Public Health FHIR® Playbook

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The Public Health FHIR Playbook is designed by the Public Health FHIR Implementation Collaborative (PHFIC) to help state, tribal, local, and territorial (STLT) public health agencies successfully implement FHIR®, a standard for electronic health data exchange.

PHFIC is supported by US Centers for Disease Control and Prevention (CDC) and includes representative groups of health departments and key partner organizations focused on improving interoperability in the public health sector. Representatives provide training, show small scale impacts, guide decisions, discuss lessons learned, and integrate best practices for FHIR®-based public health data exchange. PHFIC's core objectives are to 1) build a FHIR community, 2) demonstrate how FHIR can address public health needs, and 3) advise public health on FHIR.

The Public Health FHIR Implementation Collaborative appreciates the hard work of many individuals involved in expanding their knowledge about FHIR® and who have or will implement FHIR®.
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1 Introduction

Fast Healthcare Interoperability Resources® (FHIR®), developed by Health Level Seven International® (HL7®), is a standard for electronic health data exchange.[1] Complementing earlier HL7 standards like Version 2 and Clinical Document Architecture (CDA), FHIR has the potential to address data exchange gaps currently experienced by state, tribal, local, and territorial (STLT) public health agencies. As part of Centers for Disease Control and Prevention's (CDC) Data Modernization Initiative (DMI), CDC formed the Public Health FHIR Implementation Collaborative (PHFIC).[2]

PHFIC includes representative groups of health departments and key partner organizations focused on improving interoperability in the public health sector. Representatives provide training, identify potential use cases, guide decisions, discuss lessons learned, and integrate best practices for FHIR-based public health data exchange. PHFIC's core objectives are to 1) build a FHIR community, 2) demonstrate how FHIR can address public health needs, and 3) advise public health on FHIR.

1.1 Purpose and Scope

PHFIC developed the Public Health FHIR Playbook to describe FHIR, its policy context, and steps that enable successful FHIR implementation at public health agencies. It was developed by CDC partners engaged to manage PHFIC, provide technical assistance to STLT agencies, and facilitate pilot implementations. The playbook's content is informed by the ongoing efforts of PHFIC members and will be updated periodically to reflect findings from public health FHIR implementations.

Adopting new technologies is inherently challenging. It can require new resources and prioritization against other initiatives. The playbook seeks to support STLT public health agencies and relieve their concerns on understanding and incorporating FHIR into their health information technology (IT) practice.

Designed as a "quick start" guide, this playbook will give public health practitioners ideas on how to get started with FHIR. This could include engaging with the HL7 FHIR community or enrolling in FHIR training courses offered by HL7.[3]

The main sections of the Public Health FHIR Playbook are:

- FHIR and Public Health: a description of basic FHIR concepts and their application to public health.
- Guidelines for Creating a FHIR-Ready Organization: change management for helping public health agencies prepare to implement FHIR.

[1] Health Level Seven International. "Overview – FHIR v4.3.0." HL7.org. http://hl7.org/fhir/overview.html (accessed Dec. 30, 2022).

[2] The MITRE Corporation. "Public Health FHIR® Implementation Collaborative (PHFIC)." https://sites.mitre.org/phfic/ (accessed Dec. 30, 2022).

[3] Health Level Seven International. "Healthcare Standards Training for Interoperability." HL7.org. https://www.hl7.org/training/ (accessed Dec. 30, 2022).

- Implementing FHIR Use Cases: implementation guidance for designing FHIR-based data exchange.
- Appendices with more details and descriptions of ongoing efforts that can provide entry points for STLT agencies looking to engage with the HL7 FHIR community.

1.2 Intended Audience

This playbook intends to be an informative resource for public health informaticians that are new to FHIR and may be less technical than developers and authors of IT standards. The playbook provides high-level strategic guidance to help public health informatics teams consider FHIR as they modernize their information systems. It also points STLT agencies to more technical information for specific implementations when they are ready.

1.3 Limitations

While healthcare organizations are beginning to implement FHIR in their systems, there is very little FHIR-based data exchange used by public health agencies. PHFIC is facilitating FHIR pilot implementations with STLT agencies and will periodically update this playbook with lessons learned from these pilots and other public health implementations. Although the playbook is intended for a general public health informatics audience, PHFIC anticipates that each public health practitioner and their agency will have their own context that could affect how they implement FHIR. Please provide feedback to the PHFIC team by emailing PHFIC@MITRE.org so we can continue refining the content as needed.

2 FHIR and Public Health

Similar to *individual* data collected at the bedside in healthcare (e.g., blood pressure), public health agencies collect health-related data for *populations* of people with the goal "to protect and promote the health of *all people in all communities.*"[4] Public health activities need timely and complete data at varying levels of detail and from many disparate data sources to support public health surveillance and action.[5] FHIR could potentially address this complex interoperability challenge. Today, the FHIR community is expanding its capabilities to better support public and population health.

2.1 FHIR's Value to Public Health

Effective interoperability ensures electronic health information is shared appropriately between healthcare and public health partners in the right format, through the right channel at the right time.[6] It is essential to public health, considering the data needed for public health functions and the disparate sources and granularity of that data. FHIR could be a key tool to improve

[4] US Department of Health & Human Services. "10 Essential Public Health Services." CDC.gov. https://www.cdc.gov/publichealthgateway/publichealthservices/essentialhealthservices.html (accessed Dec. 30, 2022).

[5] D. Khullar. "What Will It Take to Pandemic-Proof America?" newyorker.com. https://www.newyorker.com/science/annals-of-medicine/what-will-it-take-to-pandemic-proof-america (accessed Dec. 30, 2022).

[6] US Department of Health & Human Services. "Public Health Data Interoperability." CDC.gov. https://www.cdc.gov/datainteroperability/index.html (accessed May 4, 2023).

interoperability between systems used by federal and STLT agencies and their healthcare partners, for the following reasons:

FHIR potentially simplifies implementation, reduces maintenance needs, and decreases costs for public health agencies. Historically, IT system interfaces using HL7 standards supported a single business need. A healthcare organization can have over a hundred HL7 Version 2 interfaces supporting separate business needs, including public health reporting. However, a FHIR interface can support a wide variety of business needs at the same time. Instead of multiple interfaces needed to exchange demographics, laboratory, and immunization data, a single FHIR server hosted by a data supplier can support various use cases requiring these data. In addition, unlike HL7 Version 2, FHIR data exchanges are human readable, lowering the technical barrier for analysts to troubleshoot messages. FHIR interfaces can be easier to implement and adjust than other HL7 interfaces and FHIR queries have flexibility to meet new needs and emergencies with less disruption to healthcare partners providing data. These applications may reduce costs by speeding up implementation and maintenance processes.

FHIR can allow for a "self-service buffet" of data feeds for public health agencies. Federal regulations encourage healthcare providers to make a standardized set of health data more readily accessible via FHIR exchange methods. United States Core Data for Interoperability (USCDI) is a collection of data elements public health organizations can access with FHIR interfaces to meet their evolving needs. FHIR and USCDI cover a wide variety of health data that would take many HL7 Version 2 interfaces to cover.

FHIR is based on web standards, providing a larger pool of developers to serve public health. Historically, public health agencies struggle to compete with healthcare or information technology organizations for limited technical expert resources. FHIR overlaps with web-based standards used in other industries, extending the potential pool of developers available to support public health data systems.

FHIR potentially streamlines data use agreements for healthcare organizations and public health agencies. Rather than executing separate data use agreements for individual business needs, data use agreements could leverage FHIR and USCDI for a single agreement following applicable state and local laws and regulations. This could reduce the number of agreements between healthcare organizations and their public health agency partners and leave the scope of the data request to be determined by public health's business needs.

2.2 FHIR Basics

Today, public health agencies rely primarily on the HL7 Version 2 and HL7 CDA standards to support electronic health information exchange. HL7 introduced FHIR as an alternative standard to improve interoperability, enhance communication efficiency, and streamline implementation.[7] FHIR combines positive aspects of Version 2 and CDA with more modern development paradigms. Initially, FHIR emerged as a potential method for efficient exchange of targeted data elements on individual patients. The FHIR standard is evolving to also support data exchange for populations or cohorts of patients. These approaches are outlined in Section 2.2.2.

