

WASHINGTON STATE DEPARTMENT OF HEALTH

HL7 FHIR Infrastructure



Roadmap and Five-year Implementation Plan



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Author

Ravi Kafle, MBBS, MSPH

Senior Architect – Informatics/Interoperability SME
 Center for Analytics, Informatics and Modernization
 Executive Office of Innovation and Technology
 Washington State Department of Health
 Email: ravi.kafle@doh.wa.gov

Washington State Department of Health Contributors

Chris Baumgartner, Deputy Chief Informatics Officer	Bryant Karras, Chief Medical Informatics Officer
Cynthia Harry, Deputy Chief Data Officer	Mark Hobson, System Operations Manager
Maggie Dorr, FHIR Specialist	Kathleen Figetakis, Interoperability Analyst
Vicki Stewart, Project Manager	Ashley Petyak, Senior Informatician
Eric Kruger, Data Architect	Ken Greenlaw, Public Health Systems Supervisor
Sachin Lande, Chief Enterprise Architect	

Purpose, Vision, and Goals

Purpose

The purpose of the document is to provide a framework for the development of Fast Healthcare Interoperability Resources (FHIR) infrastructure and services in Washington State Department of Health (WA DOH). This work would serve as a general reference to the DOH teams working on system modernization, developing, and enhancing interoperable public health information systems.

Vision

- Advance inter- and intra-organizational interoperability with reusable building blocks.
- Remove data silos and create data linkages and integration between datasets in different programs within Washington State Department of Health (WA DOH) to develop more efficient public health data systems, thus improving the health of all people living in Washington State.

Goals

- Standardize public health data with a common data model for internal and external exchange via HL7 FHIR, based on need and demonstrated business value.
- Expand the use of HL7 FHIR standards to enhance interoperability and facilitate seamless data exchange across current ad-hoc data transformation efforts and systems.
- Work towards interoperability using a common data model for external and internal sharing.
- Support an incremental transition from previous HL7 versions to FHIR.
- FHIR-enable existing systems without requiring replacement or major rewrite.
- Reduce custom solution development and promote shared services/solutions, while also accelerating the solutions development process.
- Improve staff productivity through the development and use of common solutions.
- Meet federal, state, and local HL7 FHIR requirements and contribute to public health FHIR initiatives like the Helios FHIR Accelerator.

