASTM, openEHR, CEN
Application level support	Identifiers, resource registries, disease registries, tool sets, conformance requirements, implementation manuals	HIPAA, HL7, ASTM, ISO, CEN

Interoperability – Standard

HL7

- **Health Level Seven (HL7)**
  - HL7 V2
  - HL7 V3 (RIM)
  - HL7 CDA (RIM) -- Document
  - HL7 FHIR

- **Grahame Grieve** wrote the initial Strawman version of FHIR between May and August 2011, it was called 'Resources for Health (RFH)

- FHIR is a RESTful API and it is successful to develop a RESTful architecture, Linkedln, Twitter etc.

Interoperability – Standard

HL7 Fast Healthcare Interoperability Resources Specification (FHIR®) : FIHR is a next generation standard framework.

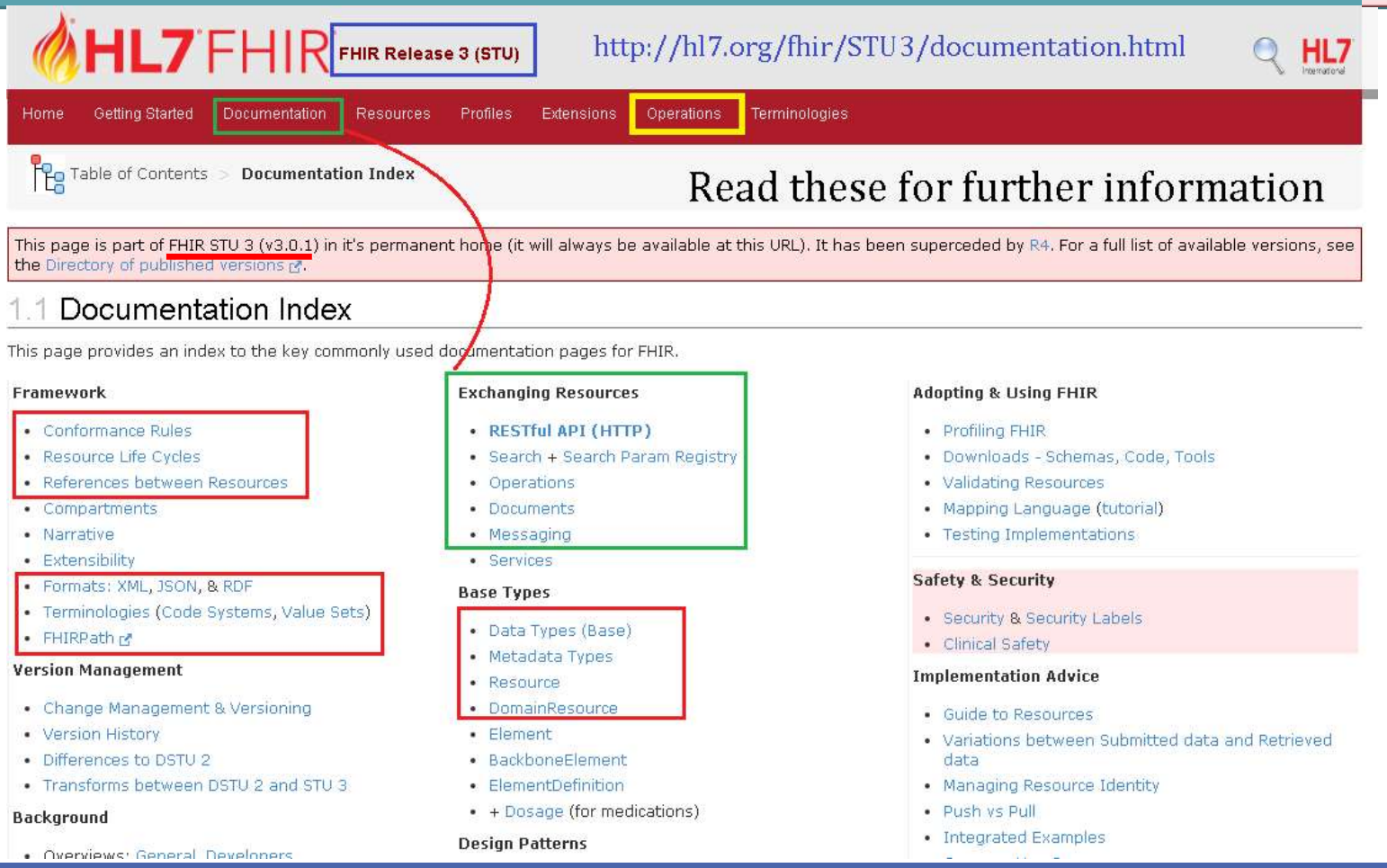
Targets:

- Clinical and public health laboratories
- Clinical decision support systems vendors
- Lab vendors
- HIS vendors
- Emergency Service Providers
- Medical Image Services Providers
- Health care institutions –
- Immunization Registries
- Pharmaceutical vendors, etc

Some Benefits:

- Multiple implementation libraries, many examples available to kick-start development
- Specification is free for use with no restriction
- Strong foundation in Web Standards :
  - XML, JSON,HTML, Atom, Oauth
- Human Read able format
- Support RESTful architectures, etc.

Interoperability – Standard



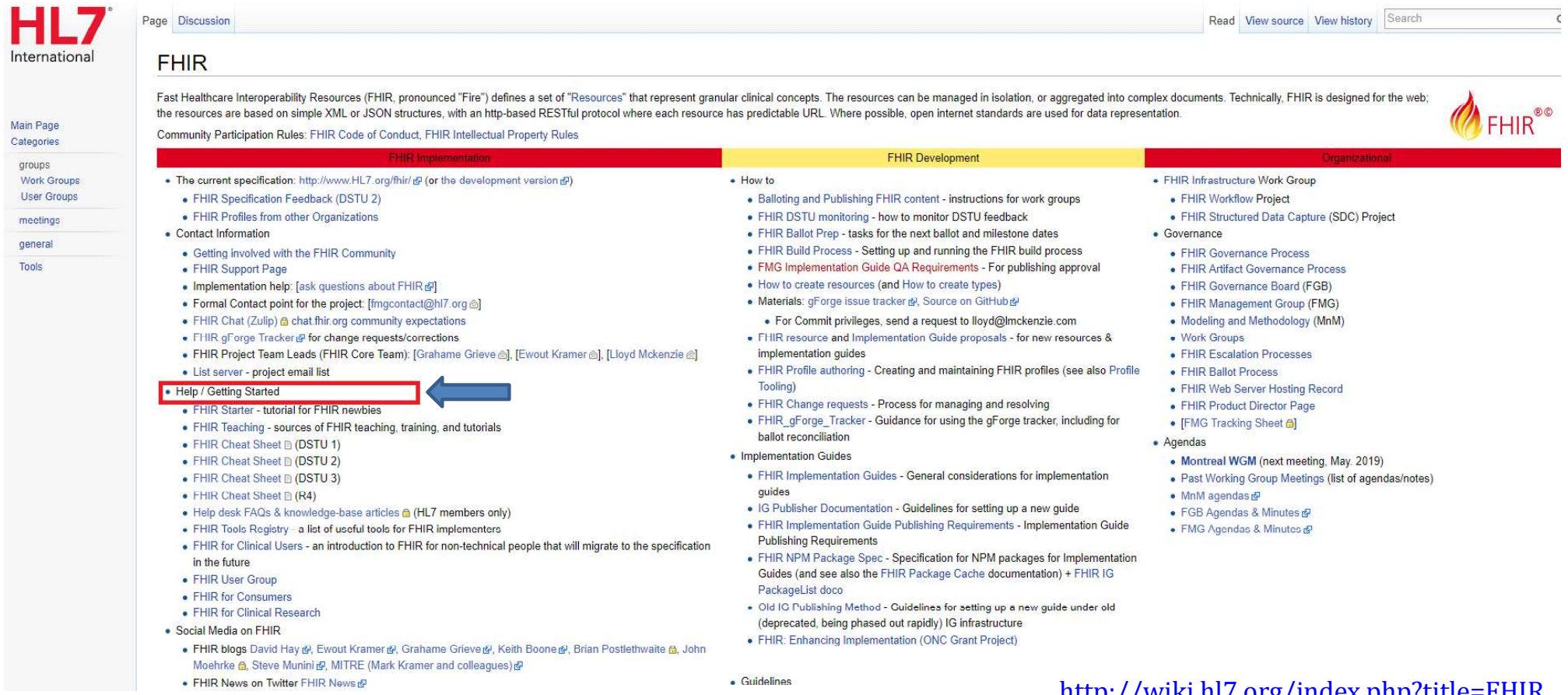
Familiarize yourself with the HL7 FHIR

Good Starting Point:

--Click Resources
--Select ***Patient S***
-

Read :
- Documentation
- Resources
- Operations

Interoperability – Standard



HL7 International

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FHIR

Fast Healthcare Interoperability Resources (FHIR, pronounced "Fire") defines a set of "Resources" that represent granular clinical concepts. The resources can be managed in isolation, or aggregated into complex documents. Technically, FHIR is designed for the web; the resources are based on simple XML or JSON structures, with an http-based RESTful protocol where each resource has predictable URL. Where possible, open internet standards are used for data representation.

Community Participation Rules: FHIR Code of Conduct, FHIR Intellectual Property Rules

Main Page
Categories
groups
Work Groups
User Groups
meetings
general
Tools

FHIR Implementation

- The current specification: http://www.HL7.org/fhir/ (or the development version)
  - FHIR Specification Feedback (DSTU 2)
  - FHIR Profiles from other Organizations
- Contact Information
  - Getting involved with the FHIR Community
  - FHIR Support Page
  - Implementation help: [ask questions about FHIR]
  - Formal Contact point for the project: [fmgcontact@hl7.org]
  - FHIR Chat (Zulip) chat.fhir.org community expectations
  - FHIR gForge Tracker for change requests/corrections
  - FHIR Project Team Leads (FHIR Core Team): [Grahame Grieve], [Ewout Kramer], [Lloyd Mckenzie]
  - List server - project email list
- Help / Getting Started
  - FHIR Starter - tutorial for FHIR newbies
  - FHIR Teaching - sources of FHIR teaching, training, and tutorials
  - FHIR Cheat Sheet (DSTU 1)
  - FHIR Cheat Sheet (DSTU 2)
  - FHIR Cheat Sheet (DSTU 3)
  - FHIR Cheat Sheet (R4)
  - Help desk FAQs & knowledge-base articles (HL7 members only)
  - FHIR Tools Registry - a list of useful tools for FHIR implementers
  - FHIR for Clinical Users - an introduction to FHIR for non-technical people that will migrate to the specification in the future
  - FHIR User Group
  - FHIR for Consumers
  - FHIR for Clinical Research
- Social Media on FHIR
  - FHIR blogs David Hay, Ewout Kramer, Grahame Grieve, Keith Boone, Brian Postlethwaite, John Moehrke, Steve Munini, MITRE (Mark Kramer and colleagues)
  - FHIR News on Twitter FHIR News

FHIR Development

- How to
  - Balloting and Publishing FHIR content - instructions for work groups
  - FHIR DSTU monitoring - how to monitor DSTU feedback
  - FHIR Ballot Prep - tasks for the next ballot and milestone dates
  - FHIR Build Process - Setting up and running the FHIR build process
  - FMG Implementation Guide QA Requirements - For publishing approval
  - How to create resources (and How to create types)
  - Materials: gForge issue tracker, Source on GitHub
    - For Commit privileges, send a request to lloyd@lmckenzie.com
  - FHIR resource and Implementation Guide proposals - for new resources & implementation guides
  - FHIR Profile authoring - Creating and maintaining FHIR profiles (see also Profile Tooling)
  - FHIR Change requests - Process for managing and resolving
  - FHIR_gForge_Tracker - Guidance for using the gForge tracker, including for ballot reconciliation
- Implementation Guides
  - FHIR Implementation Guides - General considerations for implementation guides
  - IG Publisher Documentation - Guidelines for setting up a new guide
  - FHIR Implementation Guide Publishing Requirements - Implementation Guide Publishing Requirements
  - FHIR NPM Package Spec - Specification for NPM packages for Implementation Guides (and see also the FHIR Package Cache documentation) + FHIR IG PackageList doco
  - Old IG Publishing Method - Guidelines for setting up a new guide under old (deprecated, being phased out rapidly) IG infrastructure
  - FHIR: Enhancing Implementation (ONC Grant Project)
- Guidelines