[7] Health Level Seven International. "Index – FHIR v4.3.0." HL7.org. http://hl7.org/fhir/ (accessed Dec. 30, 2022).

2.2.1 Designed for the Web

HL7 designed FHIR to take advantage of standard internet protocols and allow for more efficient data exchange between systems and devices connected to the World Wide Web (web). As a result, data exchange with FHIR is similar to how websites and web-based applications work. To achieve this, FHIR functions as both a data model and a data exchange specification. The FHIR data model is expressed with FHIR resources, which are standardized collections of data elements (see Section 2.4.1). FHIR data exchange is described below.

As with other web-based approaches, computer systems configured to act as clients or servers exchange data over the internet. Clients are applications or services that request data from or send data to servers. A familiar example is a desktop browser (a client) requesting a web page from a website server. To support existing production systems, FHIR servers often act as an intermediary between a FHIR client and the database "back-end" of the source system providing the data. (See Figure 1).

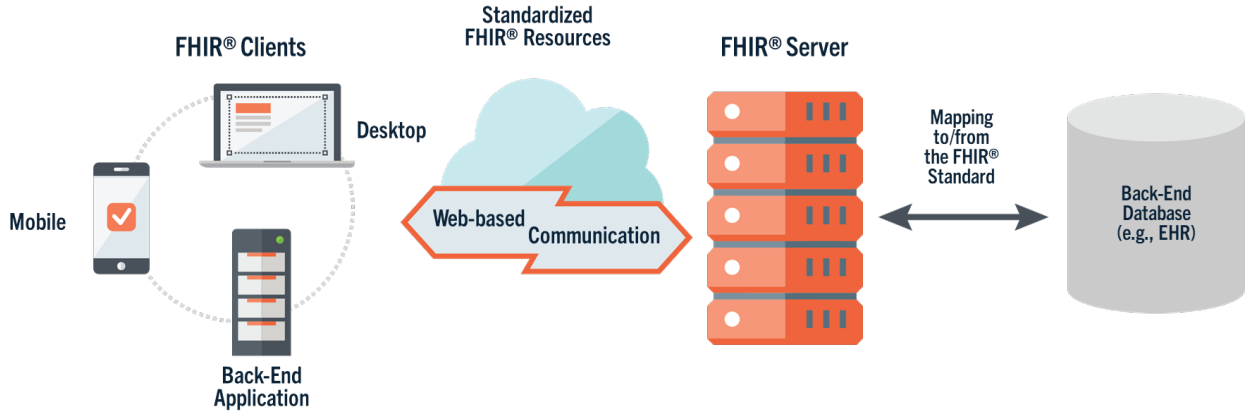

Figure 1: General FHIR Information Flow

Public health systems can act as either clients or servers, depending on the data exchange scenario. For example, state health departments could use a FHIR client to query data from a healthcare organization's FHIR server. In turn, the state health department could use a FHIR server to provide data to a FHIR client used by a local health department.

Many developers are familiar with web technologies, which reduces their learning curve compared to FHIR's predecessors. Using the same technical approaches to access websites and services on the web, FHIR-enabled systems can allow public health agencies to gather and provide data for surveillance, disease investigations, immunization status, and other public health functions. See Section 3. Public Health FHIR Scenarios for examples.

2.2.2 FHIR Exchange Methods

FHIR offers multiple methods for exchanging data among systems, including approaches similar to existing Version 2 or CDA data exchange workflows.[8] FHIR implementers often use the terms "push" and "pull" to describe data exchange methods, usually in the context of exchanging data on an individual.[9] FHIR also supports data exchange in bulk for a collection of individuals. These approaches are outlined in this section. FHIR implementers need to consider several factors when deciding which exchange method to use, including the needs of the scenario being addressed.

2.2.2.1 Push Exchange

For unsolicited sending of information between systems, the most common form of exchange for Version 2, FHIR supports the ability to "push" data from a source system to a destination system. With push exchange, the source system is a FHIR client, and the destination system is a FHIR server.

Figure 2 illustrates the concepts of push exchange:

1. The FHIR client transforms the source system's data into FHIR resources.
2. The FHIR client transmits the FHIR resources.
3. The destination system's FHIR server processes and stores the FHIR resources.
4. The destination system's FHIR server can return a response.
5. The FHIR client can record the response.

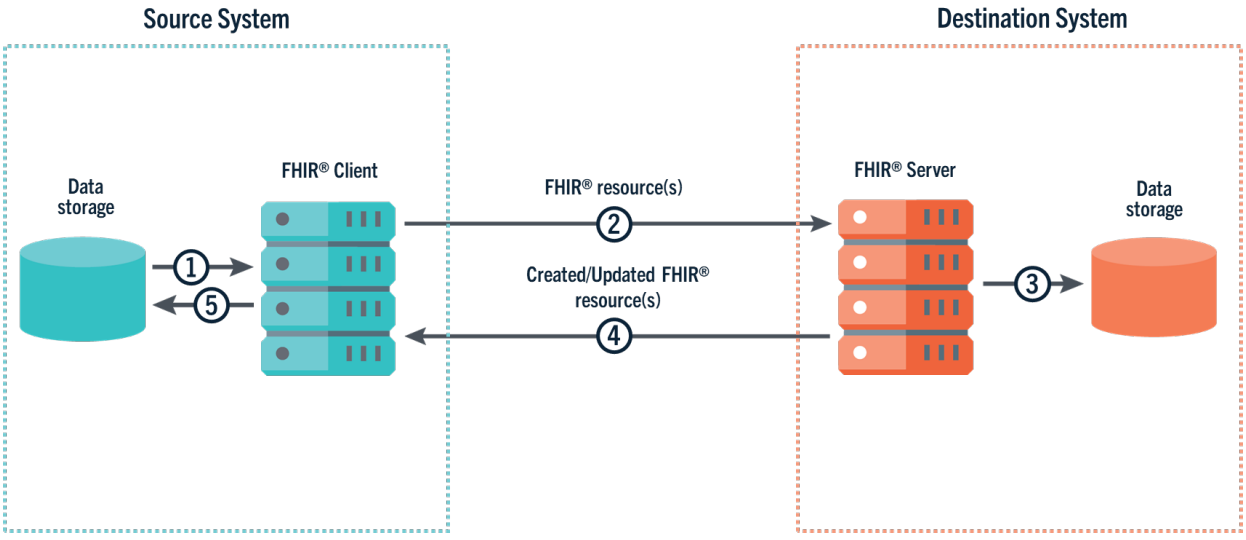

Figure 2: Push Exchange

[8] Health Level Seven International. "Exchange - module – FHIR v4.3.0." HL7.org. https://www.hl7.org/fhir/exchange-module.html (accessed Dec. 30, 2022).

[9] Health Level Seven International. "Pushpull – FHIR v4.3.0." HL7.org. https://www.hl7.org/fhir/pushpull.html (accessed May 9, 2023).

2.2.2.2 Pull Exchange

FHIR also supports the ability of a destination system to retrieve, or "pull," data from a source system. With pull exchange, the destination system includes a FHIR client that can search for needed information from a source system's FHIR server.

Figure 3 illustrates the concepts of pull exchange:

1. The destination's FHIR client requests data from the source system's FHIR server.
2. The source system's FHIR server processes the request and retrieves data from storage and converts the data to FHIR resource(s) for transmission to the client.
3. The source system's FHIR server transmits the data to the destination system's FHIR client.
4. The destination system's FHIR client processes and stores the data.
5. The destination system includes an end-user application to enable use of the data queried from the source system.