Infrastructure

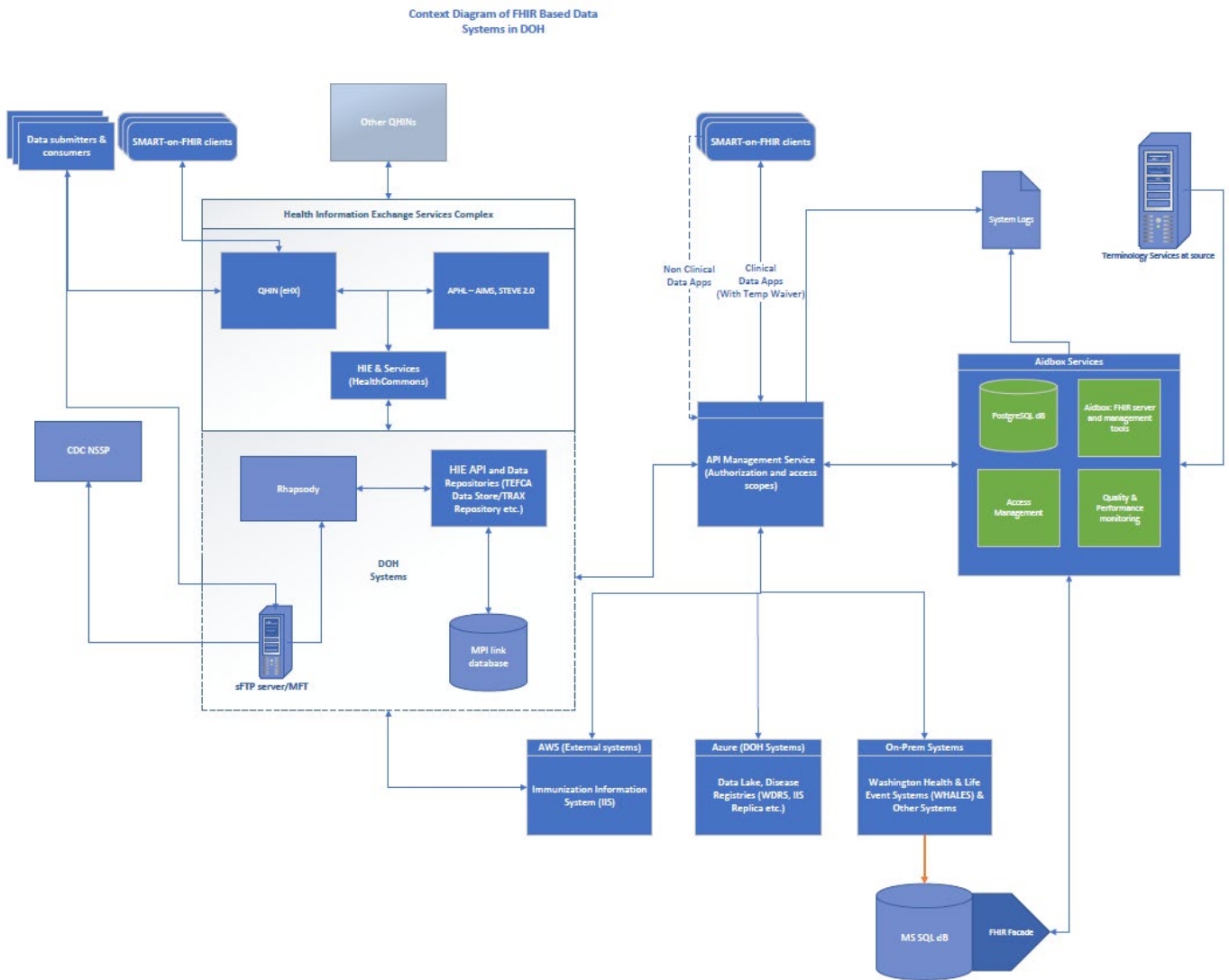


Figure 1: FHIR Infrastructure and its relationship with other services.

The infrastructure for supporting FHIR-based transactions at WA DOH will have the following components:

1. Data consumption endpoints

- RESTful API service: WA DOH will use a RESTful API service and endpoint for consumption and storage of data.
- HTTP listeners: WA DOH will use HTTP listeners for exposing endpoints in intermediary services, as per the need.

2. Data exposure endpoints

- Cross-programmatic sharing: WA DOH needs to be able to share data across programs and with external partners, prioritizing both real-time and bulk data transmission. Elements could either be injected as a single/set of resources or shared as a bundle, as per the need. For the purpose of this exchange, endpoints will be set up for programs that need to share data across other programs in WA DOH.
- Sharing with external partners: Sharing immunization and other datasets with the Centers for Disease Control and Prevention, other states/jurisdictions, the Seattle Indian Health Board, and health care organizations will be done via bulk transmission rather than real-time with RESTful API services.
- Joining a Qualified Health Information Network (QHIN): Together QHINs form a national network of networks that aid in data sharing across organizations, health systems, jurisdictions, etc. that have been established under the Trusted Exchange Framework and Cooperative Agreement (TEFCA). By joining a QHIN, WA DOH can drastically advance the exchange of data with the aforementioned trading partners. WA DOH plans to join a QHIN through the state-designated Health Information Exchange (HIE).
- Data exchange with stakeholders connected through the Association of Public Health Laboratories Informatics Messaging System (AIMS) platform: Electronic case reporting and the associated reportability response is a pertinent FHIR use case involving AIMS. There are also additional use cases with the AIMS platform for which sites could be onboarded, e.g., electronic test orders and results.
- Other use cases: Immunization data exchange across jurisdictions, social determinants of health (SDOH) data exchange across multiple organizations, death data exchange through STEVE 2.0, and all other use cases will be evaluated on a case-by-case basis for use with QHINs vs. point-to-point configurations.

3. Data processing

- Validation: Data posted to API endpoints will be validated with applicable FHIR implementation guides (IGs) for each use case. A procedure needs to be established for triaging and processing (consumption vs. error) data based on the validation status. Two different tiers of validation processes will exist.
 - Onboarding: On the test server, while onboarding external partners for data exchange.
 - Production: As part of the production pipeline, with the implementation of data quality management systems.
- Quality assurance (QA): Pipelines for data QA will be put in place before handing the data over to the analytics systems. This work will be done in conjunction with the data science team in WA DOH.