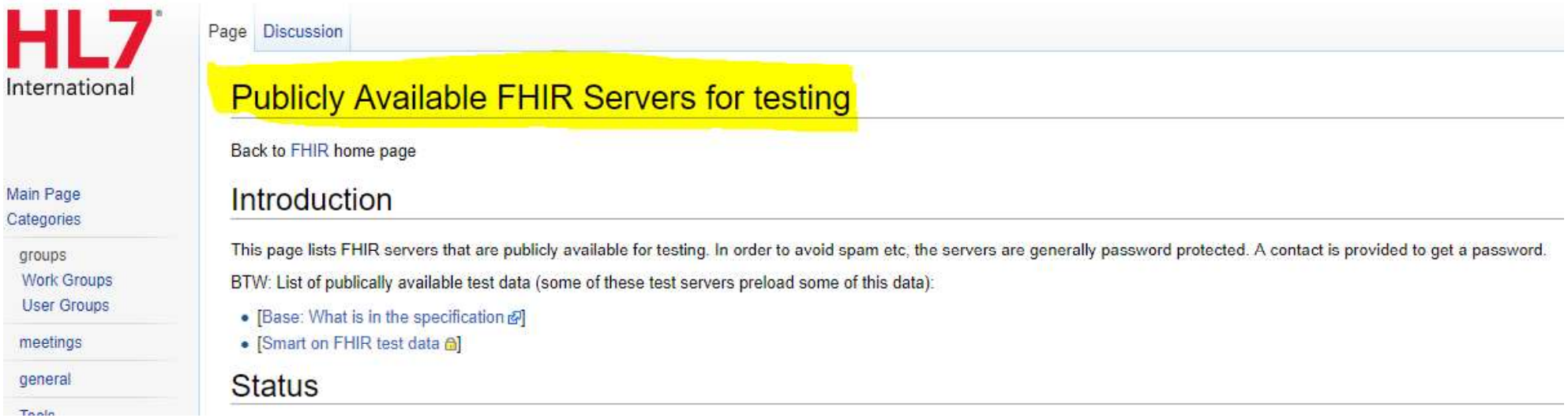
Organizational

- FHIR Infrastructure Work Group
  - FHIR Workflow Project
  - FHIR Structured Data Capture (SDC) Project
- Governance
  - FHIR Governance Process
  - FHIR Artifact Governance Process
  - FHIR Governance Board (FGB)
  - FHIR Management Group (FMG)
  - Modeling and Methodology (MnM)
  - Work Groups
  - FHIR Escalation Processes
  - FHIR Ballot Process
  - FHIR Web Server Hosting Record
  - FHIR Product Director Page
  - [FMG Tracking Sheet]
- Agendas
  - **Montreal WGM** (next meeting, May. 2019)
  - Past Working Group Meetings (list of agendas/notes)
  - MnM agendas
  - FGB Agendas & Minutes
  - FMG Agendas & Minutes

http://wiki.hl7.org/index.php?title=FHIR

Interoperability – Standard

CLICK : http://wiki.hl7.org/index.php?title=Publicly_Available_FHIR_Servers_for_testing



HL7 International

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Publicly Available FHIR Servers for testing

Back to FHIR home page

Introduction

This page lists FHIR servers that are publicly available for testing. In order to avoid spam etc, the servers are generally password protected. A contact is provided to get a password.