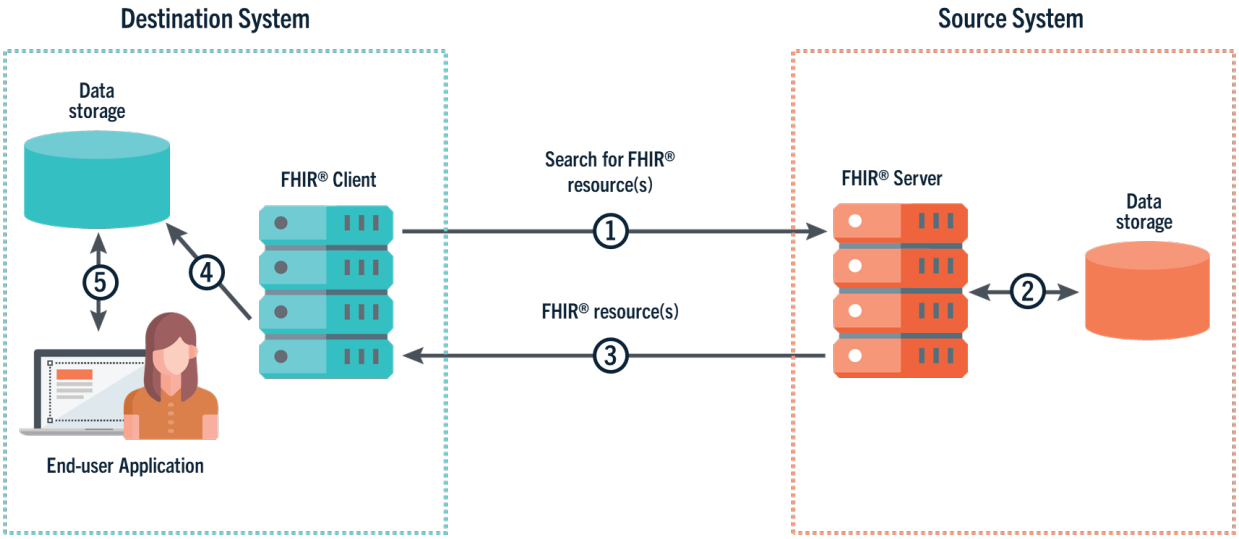

Figure 3: Pull Exchange

2.2.2.3 Bulk Data Access

As of early 2023, FHIR-based data exchange is typically at the individual patient level. This can facilitate a public health agency's follow-up on an individual communicable disease case. However public health agencies also maintain registries for tracking historical data, such as immunization records, for populations in their jurisdictions. To address these needs, HL7 is developing a method to exchange "bulk data" representing a cohort of patients, which should help populate public health registries.[10]

Figure 4 illustrates the concepts of FHIR Bulk Data Access:

1. The destination's FHIR client requests data on a specified cohort of individuals from the source system's FHIR server.

[10] Health Level Seven International. "Bulk Data Access IG." HL7.org. https://hl7.org/fhir/uv/bulkdata/ (accessed Dec. 30, 2022).

2. The source system's FHIR server processes the request and retrieves data on the cohort from storage and builds a data set of FHIR resources for transmission to the client.
3. The source system's FHIR server provides the destination system's FHIR client with a hyperlink to the FHIR data set. The destination system's FHIR client uses the hyperlink to download the FHIR resources. The amount of time this takes depends on the request, however it will be more efficient than separate data exchanges for each individual in the cohort.
4. The destination system's FHIR client processes and stores the data.
5. The destination system includes an end-user application to enable use of the data queried from the source system.

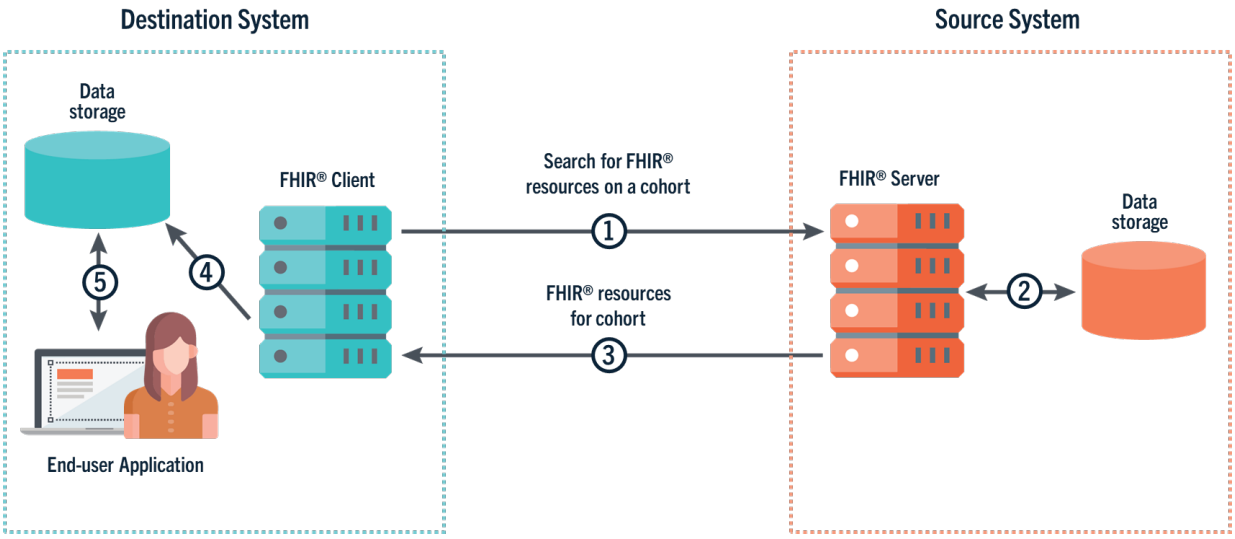

Figure 4: Bulk Data Exchange

2.3 Federal Policy Drivers

Since 2004, the Office of the National Coordinator for Health Information Technology (ONC) has been at the forefront of the federal government's efforts to advance healthcare interoperability policy. ONC's mission is to "improve the health and well-being of individuals and communities through the use of technology and health information that is accessible when and where it matters most."[11] ONC is a proponent of FHIR-based information sharing solutions and continues to develop federal policy and legislation including the implementation of provisions in the Promoting Interoperability Programs[12] and the 21st Century Cures Act.[13]

[11] US Department of Health & Human Services. "About ONC." healthit.gov. https://www.healthit.gov/topic/about-onc (accessed Dec. 30, 2022).

[12] US Department of Health & Human Services. "Promoting Interoperability." healthit.gov. https://www.healthit.gov/topic/meaningful-use-and-macra/promoting-interoperability (accessed Dec. 30, 2022).

[13] US Department of Health & Human Services. "Laws, Regulation, and Policy." healthit.gov. https://www.healthit.gov/topic/laws-regulation-and-policy (accessed May 3, 2023).

The 21st Century Cures Act entails several updated and new provisions that can support public health's access, exchange, and use of electronic health information. These include requirements for electronic health record (EHR) developers to incorporate standardized application programming interfaces (APIs) into their products, adoption of USCDI, and a trusted exchange framework and common agreement (TEFCA) for data sharing across different health information networks. Each of these provisions is briefly described below.

2.3.1 Standardized APIs

APIs enable separate computer systems to interact with one another.[14] ONC established a new API certification criterion that requires health IT developers to support standardized APIs for a single patient and population services.[15] The certification criterion requires API-enabled "read" services using the FHIR Release 4 standard. Using the FHIR standard and a set of implementation specifications provides technical specifications for third-party applications used by patients, public health agencies, and other authorized entities. According to the requirements outlined in the 21st Century Cures Act, APIs must be available for use "without special effort," a provision that encourages the exchange of electronic health information. The API certification criterion also prescribes SMART App Launch[16] (part of the SMART on FHIR application development framework) and FHIR Bulk Data Access[17] as specifications for security and data requests on a group of patients, respectively.

2.3.2 USCDI and USCDI+

The USCDI is a standardized set of health data classes and constituent data elements for nationwide, interoperable health information exchange.[18] Health IT developers need to update their certified health IT products to support the USCDI. ONC established a collaborative process to gradually update USCDI with additional data elements and alignment with FHIR specifications designed for implementation in the U.S. (see Section 2.4.2). USCDI will develop incrementally over time by weighing both anticipated benefits and industry-wide impact.