- Curation of data assets: The raw datasets received or generated will be passed through a data curation process established by WA DOH, as has been broadly categorized below:
 - Terminology Service: Datasets will be referenced in terminology sets on a server and mapped to their respective values for standardization, validation, etc. The terminology service will initially be hosted on the same FHIR server (with or without partitions, as appropriate) with a plan to periodically assess the need for a separate terminology service, as complexity and load increases on the FHIR server.
 - Data matching and linking by person identifiers: WA DOH will use a Master Person Index (MPI) to match individuals by unique identifiers and deduplicate resources. The MPI service will be placed at the primary endpoint, i.e. the HIE endpoint, for a unified approach across WA DOH programs.
 - Provisioning data assets to programs: Program areas would benefit from a collaboration between informatics, data science, and the program's subject matter experts when developing data assets through the curation of data with multiple pipelines.

4. Data transformation

- Rhapsody: Rhapsody is an integration engine used by WA DOH. While Rhapsody traditionally has been used to receive, process, and route HL7 v2 and CDA messages, the tool can also be used to process FHIR, perform HL7 version transformations, route data to multiple endpoints within WA DOH and externally, as well as manage throughput:
 - For transformation of FHIR to other data formats, where needed.
 - For transformation of HL7 v2, CDA and other data formats to FHIR.
- Application services: There are a host of applications (and 'raw' code) for writing functions that WA DOH currently uses. These need to be organized into an application services platform that provides a user interface for WA DOH programs, as well as connectivity to different datasets as per user needs. This allows the applications to be published in a way that increases accessibility and usability, lowering barriers for adoption.
 - An application gallery for hosting apps with specialized functions for internal use. For example, analytics and use case-specific transformations. These apps will use OAuth 2.0/SMART on FHIR capabilities for access management and security.
 - A SMART on FHIR platform for scoping functions of external (and possibly internal) applications intending to read data from the WA DOH APIs.

5. Data storage

- Data stores are to be in place with bundles for internal and external sharing. The bundles will be stored in binary format.

6. User Interface (UI) development tools

- Low code platforms
- Frontend frameworks
- Open-source tools for UI for FHIR based processes

Roadmap

Step 1: Common data collection capabilities

The Washington State Department of Health will develop common data collection capabilities for a variety of data formats including different versions of HL7 standards, csv files, and proprietary xml, among others.

The data formats will be transformed into two common formats:

1. FHIR for datasets that need to be exposed for internal and external exchanges.
2. A data-frame to prepare datasets for analytics and use by downstream systems.