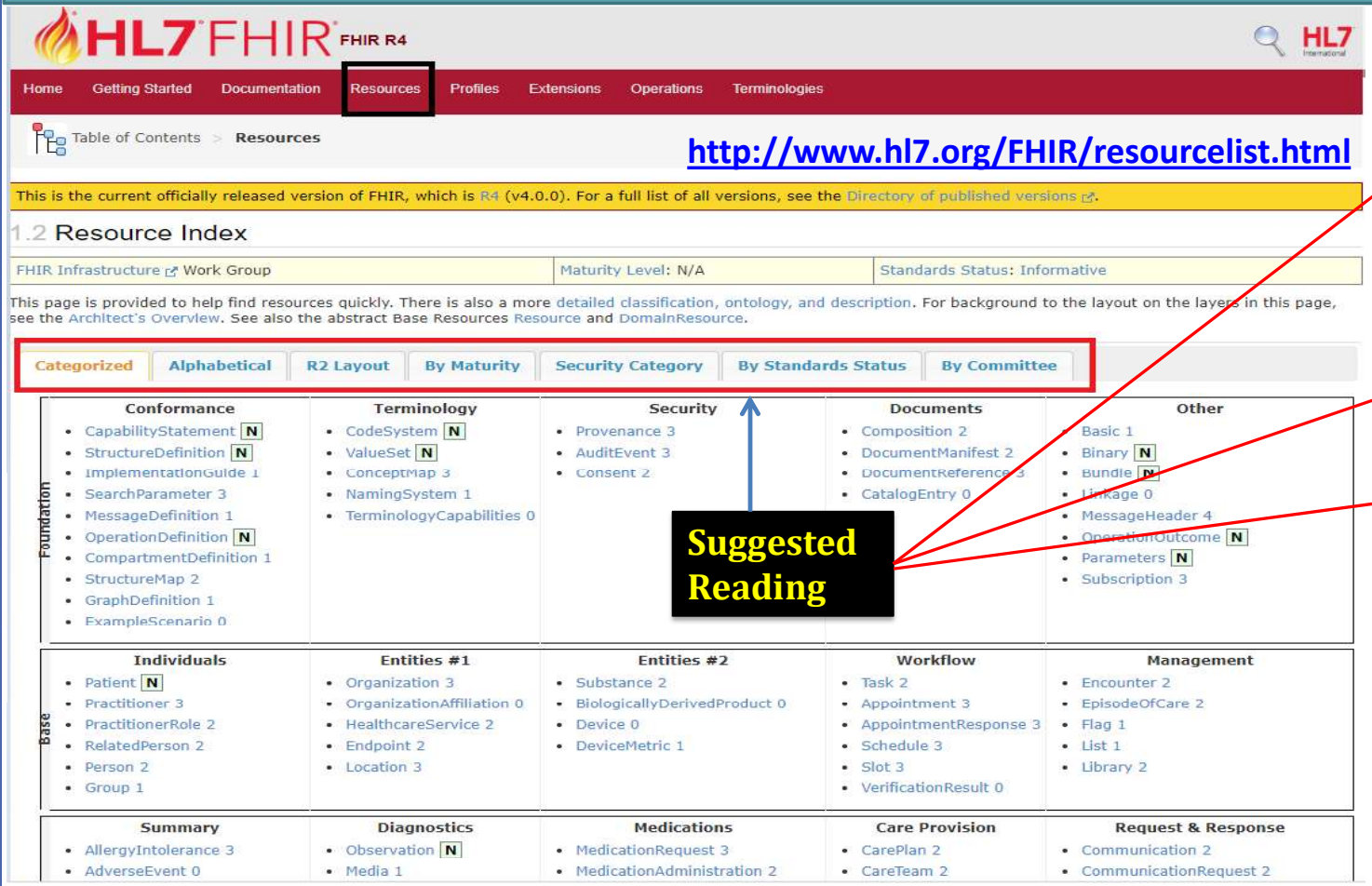
BTW: List of publically available test data (some of these test servers preload some of this data):

- [Base: What is in the specification]
- [Smart on FHIR test data]

Status

Interoperability – Standard

HL7 FHIR



Interoperability - Standard

HL7 FHIR Resource Content

Structure | UML | XML | JSON | Turtle | All

Structure

Name	Flags	Card.	Type	Description & Constraints
Resource	N		n/a	Base Resource
id	Σ	0..1	id	Logical id of this artifact
meta	Σ	0..1	Meta	Metadata about the resource
implicitRules	?! Σ	0..1	uri	A set of rules under which this content was created
language		0..1	code	Language of the resource content Common Languages (Preferred but limited to AllLanguages)

XML Template

```
<[name] xmlns="http://hl7.org/fhir">
 <!-- from Element: extension -->
 <id value="[id]"/><!-- 0..1 Logical id of this artifact -->
 <meta><!-- 0..1 Meta Metadata about the resource --></meta>
 <implicitRules value="[uri]"/><!-- 0..1 A set of rules under which this content was created -->
 <language value="[code]"/><!-- 0..1 Language of the resource content -->
</[name]>
```

UML Diagram (Legend)