ONC also launched an initiative called USCDI+, a service to federal and non-federal partners to establish, harmonize, and advance specific datasets to achieve programmatic goals.[19] Currently, USCDI+ efforts are focused on quality measurement and public health with the Centers for Medicare & Medicaid Services (CMS) and CDC. USCDI+ intends to be the next level of detail beyond USCDI and hopes to move faster on public health priorities and high impact use cases.

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[14] US Department of Health & Human Services. "Application Programming Interfaces in Health IT." healthit.gov. https://www.healthit.gov/buzz-blog/21st-century-cures-act/application-programming-interfaces-in-health-it (accessed May 9, 2023).

[15] US Department of Health & Human Services. "Standards-based Application Programming Interface (API) Certification Criterion." healthit.gov. https://www.healthit.gov/sites/default/files/page2/2020-03/APICertificationCriterion.pdf (accessed Dec. 30, 2022).

[16] Health Level Seven International. "SMART App Launch." HL7.org. http://hl7.org/fhir/smart-app-launch/ (accessed Dec. 30, 2022).

[17] Health Level Seven International. "Bulk Data Access IG." HL7.org. http://hl7.org/fhir/uv/bulkdata/ (accessed Dec. 30, 2022).

[18] US Department of Health & Human Services. "United States Core Data for Interoperability (USCDI)." healthit.gov. https://www.healthit.gov/isa/united-states-core-data-interoperability-uscdi (accessed Dec. 30, 2022).

[19] US Department of Health & Human Services. "USCDI+." healthit.gov. https://www.healthit.gov/topic/interoperability/uscdi-plus (accessed Dec. 30, 2022).

However, unlike USCDI, USCDI+ is an exploratory process and not yet reflected in federal regulations.

2.3.3 Trusted Exchange Framework and Common Agreement (TEFCA)

The 21st Century Cures Act called for developing a trusted exchange framework and a common agreement to support data sharing between organizations. As a result, ONC and its Recognized Coordinating Entity (RCE), The Sequoia Project, Inc., published the Trusted Exchange Framework and the Common Agreement, or TEFCA, in January 2022.[20] TEFCA is made up of two parts: the Trusted Exchange Framework and the Common Agreement. The Trusted Exchange Framework is a set of non-binding principles for health information exchange, and the Common Agreement establishes the infrastructure and governing approach to sharing health information between different health information networks.

The goal of TEFCA is to establish the floor of universal interoperability across the U.S. TEFCA emphasizes data exchange utilizing a network-of-networks approach between Qualified Health Information Networks, or QHINs. The RCE publishes criteria new and existing health information networks will need to meet to become QHINs. TEFCA can help advance public health information exchange through STLT participation in QHINs.[21]

Initial QHIN specifications emphasize interoperability standards that predate FHIR and support data exchange between health information networks. To better align with more modern data exchange approaches, ONC released the TEFCA FHIR Roadmap in January 2022, outlining a three-year plan to align with FHIR, and potentially accelerate FHIR adoption across the industry.[22]

2.4 FHIR Technical Specification

As an international health IT interoperability standard, FHIR provides both a data model for representing healthcare and specifications for web-based data exchange. The FHIR technical specification is comprised of a collection of *resources* designed to support most healthcare use cases globally. Resources can be adapted for specific scenarios using *profiles*, *extensions*, and *implementation guides*.

2.4.1 Resources

FHIR *resources* are the building blocks of the specification. A resource is a stand-alone component that represents a unique piece of the FHIR data model. Example resources include Patient, Procedure, and Observation. Each resource is comprised of a collection of data elements for conveying detailed information for each occurrence, or instance, of a resource. For example, a patient's date of birth would be stored in the *birthDate* element of a Patient resource.

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[20] US Department of Health & Human Services. "Trusted Exchange Framework and Common Agreement (TEFCA)." healthit.gov. https://www.healthit.gov/topic/interoperability/trusted-exchange-framework-and-common-agreement-tefca (accessed Dec. 30, 2022).

[21] The Sequoia Project. "Benefits for State Governments and Public Health." rce.sequoiaproject.org. https://rce.sequoiaproject.org/benefits-for-state-governments-and-pubic-health/ (accessed Dec. 30, 2022).

[22] The Sequoia Project. "Three-Year FHIR Roadmap for TEFCA." rce.sequoiaproject.org. https://rce.sequoiaproject.org/three-year-fhir-roadmap-for-tefca/ (accessed Dec. 30, 2022).

Resources are "composable" in that they are only used when needed to fulfill a use case. Resources can reference other resources as needed. For example, an Observation resource has a *subject* element that is used to hold a reference to the Patient resource representing the relevant patient.

Developers can use multiple coding languages to represent FHIR resources including JavaScript Object Notation (JSON, the most popular), eXtensible Markup Language (XML), and Turtle (or Terse RDF Triple Language, used more in academic settings).[23]

FHIR currently has over 140 resources. To help make sense of these resources and how to use them, HL7 groups FHIR resources into five levels that are further subdivided into modules:[24]

- **Level 1:** This level includes the basic framework for the FHIR specification. There is one module at this level – Foundation.
- **Level 2:** This level includes supporting implementation and binding to external specifications. There are five modules at this level – Implementer Support, Security and Privacy, Conformance, Terminology, and Exchange.
- **Level 3:** This level includes linking to real-world concepts in the healthcare system, such as patient and organization. There is one module at this level – Administration.
- **Level 4:** This level includes record keeping and data exchange for the healthcare process. There are five modules at this level – Clinical, Diagnostics, Medications, Workflow, and Financial.
- **Level 5:** This level includes the ability to reason about the healthcare process. There are two modules at this level – Clinical Reasoning and Medication Definition.

2.4.2 Profiles, Extensions, and Implementation Guides

Developers refer to the standard FHIR resources as *base* resources. To better support specific use cases or settings, base resources can be customized with *profiles.* Profiles can specify additional rules, such as requiring a data element that is optional in the base resource specification. Profiles can also require a resource's data element to be represented with specific codes from a standard vocabulary, such as a list of acceptable laboratory test codes used to report conditions of public health concern. Profiles also define *extensions* to add data elements that are not included in a base resource.

A collection of FHIR profiles can be published as an *implementation guide* (sometimes referred to as an "IG"). The FHIR US Core Implementation Guide defines a collection of US Core profiles that adapt base FHIR resources to the interoperability needs of healthcare in the United States and federal initiatives like USCDI (see Section 2.3.2). For example, the US Core profile of the Patient resource requires the *patientName* element, which is optional in the base Patient resource. The US Core Patient Profile also includes extensions to add data elements not included in the base Patient resource. An example is the *patientEthnicity* data element which aligns with

[23] M. L. Braunstein, *Health Informatics on FHIR: How HL7's API is Transforming Healthcare, 2nd ed.* Springer Nature Switzerland AG, 2022.

[24] Health Level Seven International. "Index – FHIR v4.3.0." HL7.org. https://www.hl7.org/fhir/index.html (accessed Dec. 30, 2022).

USCDI's Ethnicity data element in the Patient Demographics/Information data class.[25] A public health FHIR implementation in the U.S. would be based on the US Core Implementation Guide, and potentially other relevant implementation guides or profiles.

2.4.3 Standards Development

The creation of FHIR profiles and implementation guides is part of HL7's standards development process. This process includes updates to the FHIR base resources as well.

HL7 maintains lists of FHIR profiles,[26] extensions,[27] and implementation guides[28] to encourage their reuse. As the use of FHIR grows, so does the number of implementation guides and reuse is encouraged whenever possible. CDC's FHIR Community of Practice developed a FHIR Implementation Guidance Checklist (see Appendix A) to assist CDC programs and partners and inform key considerations before choosing a new resource or implementation guide.