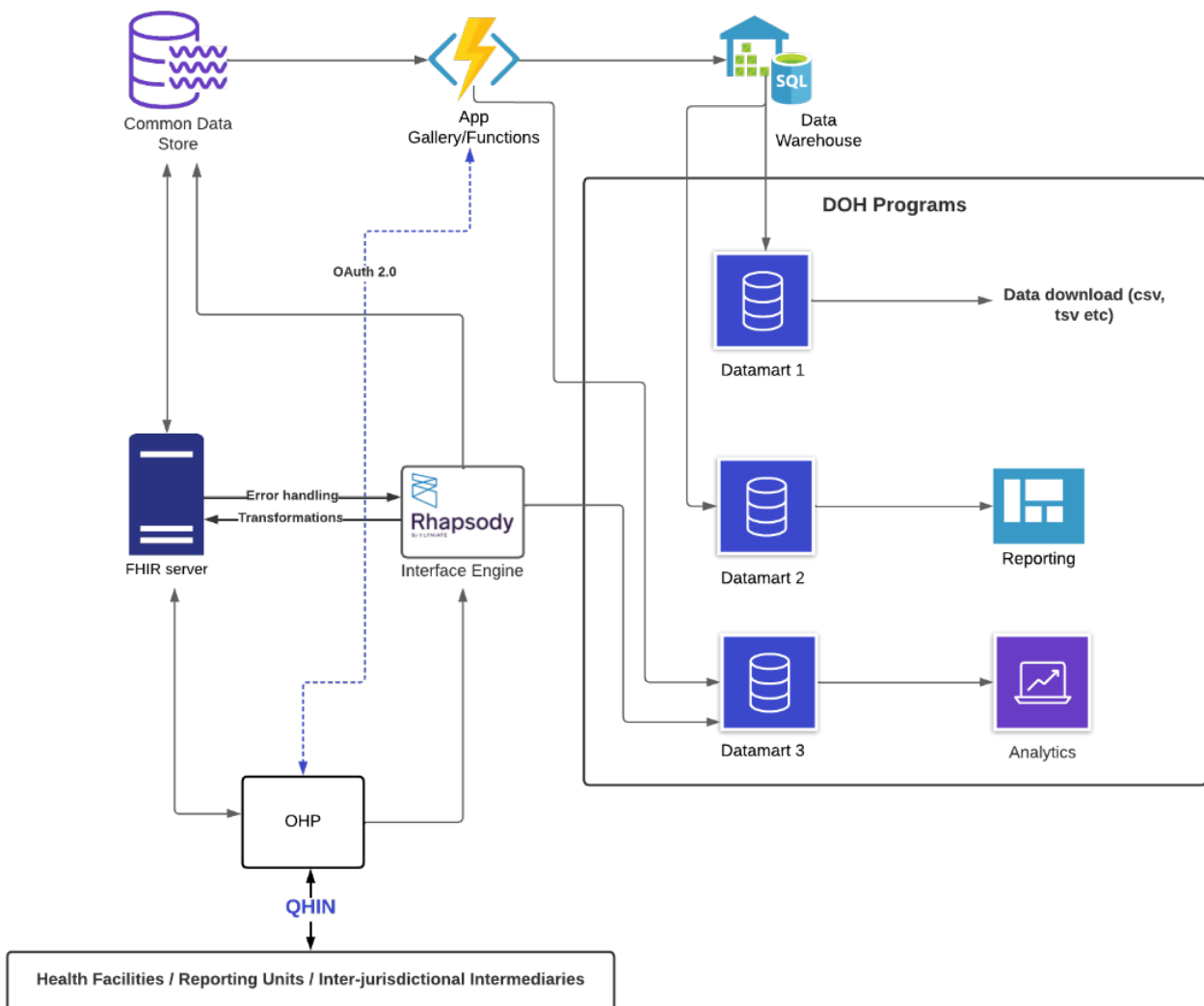


Figure 2: High-level diagram of common data collection capabilities.

General infrastructure components:

- FHIR server: Conformance and persistence layer
- Interface engine for routing, transformations, etc.
- API gateway for access management
- Application gallery for plug and play tools
- Relational databases for storage of normalized data, as needed
- Data quality analytics platform/tools (collaboration with the Office of Health and Science (OHS) at WA DOH)
- Data pipelines and analytics environment (collaboration with OHS)
 - Automation
 - Machine learning
 - Visualization tools
- MPI linking datasets across WA DOH programs
- Secure File Transfer Protocol (sFTP) and other transport methods, if needed, to support legacy data feeds for integration into the infrastructure

Additional tools that aid in development and workflow management:

- HL7 transformation – FHIR, CDA, V2, and other data formats
- Tools to develop business logic and write queries – CQL, GraphQL, and other languages
- Parser and mapper for HL7 and other message formats
- Frontend framework as the top layer with user interface (low code vs programming language specific frameworks)
- Standalone validation tools
- Profiling tools (optional based on need)
- GitHub repositories for application code storage and deployment
- DevOps tools – Agile methodology, continuous integration/continuous delivery, containers, etc. for development, testing, and deployment

Step 2: Process Flow

Figure 3 is a high-level representation of the process flow planned for WA DOH systems adapting FHIR-based data exchange. In future publications, this diagram will further drill down to multiple use cases with operational level details. Use case-based process flow definitions will be done over a period as implementation progresses.