Turtle Template

```
@prefix fhir: <http://hl7.org/fhir/> .


[ a fhir:[name];
  fhir:nodeRole fhir:treeRoot; # if this is the parser root

 # from Element: Element.extension
  fhir:Resource.id [ id ]; # 0..1 Logical id of this artifact
  fhir:Resource.meta [ Meta ]; # 0..1 Metadata about the resource
  fhir:Resource.implicitRules [ uri ]; # 0..1 A set of rules under which this content was created
  fhir:Resource.language [ code ]; # 0..1 Language of the resource content
]
```

JSON Template

```
{
  "resourceType" : "[name]",
  "id" : "<id>", // Logical id of this artifact
  "meta" : { Meta }, // Metadata about the resource
  "implicitRules" : "<uri>", // A set of rules under which this content was created
  "language" : "<code>" // Language of the resource content
}
```

Interoperability – JSON

JSON : JavaScript Object Notation representation describing a person. (*Copied from* Wikipedia)

```json
{
  "firstName": "John",
  "lastName": "Smith",
  "isAlive": true,
  "age": 27,
  "address": {
    "streetAddress": "21 2nd Street",
    "city": "New York",
    "state": "NY",
    "postalCode": "10021-3100"
  },
  "phoneNumbers": [
    {
      "type": "home",
      "number": "212 555-1234"
    },
    {
      "type": "office",
      "number": "646 555-4567"
    },
    {
      "type": "mobile",
      "number": "123 456-7890"
    }
  ],
  "children": [],
  "spouse": null
}
```

JSON

Base standards JSON, XML, RDF

Resource Description Framework (RDF)

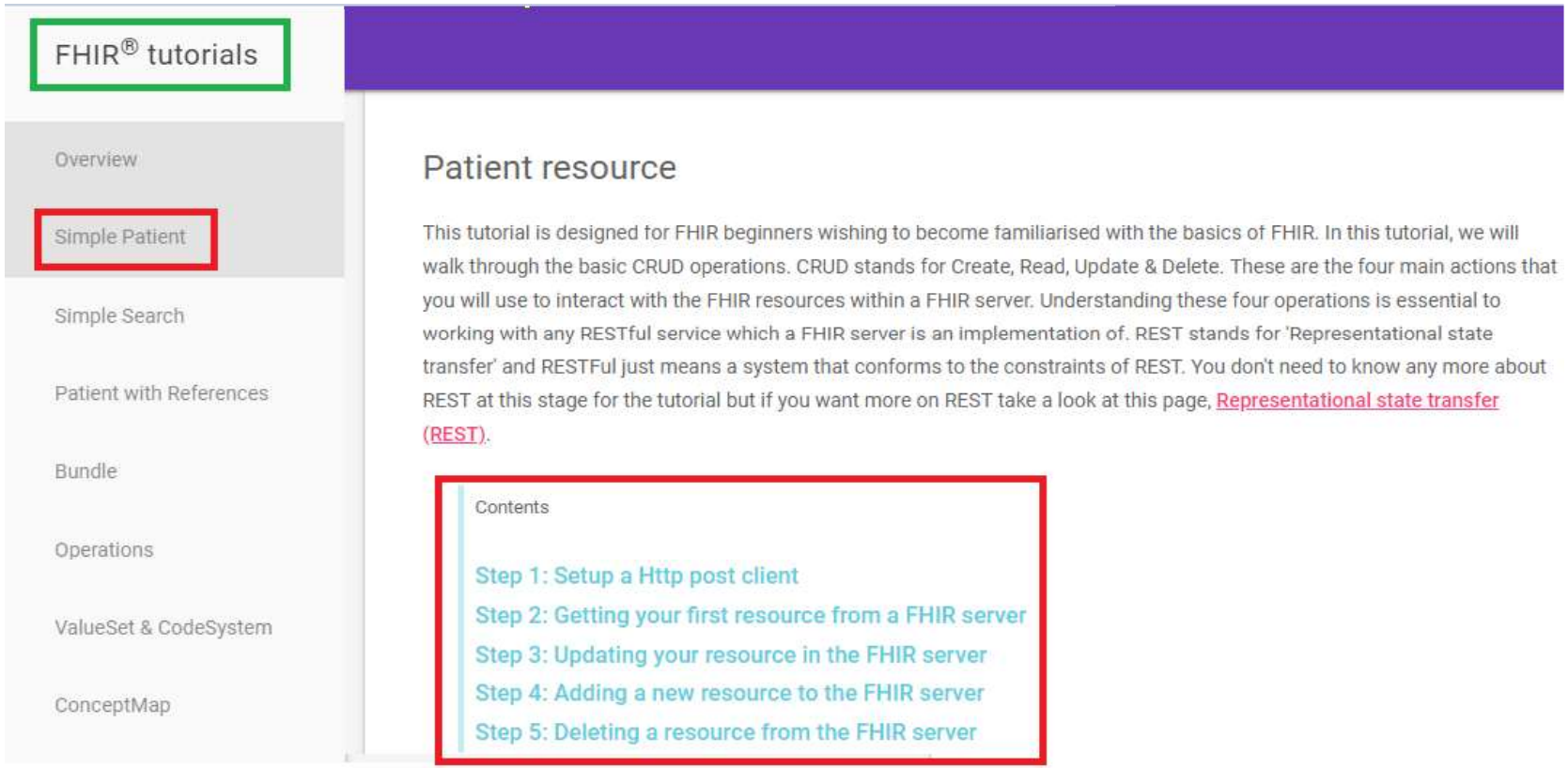
```rdf
<?xml version="1.0" encoding="utf-8"?>
<rdf:RDF xmlns:contact="http://www.w3.org/2000/10/swap/pim/contact#" xmlns:eric="http://www.w3.org/People/EM/contact#" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <contact:fullName>Eric Miller</contact:fullName>
  </rdf:Description>
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <contact:mailbox rdf:resource="mailto:e.miller123(at)example"/>
  </rdf:Description>
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <contact:personalTitle>Dr.</contact:personalTitle>
  </rdf:Description>
  <rdf:Description rdf:about="http://www.w3.org/People/EM/contact#me">
    <rdf:type rdf:resource="http://www.w3.org/2000/10/swap/pim/contact#Person"/>
  </rdf:Description>
</rdf:RDF>
```

```xml
<person>
  <firstName>John</firstName>
  <lastName>Smith</lastName>
  <age>25</age>
  <address>
    <streetAddress>21 2nd Street</streetAddress>
    <city>New York</city>
    <state>NY</state>
    <postalCode>10021</postalCode>
  </address>
  <phoneNumber>
    <type>home</type>
    <number>212 555-1234</number>
  </phoneNumber>
  <phoneNumber>
    <type>fax</type>
    <number>646 555-4567</number>
  </phoneNumber>
  <gender>
    <type>male</type>
  </gender>
</person>
```

