

## FAIR Connect article

# Leveraging FHIR in health data FAIRfication process: In the case of VODAN-A

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### Keywords

FAIRfication, FAIRness, FHIR for FAIR, FAIR4Health

**Date: Sep 10, 2022**

People often confuse FAIR and FHIR given the similarity in the acronym as well as the contexts in which they are used. While the first stands for Findable Accessible Interoperable and Reusable data (FAIR)<sup>1</sup>, the later refers to Fast Healthcare Interoperability Resource (FHIR)<sup>2</sup>. FAIR, as community-agreed guiding principles, aims to prepare machine-actionable and human-readable digital objects<sup>3</sup>. FAIR, in its philosophy is technology and standard agnostic. Hence, implementing organizations consider different standards, technologies, and protocols to attain these principles. The uptake for FAIR principles by implementing organizations has increased and proof of concepts demonstrating buy-in to the principles are being published in different research areas<sup>4</sup>. Health data is one of the research areas where the concept of FAIR data is being introduced<sup>5</sup>. Health as a complex system demands a system of standardized data exchange between electronic health applications to support a longitudinal continuum of care supporting patient referral, appointment follow-up, and other data demand use cases, recognizing the sensitivity of patient data. One of the prominent health data interoperability standards is HL7 FHIR. The relevance of FHIR to achieving FAIR principles is an ongoing discussion between FAIR and FHIR communities. Fair4health and the Research data alliance (RDA) FAIR maturity model Working group have initiated the FAIRness for FHIR standard implementation guide (IG)<sup>6</sup>.

This commentary draws attention to the possibility of leveraging FHIR in the health data FAIRfication process. Taking the VODAN-Africa MVP (Virus Outbreak Data Network - Africa Minimum Viable Product) as a FAIR health data implementation in Africa, the development of horizontal and vertical interoperability between different

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<sup>1</sup> Mark D. Wilkinson et al. # The FAIR Guiding Principles for scientific data management and stewardship DOI: 10.1038/sdata.2016.18

<sup>2</sup> Overview - FHIR v4.3.0 <https://www.hl7.org/fhir/overview.html> Accessed: 2022-10-09

<sup>3</sup> Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data 3, 160018 (2016). <https://doi.org/10.1038/sdata.2016.18>

<sup>4</sup> Mirjam van Reisen et al. Towards the Tipping Point for FAIR Implementation [https://doi.org/10.1162/dint\\_a\\_00049](https://doi.org/10.1162/dint_a_00049)

<sup>5</sup> Inau, Esther Thea Sack, Jean Waltemath, Dagmar Zeleke, Atinkut Alamirrew. Initiatives, Concepts, and Implementation Practices of FAIR (Findable, Accessible, Interoperable, and Reusable) Data Principles in Health Data Stewardship Practice: Protocol for a Scoping Review JMIR Res Protoc 2021;10(2):e22505 <https://www.researchprotocols.org/2021/2/e22505> doi: 10.2196/22505

<sup>6</sup> HL7.FHIR.UV.FHIR-FOR-FAIR\RDA Indicators - FHIR v4.3.0 <http://build.fhir.org/ig/HL7/fhir-for-fair/RDAMetrics.html> Accessed: 2022-10-09

systems in the Virus Outbreak Data Network (VODAN)-Africa is discussed. But before assessing FAIRness in FHIR and discussing FHIR server capabilities in VODAN-A, the concept of FHIR is discussed and the VODAN-A architecture is presented.

## **FHIR and FAIR**

FHIR is a healthcare information exchange standard. FHIR defines “Resources” as the atomic unit of exchange. Hence, everything in FHIR is a resource<sup>7</sup>. FHIR provides a RESTful API designed for the web and supports common web standards and protocols such as XML, JSON, RDF, and HTTP<sup>8</sup>. Therefore, a given resource has structured W3C-compliant data types that define reusable metadata and a human-readable part. The data is also structured and standardized to support machine-based processing. A clinical use case can be covered by linking those “resources” as data elements with “references”<sup>9</sup>. In addition, resource profiling with specific extensions is possible for the implementer’s specific use cases of interest. Table 1 maps each FAIR data principle with its associated capability provided by FHIR.