The HL7 standards development community includes public health experts contributing to the evolution and application of FHIR. The Helios FHIR Accelerator is an HL7 initiative to convene partners for the development and adoption of FHIR-based solutions to public health challenges. Their priorities include making public health data available to partners, aligning and optimizing public health data sharing, and delivering aggregated healthcare information to public health agencies.[29] In addition to Helios, the HL7 Public Health Work Group is creating the US Public Health Profiles Library, a collection of reusable profiles representing common public health concepts and patterns to complement US Core and ease implementation burden for healthcare organizations and other partners.[30]

Pilot testing is essential for the standards development process. This involves using implementation guides under real-time operating conditions, evaluating their utility, and refining them as necessary. PHFIC will facilitate pilots to demonstrate FHIR's functionality in public health workflows, beginning with FHIR-based data exchange between local and state health departments. Findings from the pilots will be shared with HL7 FHIR community to inform the ongoing evolution of the standard and its implementation guides.

See Examples of FHIR Initiatives (Appendix C) for projects related to public health and Additional FHIR Material (Appendix D) for more information on communities working on the FHIR standard.

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[25] US Department of Health & Human Services. "Patient Demographics/Information." healthit.gov. https://www.healthit.gov/isa/uscdi-data-class/patient-demographicsinformation#uscdi-v3 (accessed Jun. 22, 2023).

[26] Health Level Seven International. "Profilelist – FHIR v4.3.0." HL7.org. https://www.hl7.org/fhir/profilelist.html (accessed Dec. 30, 2022).

[27] Health Level Seven International. "Extensibility-registry – FHIR v4.3.0." HL7.org. http://hl7.org/fhir/R4B/extensibility-registry.html (accessed July 17, 2023).

[28] HL7® FHIR® Foundation. "Implementation Guide Registry." fhir.org. http://www.fhir.org/guides/registry/ (accessed Dec. 30, 2022).

[29] Helios FHIR® Accelerator for Public Health. "2022 Use Cases." confluence.hl7.org. https://confluence.hl7.org/display/PH/2022+Use+Cases (accessed Mar. 3, 2023).

[30] Health Level Seven International. "US Public Health Profiles Library." build.fhir.org. https://build.fhir.org/ig/HL7/fhir-us-ph-common-library-ig/ (accessed Mar. 3, 2023).

3 Public Health FHIR Scenarios

Deciding on how to implement FHIR depends on several factors, including the needs of the scenario being addressed, IT architecture considerations, levels of process integration, and levels of trust between exchange partners. In this section, hypothetical public health FHIR scenarios are described to illustrate examples.

As PHFIC works with partners on their FHIR implementation plans, this Playbook will be updated with additional examples of FHIR-based data exchange for public health.

3.1 Send Case Data to Partner Agency

Scenario Description: A local public health agency uses a contact tracing application that is separate from the state public health agency's communicable disease surveillance system. A data manager at the state public health agency needs to send data on a legionellosis case to a disease investigator in the local public health agency. To reduce redundant data entry and ensure higher data quality, the disease investigator wants to receive case data from the state's surveillance system and avoid manual data entry into the contact tracing system.

- FHIR exchange mechanism: In this example scenario the state and local agencies agreed to use FHIR push exchange because the local agency wants to receive an authoritative case report from the state agency. The state agency receives case reports from healthcare providers on behalf of the local agencies in the state.
- Source: The state public health agency's communicable disease surveillance system and FHIR client. In this example scenario the state agency is using an integration engine as a FHIR client. For more on integration engines, see Section 5.3 Set Up FHIR Infrastructure.
- Destination: The local public health agency's contact tracing system and FHIR server. In this example scenario the local agency is using an integration engine as a FHIR server.
- Intermediary system: Not applicable in this example scenario.

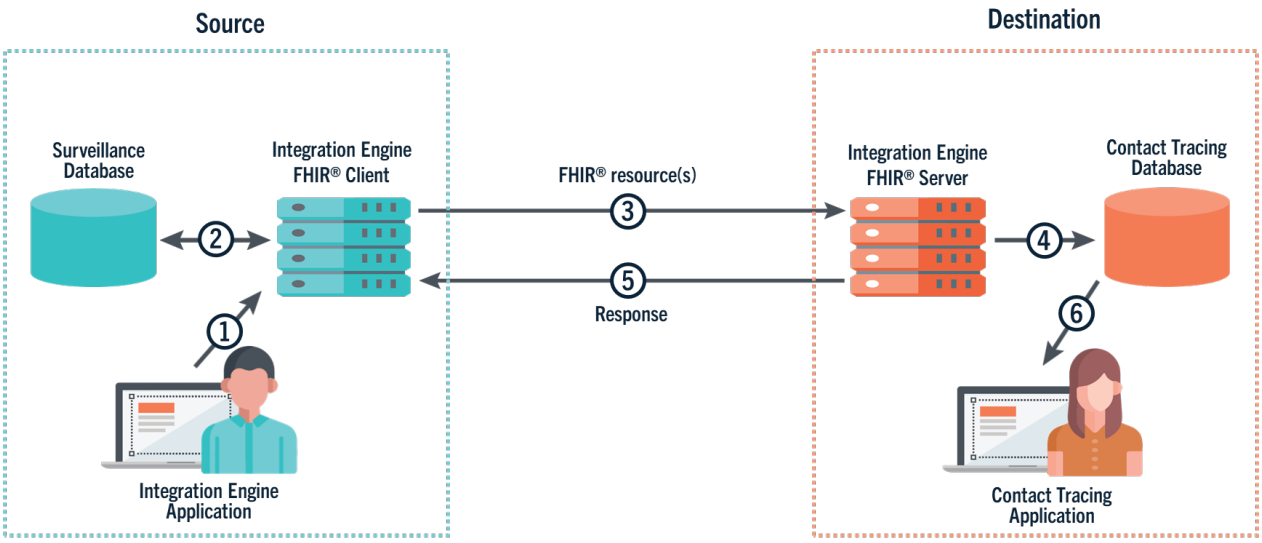

Figure 5: Send Case Data to Partner Agency Example

Figure 5 illustrates the FHIR data exchange for this example:

1. The state public health data manager uses the agency's integration engine application to create a data transmission that will be sent to the local public health agency. Alternatively, the data manager could establish rules in the integration engine that specify when a data transmission should be sent.
2. The integration engine, acting as a FHIR client, retrieves case report information from the surveillance database and transforms it into FHIR resources such as the Patient, Encounter, and Observation resources.
3. The FHIR client transmits the FHIR resources.
4. The local public health agency's integration engine, acting as a FHIR server, processes the FHIR resources by transforming and loading the data into the contract tracing system format.
5. The local agency's FHIR server returns a response indicating the FHIR transmission was received. The state agency's FHIR client records the response.
6. The case data is available for use in the local agency's contract tracing system.

3.2 Query Case Data from Healthcare

Scenario Description: A state public health agency receives an electronic laboratory report (ELR) for a listeriosis case via its HL7 Version 2 lab reporting feed. However, the ELR lacks the address and phone number of the patient, which the public health disease investigator needs to follow up on the case. The state public health agency wants to obtain the patient's address and phone number from the clinician that ordered the lab test but does not want to disturb the clinician's medical practice with an inconvenient phone call.

- FHIR exchange mechanism: In this example scenario the state public health agency and healthcare provider agreed to use pull exchange because the provider's EHR supports FHIR-based queries from authorized entities.

- Source system: The healthcare provider's EHR, which includes a FHIR server.
- Destination system: The state public health agency's surveillance system and FHIR client. In this example scenario, the state agency is using its integration engine as a FHIR client.
- Intermediary system: Not applicable in this example scenario.