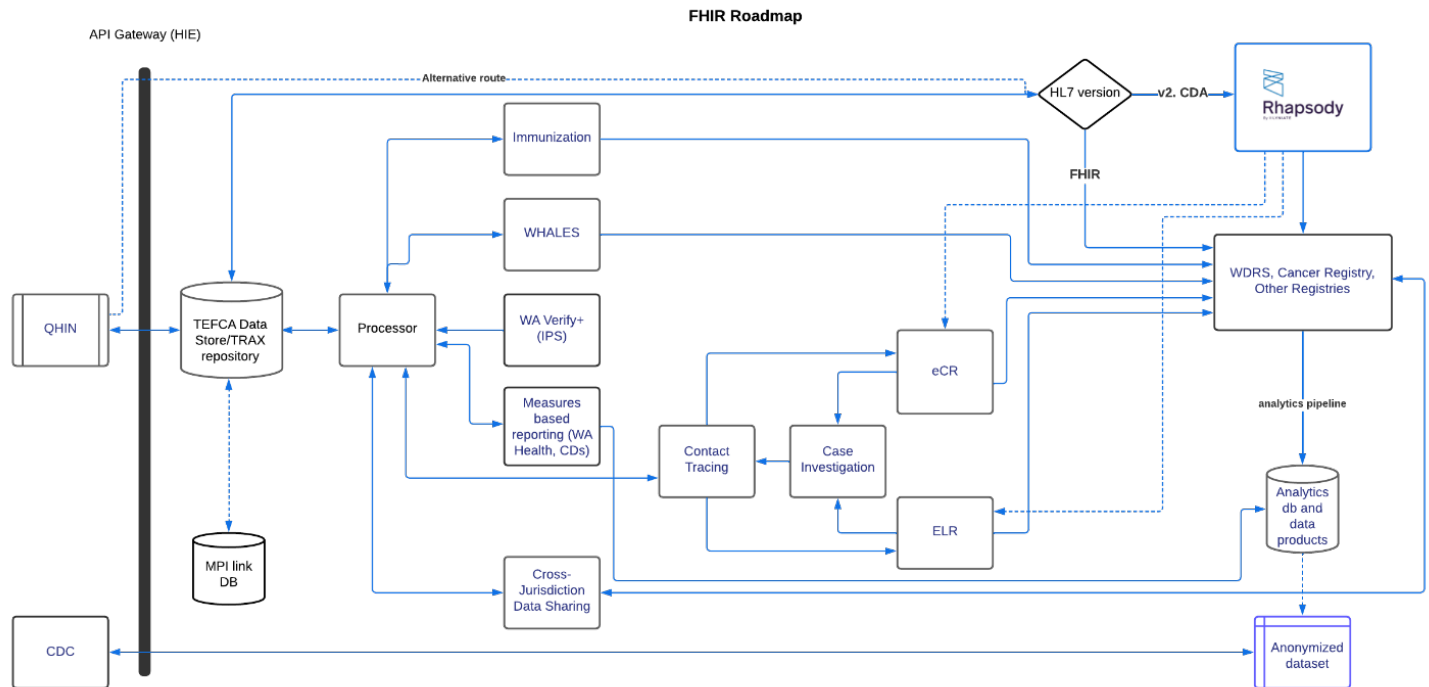


Figure 3: Process flow for WA DOH systems adapting FHIR based exchange.

FHIR Architectural Patterns

WA DOH has performed a detailed analysis of its HL7 FHIR needs by evaluating business requirements and building architectural patterns needed to mature FHIR capabilities over time. Eight solution patterns were identified that can be used to build components necessary to meet most anticipated use cases. These patterns are provided so vendors understand 'what' is needed and to not constrain 'how' things are accomplished (within the FHIR standard).

The tools must be able to build out and operate the following architectural solution patterns:

- FHIR Façade
- FHIR Broker Adaptor
- FHIR/Proprietary API Mixed Use
- FHIR Based Integration Hub

WA DOH also needs support for the following patterns in the future:

- FHIR API Encapsulating a Vendor-Neutral Clinical Repository
- FHIR-Based Health Data Repository
- FHIR Based Analytics Solutions
- SMART on FHIR

The following is a list of the minimum set of FHIR capabilities needed:

- Send and receive FHIR RESTful requests (synchronous and asynchronous)
- Store and manage FHIR data on a FHIR server
- Define and manage FHIR profiles
- Transform data to and from relational databases and FHIR resource format
- Transform between HL7 2.x, .CSV, and FHIR formats
- Bulk import and export FHIR
- Develop, manage, and operate FHIR API's
- Test FHIR data flows
- Develop, deploy, operate, and maintain FHIR solutions
- Share FHIR solutions with other organizations
- Draft, edit, share, and publish implementation guides
- Connect to and translate between FHIR API's and other proprietary endpoints