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<sup>7</sup> Resource - FHIR v4.3.0 <https://www.hl7.org/fhir/resource.html> Accessed: 2022-10-09

<sup>8</sup> Formats - FHIR v4.3.0 <https://www.hl7.org/fhir/formats.html> Accessed: 2022-10-09

<sup>9</sup> References - FHIR v4.3.0 <https://www.hl7.org/fhir/references.html> Accessed: 2022-10-09

Principle/Facet of FAIR	FHIR Solution
F1: (Meta)data are assigned a globally unique and persistent identifier	A resource id combined with the URL prefix of the FHIR server constructs a globally unique and machine-resolvable identifier.
F2: Data are described with rich metadata	FHIR provides 'intrinsic' metadata such as version Id and the last Updated attached with data. FHIR also provides 'contextual' metadata.
F3: Metadata clearly and explicitly include the identifier of the data it describes	FHIR has "reference resource" datatypes or canonical URLs so that metadata includes an identifier of the data.
F4: (Meta)data are registered or indexed in a searchable resource.	FHIR has a search framework. By indexing resources into the FHIR server, a given resource could be indexed or searched.
A1: (Meta)data are retrievable by their identifier using a standardized communication protocol	FHIR adheres to the 'RESTful' specification. HTTP request/response communication protocols are performed directly on the server resource to retrieve the data or metadata using the identifier as a filtering mechanism.
A1.1: The protocol is open, free and universally implementable	The HTTP protocol and FHIR RESTful API are the backbones of FHIR. These protocols are open-free and universally implementable. Though 'open standard' could mean different things in different scenarios, considering the openness of access to the process and the rights of use, FHIR fulfills all of them.
A1.2: The protocol allows for an authentication and authorization procedure, where necessary	FHIR defines exchange protocols and content models with various open security protocols such as HMAC authentication, HTTPS, or OAuth2.
A2: Metadata are accessible, even when the data are no longer available	Metadata and data can be represented with distinct FHIR resources. Hence, the longevity of data is defined using separate metadata.
I1: (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation	If implementers set vocabularies, profiles, and other conformance resources, FHIR supports XML, JSON, and RDF for knowledge representation which are common schemes in FAIR as well.
I2: (Meta)data use vocabularies that follow FAIR principles	If implementers select FAIR-compliant vocabularies, FHIR can provide vocabulary resources and API specifications to facilitate the overall FAIRness.
I3: (Meta)data include qualified references to other (meta)data	FHIR technically supports different kinds of references among FHIR resources that are represented as data or metadata.
R1: (Meta)data are richly described with a plurality of accurate and relevant attributes	General considerations made for F2 also apply to R1. The fact data and metadata are richly described and have accurate and relevant attributes depending on the context of use.

R1.1: (Meta)data are released with a clear and accessible data usage license	FHIR provides different means to specify the license and the conditions under which data can be used. E.g., GNU, CC
R1.2: (Meta)data are associated with detailed provenance	FHIR associates Meta(data) with provenance information using the “Provenance” resource. Similarly, publication information using “citation” recourse.
R1.3: (Meta)data meets domain-relevant community standards	FHIR supports resource profiling to fulfill community-specific domain-relevant standards. Communities are encouraged to prepare implementation guides specific to their model, vocabulary, and context.

Table 1: FHIR solution matrix for each FAIR principle adapted from Native HL7 FHIR architectures aiming at being FAIR<sup>10</sup>

FHIR solution for each FAIR principle can be classified into three broad categories (Figure 1). 1) native solution provided by FHIR, 2) solution provided by other hosted standards and protocols, and 3) solution provided by implementation user guide.

For the third interpretation category, implementers are encouraged to qualify the given principle according to the needed level by fulfilling the requirement and functionality. For example, when describing data with rich metadata (F2:), FHIR provides a metadata declaration. However, the “Richness” of the metadata depends on the conformance to the implementation guide. Similarly, Meta(data) qualified reference to other meta(data) (I3:) can be fulfilled technically with FHIR resource capability to reference other FHIR resources, although these are not sufficient. Hence, implementers are encouraged to determine qualified references that are needed to provide contextual knowledge for the scope of their community.