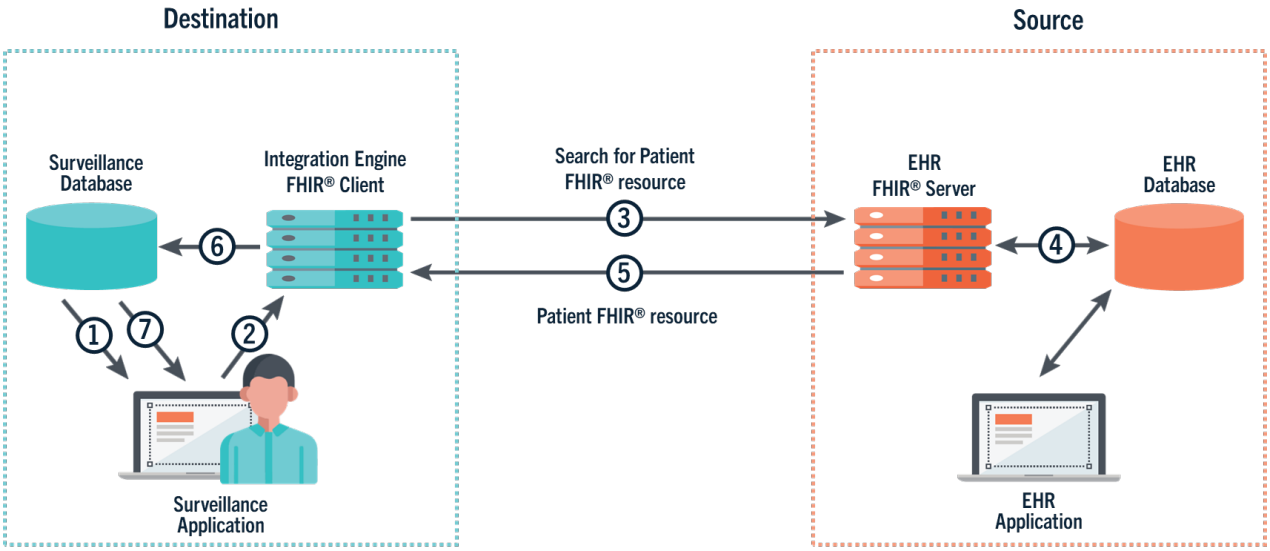

Figure 6: Query Case Data from Healthcare Example

Figure 6 illustrates the FHIR data exchange for this example:

1. The state public health agency epidemiologist reviews the ELR-based case information in the surveillance database and notices the missing demographic information (i.e., address and phone number).
2. The epidemiologist uses a customized feature of the surveillance system that triggers the agency's integration engine to query the EHR of the provider that ordered the laboratory test associated with the ELR.
3. The agency's integration engine, acting as a FHIR client, constructs a query requesting the Patient resource from the provider's EHR. The patient's name and date of birth are used as search criteria for the query.
4. The provider's EHR includes a FHIR server that receives and processes the query by retrieving the requested data from the EHR's back-end database. The EHR's database is populated by the provider organization's EHR users.
5. The provider's FHIR server converts the requested EHR data from its native format to the Patient FHIR resource and returns it to the state public health agency's integration engine, which is acting as a FHIR client.

6. The agency's integration engine converts the Patient FHIR resource into the surveillance system data format and supplies the missing address and phone number (using Patient.address and Patient.telecom, respectively).
7. The updated case data is available to the epidemiologist and other users of the agency's surveillance system.

3.3 Bulk Data Access for Immunization Information Systems

Scenario Description: In support of an outreach campaign to increase vaccination coverage, a population health analyst at a state Medicaid agency needs current vaccination histories for its enrollees. The state public health agency operates an immunization information system (IIS) that receives patient-level vaccination updates from healthcare providers, pharmacies, and mobile clinics each time a vaccine is administered. While providers can query an individual patient's vaccine history during a clinical encounter, the Medicaid agency needs an efficient way to query the IIS for the entire Medicaid patient population.

- FHIR exchange mechanism: In this example scenario the state Medicaid office and state public health agency agreed to use the FHIR Bulk Data Access exchange mechanism because the Medicaid office needed to update vaccination information on its entire patient population. Prior to exchanging data, the agencies confirmed Medicaid's authority to access IIS data.
- Source system: State public health agency's IIS
- Destination system: State Medicaid agency's population health management system
- Intermediary system: Not applicable in this example scenario
- Reference: HL7 Helios IIS Bulk Data Query[31]

[31] Helios FHIR® Accelerator for Public Health. "IIS Bulk Data Query – Make Data in Public Health Systems Accessible in Bulk." confluence.hl7.org. https://confluence.hl7.org/display/PH/IIS+Bulk+Data+Query+-+Make+Data+in+Public+Health+Systems+Accessible+in+Bulk (accessed Jun. 19, 2023).

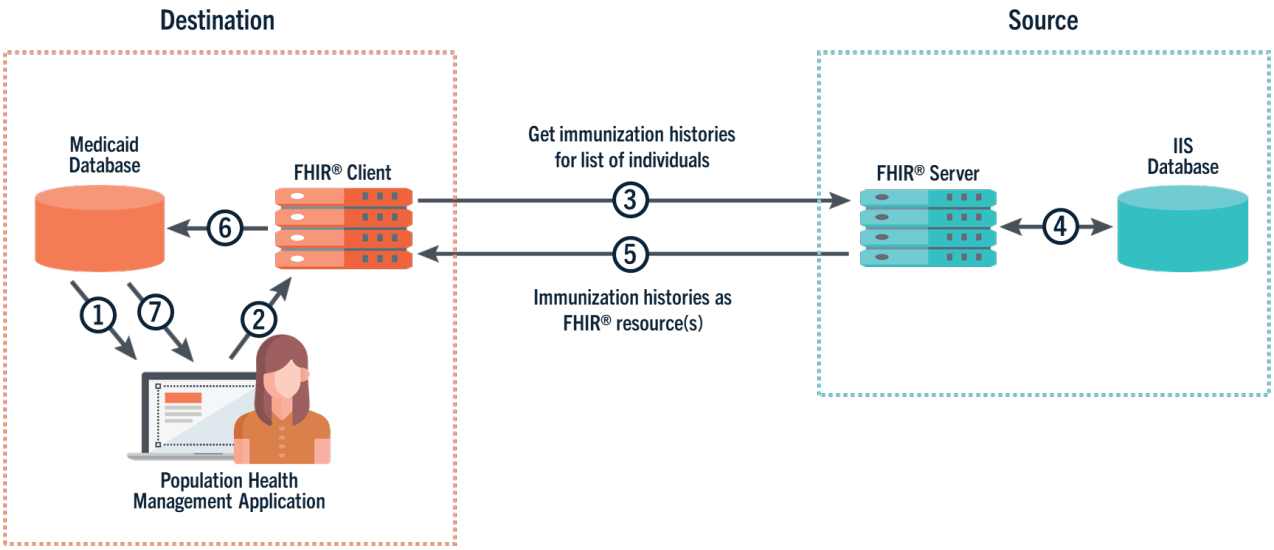

Figure 7: Bulk Data Access for Immunization Information System (IIS) Example

Figure 7 illustrates the concepts of FHIR Bulk Data Access:

1. An analyst at the state Medicaid agency uses their population health management application to assess vaccination coverage for Medicaid patients.
2. Noticing current vaccination information seem to be missing for a significant number of Medicaid patients, the analyst uses the population health management application to build a query for all enrollees' immunization histories.
3. The Medicaid agency implemented FHIR client software that converts the query authored in the population health management application into a Bulk Data Access query for immunization histories.
4. The state public health agency implemented a FHIR server that supports Bulk Data Access. The FHIR server processes the Medicaid query by retrieving patient-level vaccination histories from the IIS database.
5. The state public health agency's FHIR server constructs immunization histories by converting the data retrieved from the IIS database into FHIR resources including Patient, Immunization, and other relevant resources. The FHIR server transmits immunization histories to the state Medicaid agency's FHIR client using the Bulk Data Access exchange method.
6. The state Medicaid agency's FHIR client converts the FHIR resources received from the state public health agency into the Medicaid database format.
7. The Medicaid analyst uses the updated immunization histories to review vaccination coverage gaps and plan an outreach campaign to increase vaccine uptake.

4 Guidelines for Creating a FHIR-Ready Organization

FHIR has advantages over other interoperability standards. Healthcare and public health organizations are looking to implement FHIR as a solution to their existing data exchange needs.