XML

Interoperability – Standard

For FHIR tutorials : http://fhir-drills.github.io/simple-patient.html



Interoperability – Challenges

- **Lack of Standardization : Developing the Electronic Clinical Documents, for instances:**
  - Inpatient/Outpatient Discharge Summary,
  - ED Discharge Summary,
  - Inpatient/Outpatient Clinical Letters, Clinical Notes, Appointment etc.

- Non-standard messaging…… formats and lack of standard workflows….

- **Lack of Standardization of other Clinical Setting, for instances:**
  - NHS Number (MRN, Patient ID, Clinical ID) – required unique single point patient access ID
  - Medication – Standard Electronic Medical Message
  - Inconsistency of GP code, Practice Code, Consultant Code, Diagnostic Coding,
  - Vague Patients, Radiology, Pathology, Scan, Ultrasound, Video Data etc.

Interoperability – Challenges

- Non-standard Data Format (*structure data, unstructured data, linguistic variables*) & Data Quality
- Who generate data – ***Human* or Machine ?;** *Source of data, format of data etc*

➢ **Lack of Standardization Technical Data; for instances:**

- Patient's name, gender, dob, race, ethnicity, religion etc.
- Patient address filed, next of kin information,
- Vital signs, standard care plan fields, laboratory tests and results,
- Medication, medication allergies, Immunization etc.