## VODAN-Africa

In Africa, the culture of data use rests on sharing data between different systems, whereby data leaves the provenance. VODAN Africa, as one implementer of the GO-FAIR implementation network, has been developing and testing an MVP to provide a

<sup>10</sup> Conglioli, G, and Van Bochove, K. (2022) HL7 FHIR and FAIR principles - Services Oriented Architecture - Confluence <https://confluence.hl7.org/display/SOA/HL7+FHIR+and+FAIR+principles> Accessed: 2022-10-09

proof-of-concept solution to the infrastructural and contextual issues regarding privacy, diversity, and ownership of digital data. The MVP is the first to revitalize health data acquisition, management, and use by generating FAIR data points in nine African countries and 88 Health facilities. To achieve the FAIR principles, the MVP used different technologies and standards<sup>11</sup>.

The MVP prepares machine-readable clinical FAIR data from the outpatient department (OPD), antenatal care (ANC), and COVID registers to produce interoperable and reusable data. The architecture (Figure 2) has input/bulk input of meta/data, data processing, machine data conversion, a metadata repository, analytic dashboards, and a FAIR Data Point. The architecture has the capability of data production and uses a federated modality without data losing its provenance as SPARQL queries can be executed over the internet on machine-actionable linked data without the data leaving the residence. The MVP is collecting data from registers, but the capability to accept data from an electronic medical record and sending data to Health Management Information Systems (HMIS) such as DHIS2 is also part of the architecture.

### **A proposal for leveraging FHIR in VODAN-A**

FHIR through its FHIR-server adapter such as HAPI FHIR could have a role in easing the data exchange (Figure 3) in VODAN-A. A given health facility MVP interoperates with other similar facility MVPs horizontally and simultaneously exchanges data with DHIS2 and the triple store vertically. Complementing the architecture, FHIR could be a convenient option for vertical interoperability without complicating horizontal data interoperability. Hence, The FHIR resource will be exposed by the plugged-in HAPI FHIR server between the vertically interoperating systems and the data production repository databases<sup>12</sup>.

### **Conclusion**

FHIR as a native solution or through the standards it supports or with the community implementation guides could be a viable option for the Farification process of health

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<sup>11</sup> Van Reisen et al. Incomplete COVID-19 data: The curation of medical health data by the Virus Outbreak Data Network-Africa. Data Intelligence 4(4) (2022). doi: 10.1162/dint\_a\_00166

<sup>12</sup>Amare,S.Y, Taye, G.T, Gebreselassie, T.G, Van Reisen, M.,: Realising health data-interoperability in low connectivity settings: the case of VODAN-Africa. FAIR Connect (Forethcoming)

data. Non-native FHIR-based architectures could also support health data interoperability and the FAIRification process. Hence, further exploration is needed to see the possibility of non-native FHIR implementation, such as HAPI FHIR serving as a FAIR data point.

## Figure item(s)

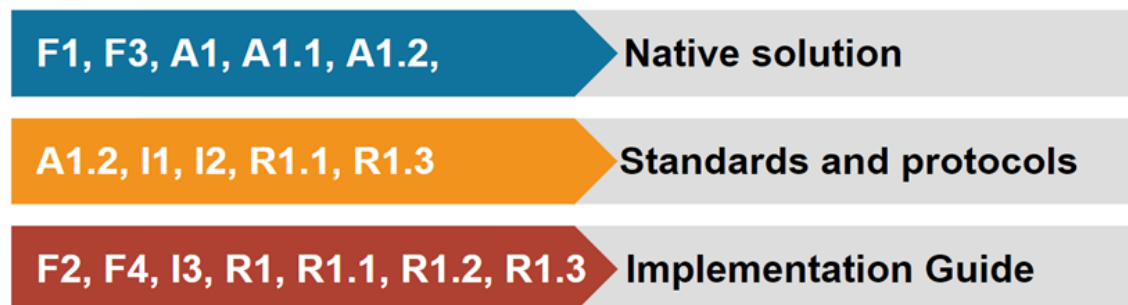


Figure 1: FHIR categorization in addressing FAIR principles as FHIR native solution, a solution provided by other standards and protocols, and a solution provided due to the implementation guide considered.