Use cases

- **Communicable Disease surveillance:** Reportable conditions get submitted as electronic case reports and lab reports. The data is then processed to communicable disease registry and the case investigation is continued, gathering information from different sources, including contact tracing, for the relevant conditions where needed.
- **Chronic Disease Surveillance:** Chronic disease information gets requested/queried from the EHRs. Data is deidentified and aggregated for use with CQL libraries and Azure functions, together with cloud based deidentification services, as needed.
- **Situational Awareness:** WA HEALTH was established during COVID-19 pandemic to fulfill the need for daily and weekly updates regarding bed occupancy, resources used and in stock, and daily admission of patients diagnosed with a given set of conditions. WA TRAC collects information on emergencies that could occur throughout the state including the information required to mobilize EMS services.
- **SDOH data platform** [at the HIE]: The collection of SDOH data from patients directly through a mobile app or with the help of service providers is imperative to understand the distribution of disease through the equity lens. A database of SDOH data should be hosted by the HIE that serves not only WA DOH, but across the coalition.
- **Vital Statistics:**
 - Vital Records Death Reporting (VRDR) - for submitting death records to the National Center for Health Statistics (NCHS), receiving coded cause of death from NCHS for the submitted records, and inter-jurisdictional exchange of death records.
 - Medicolegal Death Investigation (MDI) – for exchanging medicolegal information related with death investigations done by medical examiners’/coroners’ offices with the state death registry.
 - Birth and Fetal Death Reporting (BFDR) – for recording Washington state births and fetal deaths.
- **Contact tracing for communicable diseases:** Used for tracking communicable diseases cases and their respective contacts to support active case finding and detailed epidemiological investigations. A SMART on FHIR app will be developed for deploying a contact tracing tool. The tool will be used to collect information from the field and the data will be integrated into the State disease registry - Washington Disease Reporting System. This data could also be shared with other jurisdictions as FHIR resources.
- **WA Verify+ (International Patient Summary):** This state-supported platform allows Washington state residents to generate and share a summary of their health information, including content such as clinical information, laboratory information, immunization records, mental health, and advanced directives.

- **Immunization Information System (IIS) Bulk data exchange:** Immunization information is exchanged with healthcare providers in bulk, based on patient requests.

Data and system lifecycle management plan

The plan will follow industry standards and data lifecycle management plan, based on state and federal mandates that govern the use of data by different programs in the department. Some of the systems, documents, and artefacts that govern this process are as follows:

- Washington Administrative Code
- Code of Federal Regulations (CFR)
- United States Core Data for Interoperability (USCDI) and USCDI+
- HL7 FHIR as per the version upgrade timeline set based on federal regulations

First year's deliveries

The planning of timelines, project tracking, and performance monitoring will be conducted on a periodic and ongoing basis. The breakdown of the yearly timeline estimates will be done at a higher level together with the Informatics and TechOps, Data Science, Disease Surveillance, and the respective program teams.

The deliverables for the establishment of FHIR infrastructure are as follows:

- Test and fully define production grade infrastructure that handles standardized data elements through HL7 FHIR messages.
- Deploy the FHIR messaging infrastructure in a production environment at WA DOH.
- Use of REST API based technology to exchange data internally in WA DOH as well as externally.
- Application gallery (backend services and SMART-on-FHIR) for performing specific actions in different use cases. The codes that are currently being used will be replaced by task specific applications registered in the gallery.
- Use person-centric data links to identify FHIR resources with each person's personal identifiers.
- Data products for analytics by program areas for use by epidemiologists.
- Complete FHIR proof of concept and subsequent pilot projects VIZ.
 - FHIR-based exchange of death reports data.
 - Situational awareness implementation with WA HEALTH automation

FHIR implementation guides for public health use cases

The following FHIR IGs are to be implemented in the coming years:

- Vital Records Death Registry (VRDR) IG
- Medicolegal Death Investigation (MDI) IG
- Birth and Fetal Death (BFDR) IG
- Social Determinants of Health (SDOH) Clinical Care IG – Gravity Project
- Bidirectional Services eReferrals (BSeR) IG
- Situational Awareness for Emergency Response (SANER) IG
- Data exchange for Quality Measures (DEQM) IG
- Electronic case reporting (eCR) FHIR IG
- Laboratory data exchange (Orders and Observations)
- US Core FHIR IG (with focus on US Core Immunization Profile)
- Bulk FHIR IG
- Others will be decided on a case-by-case basis based on WA DOH's priorities.

Resources

WA DOH Program	Work Responsible
OIT – CDMI, EA	Product Ownership, Infrastructure Planning and Development lead, data provisioning to downstream systems
OHS – CDS, DCHS, CEPEA	Data quality management, analyzed data products
OIT - Cloud program	DevOps, Cloud Development

Staffing: FHIR Infrastructure, applications, and services

- Product Owner/Architect
- FHIR Specialist
- Cloud DevOps Lead
- Cloud Services Developer
- IT Project Manager
- Business Analyst
- Applications Quality Assurance
- Data Quality Assurance
- Data Products Coordinator/Liaison

Contact Information: If you have questions, please contact Ravi Kafle at ravi.kafle@doh.wa.gov.



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