This Playbook outlines six ways to integrate FHIR into workflows and create a FHIR-ready organization:

1. Identify your leader and executive sponsor.
2. Set your interoperability goals, strategy, and priorities.
3. Communicate priorities.
4. Assess your team.
5. Plan for sustainability.
6. Evaluate outcomes to continually improve.

While these activities are listed in a notional sequence, public health agencies may choose the sequence that works best for them. This could include conducting activities in an iterative or parallel fashion.

4.1 Identify Your Leader and Executive Sponsor

Engaging your senior leadership to gain support for creating a FHIR-ready organization and securing an executive sponsor is a key early step to success. A member of your senior leadership team should serve as an executive sponsor for this effort, helping convey its value and vision to others in your agency.

Checklist

- [ ] Identify a senior leader to champion the initiative to create a FHIR-ready organization.
- [ ] Meet with the senior leader to describe the initiative, get buy-in, and identify a potential executive sponsor.
- [ ] Meet with the identified executive sponsor (if different from the senior leader).
- [ ] Work with your executive sponsor to secure resources for the initiative.
- [ ] Identify other senior leaders that should be engaged. Include these individuals in your outreach strategy to other departments.
- [ ] Gain senior leadership and programmatic buy-in across the agency through a pilot/proof-of-concept project.

Key Questions

- Who in your agency understands both the need for FHIR-based solutions and has the influence to convince others across the agency to create a FHIR-ready organization?
- How would you describe the value of creating a FHIR-ready organization?
- How does this initiative to create a FHIR-ready organization fit within your organization's vision for public health data modernization?

4.2 Set Your Interoperability Goals, Strategy, and Priorities

In October 2020, ONC released the 2020-2025 Federal Health IT Strategic Plan.[32] Many of the strategies contained within it pertain to public health, including:

- "Leverage individual- and population-level data to prepare for, respond to, and recover from disasters; inform and monitor public health activities; improve quality of life; and address disease occurrence and preventable deaths" (p. 22).
- "Promote interoperability and data sharing through widely accepted standards to ensure health information is available across care settings for use in patient care, public health, research, and emergency and disaster preparedness, response, and recovery" (p. 24-25).
- "Sustain collaborative activities necessary to ensure public health surveillance, preparedness, and response" (p. 26).
- "Assess availability of health and human services data and streamline the appropriate collection, submission, and sharing of this data between federal, state, tribal, and local systems to enable population health planning; analysis of quality and patient outcomes across settings and programs; and clinical research" (p. 30).
- "Continue collaboration across public and private sectors to adopt and advance nationally supported standards, implementation specifications, and certification criteria, including the United States Core Data for Interoperability (USCDI), Interoperability Standards Advisory (ISA), and FHIR" (p. 33).

You may want to use these statements as a reference when setting your interoperability goals, strategy, and priorities.

Checklist

Establish or identify a strategy working group that is broadly representative of your organization's programs and staff members.
Consider Public Health Accreditation Board (PHAB) criteria for sharing data in response to requests and using interoperable systems to exchange data.
Assess FHIR needs across the organization and its programs.
Develop interoperability goals and measurable objectives.
Review and understand jurisdictional policies with potential FHIR implications.
Develop organization-level strategy and priorities.
Develop program-level interoperability plans and associated measures that align with the organization's strategy and priorities.

Key Questions

- With whom do you currently exchange information? Is it efficient? What are the pain points?

[32] US Department of Health & Human Services. "2020 – 2025 Federal Health IT Strategic Plan." healthit.gov. https://www.healthit.gov/sites/default/files/page/2020-10/Federal%20Health%20IT%20Strategic%20Plan_2020_2025.pdf (accessed Dec. 30, 2022).

- Will execution of your interoperability strategy result in better information to address health inequities?
- Do potential data exchange partners have the capacity for FHIR-based exchange, or will inequities in partners' technical capabilities need to be addressed?
- Do jurisdictional policies inhibit some FHIR exchange scenarios (e.g., pulling data from healthcare systems)?
- Do you want to actively participate in FHIR standards development?
- How will interoperability support your public health mission in one year, five years, or 20 years?

4.3 Communicate Priorities

Open, timely, and frequent communication is essential to ensure all participants understand the organization's interoperability priorities, goals, strategy, plans, and progress.[33] Leadership and FHIR implementation teams should communicate priorities through multiple channels. A communications management plan is an effective tool that guides delivering the correct information to the right audience at the right time with the right impact.

Checklist

Create a plan to communicate strategy and priorities to internal and external partners.

Decide who needs what information, when, and how often.

Define the purpose of each form of communication.

Identify who is responsible for creating the communication.

Decide the format, method, and location for information creation, dissemination, storage, and disposition.

Explain the process for the escalation and communication of risks, issues, and concerns.

Identify any constraints on communications (e.g., organization policies).

Review the communications strategy and plan regularly to ensure they remain applicable and efficient.

Key Questions

- Who needs to be informed and why?
- What are the information security or confidentiality requirements to consider as communication materials are created and disseminated?
- What value is achieved through a particular communication?
- What methods are available to monitor and control communications?
- Are any existing or planned communications unnecessary?

4.4 Assess Your Team

One of the first steps to create a FHIR-ready organization is to assess the agency's team that will be leading an implementation. This can include a training needs assessment to determine the

[33] Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th ed. Project Management Institute, 2013.

gaps between your organization's current FHIR knowledge, skills, and abilities and those required to achieve your objectives.[34] Suggestions for team member roles are included in the checklist below. It is possible for a single person with the right experience to hold multiple roles. Depending on the team's expertise, you may want to consider engaging a contractor. Decisions for outsourcing implementation tasks depend on your organization's internal FHIR competencies, acquisition culture, and strategic direction in terms of FHIR implementation, among other factors.[35]

Checklist

Describe the desired outcomes of having FHIR expertise in your health department.
Identify an informatician with a blend of public health, IT, and project management experience to lead the implementation.
Identify a developer with experience in FHIR or web application development with APIs and client/server architectures.
Identify a health IT expert with experience using integration engines, HL7, and terminology standards to map data requirements to resources in the FHIR data model.
Identify a data manager with experience in the planned back-end data storage and retrieval technology (e.g., relational database management system).
Identify one or more team members responsible for data use agreements and ensuring privacy and security requirements are met.
Identify subject matter experts that can represent the FHIR application's users and ensure functional requirements are met.
Determine knowledge, skills, and abilities gaps of groups and individuals.
Evaluate options to fill the gaps. If training is a viable option, determine suitable training(s). For example, HL7 is one organization that offers training for individuals and organizations as well as FHIR certification.[36]
Justify the cost of training.
Establish whether to develop FHIR staff in house, through a contract, or with a hybrid strategy.

Key Questions

- What are your current FHIR skill sets and technologies?
- How will you build FHIR expertise in your organization, and why is it not being done now?
- Is training the right solution to fill a particular gap?

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[34] US Office of Personnel Management. "Policy, Data, Oversight: Training and Development." opm.gov. https://www.opm.gov/policy-data-oversight/training-and-development/planning-evaluating/ (accessed Dec. 30, 2022).

[35] Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th ed. Project Management Institute, 2013.

[36] Health Level Seven International. "Healthcare Standards Training for Interoperability." HL7.org. https://www.hl7.org/training/index.cfm (accessed Dec. 30, 2022).

- Who needs training, and what training do they require?
- What long-term plans do you have for internal staff to support FHIR implementation?
- If using a contractor, what contract management and change control processes are currently available?

4.5 Plan for Sustainability

Sustainable FHIR implementations and supporting personnel ensures that project operations and outcomes remain beneficial over the long term.[37] Sustainable FHIR solutions should be a goal at the outset of the FHIR-ready organization.[38] By communicating and viewing sustainability as a visionary requirement for the organization, this perspective permeates throughout the organizational culture and the entire lifecycle of every FHIR project. Sustainable FHIR implementations are adaptable, auditable, scalable, extensible, maintainable, and manageable.[39]

Checklist

Make FHIR implementation sustainability part of your goals, strategy, and priorities.

Define what it means to be sustainable.