➢ **Real-Time Health Care Information System : What ?**

➢ **Real Time Decision : How ?**

➢ **Big Data : capturing, storing and managing:**

- *How to process and extract valuable information from huge volume of data within a given timeframe ?*

Interoperability/Healthcare – Future

- **Artificial Intelligence**, **Machine Learning**, **Big Data, Block Chain** are the potential tools - big impact on the future of healthcare delivery system and interoperability.
- **Big Data : Challenges and Opportunities** – it is tough for managing the data. But can be generated new ***Knowledge*** by ***Analysis the data*** and can be introduced the new ***Wisdom*** that can be applied in health care delivery system.
- **Examples :**
  - *Decision Support System, Expert System, Prediction, Recommendation, Alert, Warning System, Drug-to-Drug Reaction, etc.*

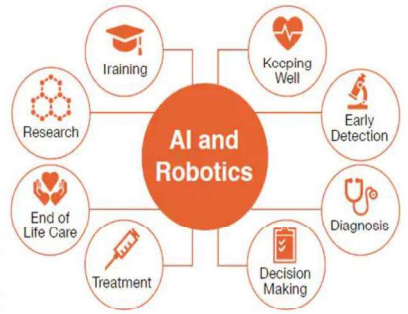
Interoperability/Healthcare – Future

- *Machine Learning Techniques can be used in various sectors – eg Auto Scheduling the Patient Appointment ….*
- *AI can be used to better interpret - images, videos, audio data……*
- *AI can be used to auto mapping the clinical data sets between the EPR and other downstream system and vice versa.*
- *Big data type can be analysed by AI systems,*
- *AI System can generate fast and meaningful clinical results, etc.*

➢ AI can be used to early *Detection* and *Diagnosis* of *diseases*.

Interoperability/Healthcare – Future

- **Machine Learning** can be applied for **predicting and analysis** for various diseases and can also assist to provide the better treatment for life threading diseases - *Heart, Lungs, Cancer, Stroke* etc and treatment etc.



- AI and Robotics is using in health care – **Robotics Healthcare**,

https://365.himss.org/sites/himss365/files/365/handouts/552330817/handout-12_1030_ISED01_Artificial%20Intelligence%20%E2%80%93%20A%20Solution%20for%20Interoperability.pdf

Read :

https://www.zdnet.com/article/healthcare-tech-ai-apis-and-interoperability/

https://hitinfrastructure.com/news/data-proliferation-fuels-need-for-healthcare-interoperability

https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html

Interoperability – Future

- There is a need to work together to develop a common standard for health information.
- Required to develop interoperability standards for the health sector. All stakeholder required to support for interoperable structures.
- Health Information Exchange and Interoperability.
- Innovation in Interoperability and Informatics.
- Establishing common Technical Data standardizing : e.g. *patient's gender, dob, vital signs, care plan fields, laboratory tests & results, immunization etc.*
- Real-Time Health Care Information System required to enrich interoperability and intelligences system to make a **Real-Time Decision.**

HIE – Health Information Exchange

How patient should have the ability to access and control over their health information.

- Required strong policy to related to the electronic exchange of HIS. Consent Models
- **Consent HIE could be : No Or Yes**
  - **Yes with Restrictions**
  - **No with Exception**
- **Collection of Consent :**
  - Web-based capturing form;
  - on paper-based form - required to fill by person;
  - over telephone (required to record the data)
- Required to design and develop : **Consent Management System for HIE.**

HIE – Health Information Exchange

- Health Information Exchange (HIE) systems rests in their potential to provide clinicians and administrative staff rapid access to relevant patient data to support judgment and decision-making.

- HIE must be very smart system to provide quick access to relevant data for doctors, administrative staff and other health care support staff to support a decision making.

- For HIE the source of data is Electronic Patient Record (EPR) and EPR has multiple sources of data ? How to access all these data and manage it ?

Summary

- So, the advancement of technologies have the ability to share and exchange data that is generate by one system into another system.
- All **directors** must be **educated with IT system** and understand the **importance of Interoperability** so it will help them to buy appropriate (interoperable) medical system or products.
- Health care delivery system, product, manufactures, suppliers must have agreed standard unique architecture.
- We could deploy the AI, Machine Learning techniques in the various sectors of health care delivery system.
- **Robust** healthcare system should be offered "**Patient-Centre-Service**" which means - service should be available ***when people want to use it***, not ***when people need it***.
- You can not feel safe even if you are living near a hospital, if hospital doesn't have the robust interoperable system.

Interoperability

Any Questions ?

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