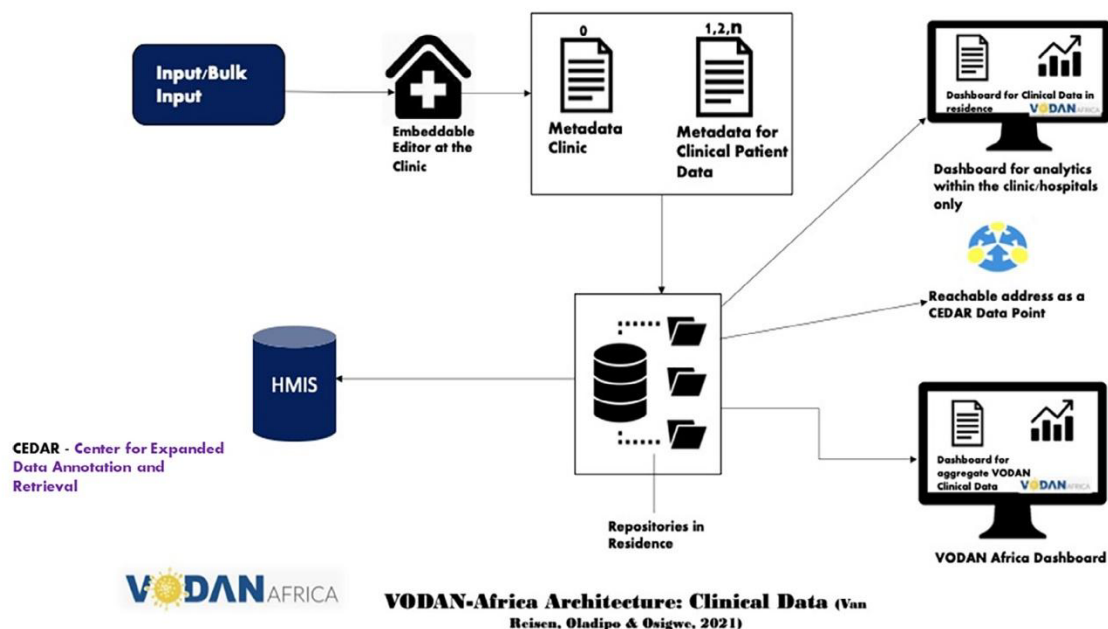


Fig 2: VODAN MVP Architecture

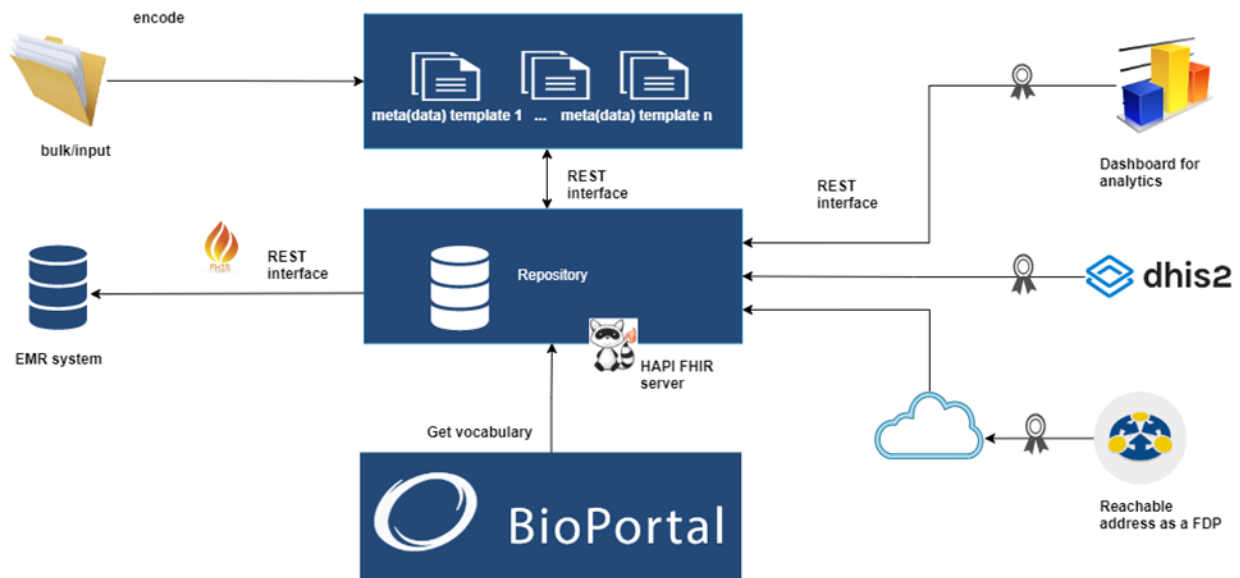


Figure 3: FHIR Leveraging VODAN-A architecture