Identify the resources and competencies necessary over the long term.

Plan to support potential future use cases with components of the FHIR infrastructure you will build for an initial use case.

Monitor and evaluate status and progress as it relates to sustainability.

Key Questions

- What does a sustainable FHIR organization mean within your organization?
- What must you implement to meet partners' (and funders') current requirements? What can you implement in the future with additional funding?
- What is your plan for ongoing IT infrastructure costs and support for maintaining FHIR applications?
- Have you considered overhead charging or braided funding where multiple programs contribute to a shared FHIR solution?
- Have you identified staff members for specific FHIR implementation roles? Will these roles be distributed across the agency or consolidated in a specific program that supports the entire agency?
- What tasks do you need to accomplish to achieve FHIR sustainability? Who will do them?

[37] Association for Project Management. "What Is Sustainability in Project Management?" apm.org.uk. https://www.apm.org.uk/resources/what-is-project-management/what-is-sustainability-in-project-management (accessed Dec. 30, 2022).

[38] Institute of Project Management. "Sustainability in Project Management." projectmanagement.ie. https://www.projectmanagement.ie/blog/sustainability-in-project-management/ (accessed Dec. 30, 2022).

[39] J. Morfaw. "Fundamentals of Project Sustainability." pmi.org. https://www.pmi.org/learning/library/fundamentals-project-sustainability-9369 (accessed Dec. 30, 2022).

4.6 Evaluate Outcomes to Continually Improve

Continuous improvement programs facilitate a learning public health organization or one that values capacity growth and maturation. Your agency can evaluate FHIR implementations to measure impact on data management and use. An iterative approach promotes opportune decision-making, expansion of promising programs, and prompt corrective action to address challenges. Continuous improvement programs are successful when organizations "become adept at translating new knowledge into new ways of behaving."[40] Action drives change as part of an organizational commitment to a long-term strategy of iteration, learning, and growth.

Checklist

Develop an evaluation plan that includes success measures. Measures should be SMART (specific, measurable, accurate, reliable, and timely).

Consider aligning evaluation plan with any agency plan for quality improvement or performance management.

Establish baseline measures for comparison to outcome measures.

Use outcome-oriented metrics such as data timeliness, accuracy, and completeness to conduct a systematic evaluation of the implementation.

Consider qualitative evaluation criteria to measure factors such as agency and data exchange partner satisfaction with the FHIR implementation.

Experiment with new ideas and new approaches to improve interoperability.

Key Questions

- What public health outcomes are you trying to achieve using FHIR?
- What are the supporting infrastructure and processes necessary to achieve the outcomes?
- What data quality indicators will assist with learning and decision-making?
- What sources of evidence will you use to support learning?[41]
- What is the continuous improvement program that your agency uses?

5 Implementing FHIR Use Cases

Ultimately, FHIR is a tool to exchange data; like any tool, it can be used well or poorly. Ideal scenarios to use FHIR would be for daily data exchange and when the current data exchange mechanism is cumbersome, such as a manually created and exchanged flat file. This section has seven steps for implementing FHIR use cases:

1. Define the FHIR use case.
2. Bring the right partners to the table.
3. Set up FHIR infrastructure.
4. Map data sources to FHIR APIs.

[40] J. Morfaw. "Fundamentals of Project Sustainability." pmi.org. https://www.pmi.org/learning/library/fundamentals-project-sustainability-9369 (accessed Dec. 30, 2022).

[41] Wright, A. L., Zammuto, R. F., Liesch, P. W., Middleton, S., Hibbert, P., Burke, J., & Brazil, V. (2016). Evidence-based management in practice: Opening up the decision process, decision-maker and context. British Journal of Management, 27(1), 161–178. doi: 10.1111/1467-8551.12123

5. Manage testing and deployment.
6. Ensure data quality.
7. Manage security.

While these activities are listed in a notional sequence, public health agencies may choose the sequence that works best for them. This could include conducting activities in an iterative or parallel fashion.

5.1 Define the Use Case

Clearly describing the data exchange use case will help your agency, and your partners, better utilize FHIR to advance information sharing. The process of developing use cases identifies public health outcomes, key actors (human and system), objectives, activities, and risks. For examples of public health use cases, see *Examples of FHIR Initiatives* in Appendix C.

Checklist

- Identify the use case business process and actors (e.g., organizations, systems, roles)[42].
- Define the use case data needs.
- Determine necessary prerequisites (e.g., infrastructure, organization).
- Define use case initiation trigger events.
- Determine the data flows for the use case.
- Define the postconditions and outcomes of the use case.

Key Questions

- Is there an existing FHIR implementation guide (IG) that supports the use case?[43]
- Can profiles from other IGs be leveraged to support the use case?
- What are the priority information sharing needs for the public health use case?
- Who are the key actors in the use case?
- What does success look like for the use case?

5.2 Bring the Right Partners to the Table

By its very nature, health information sharing implies collaboration among public health agencies, healthcare professionals, vendors, health information exchange networks, and, importantly, end users. Having the right partners is critical for achieving success. Partners should be reputable and have a strong interest in supporting and maintaining the exchange of information. Official partners should also include the targeted end users and beneficiaries of the information exchange. Partners can establish governance for FHIR-based data exchange through data use agreements that codify the partners' authority to use the data and specify how the data will be used.

[42] For an example, see the Public Health Informatics Institute's Collaborative Requirements Development Methodology description at https://phii.org/crdm/ (accessed on Jun. 22, 2023)

[43] See Appendix A for a list of FHIR implementation guides related to public health.

Checklist

Contact potential data exchange partners and ask about their FHIR capabilities.
Design processes with the idea that the first connection is the beginning; processes should scale to accept more connections and be easily reused and adopted by other partners.
Consider using existing trusted organizations such as Health Information Exchanges (HIEs), Health Information Networks (HINs), and Qualified HINs (QHINs).
Consider using existing relationships with community representatives, providers, and vendors.
Draft a project charter that includes a collaborative governance structure with shared and transparent decision-making.
Develop or update data use agreements as necessary.
Set expectations for everyone involved, including consensus on approaches for addressing data quality issues identified in pilot or production data exchange.
Choose an appropriate time horizon for implementation and sustainable operations.
Assess the partnership dynamics as well as the use case outcomes and impacts, including intermediary measures that may identify concerns early.

Key Questions

- Who in the public will benefit from this FHIR implementation? (Include representatives in your partnership.)
- Can data use agreements be updated to leverage federal policy drivers for FHIR?
- How will you empower the end users through shared decision-making?
- What collaborators are needed to design and build this FHIR solution?
- What collaborators are needed to operate and maintain the implementation?
- What can you do to manage project risks, including avoiding unintended consequences?
- How will you monitor, evaluate, and improve the partnership and use case outcomes?
- Does the complexity of this effort warrant coordination by a reputable, intendent convenor?

5.3 Set Up FHIR Infrastructure

FHIR uses a classic internet client-server architecture where the client submits requests for information to the server, and the server responds. Public health departments may need to support clients, servers, or both depending on the use case and data exchange method (see Section 2.2.2 FHIR Exchange Methods). To start, some public health departments are using their existing integration engines as FHIR clients or servers. Integration engines (also known as interface engines) are software products that process an organization's incoming and outgoing data. Many public health agencies use them to receive incoming data formatted in HL7 Version 2 or CDA.

Checklist

Design an implementation architecture that meets the needs of the use case.

Determine which data exchange partner will use a FHIR client and which will host a FHIR server.
Establish production and test environments.
Determine what IG will be used to establish the infrastructure.
Determine what profiles from the IG will be used.
Determine what operations[44] will be performed on the FHIR resources or profiles.
Establish FHIR server support.
Establish FHIR client support.
Reuse FHIR services when possible and appropriate.

Key Questions

- What server (or servers) and client (or clients) do you need to satisfy the FHIR solution roles?
- Does your agency have an existing integration engine that can function as a FHIR client or server?
- What core capabilities are required for your server(s) or client(s)?
- Do you need intermediary code to translate underlying source databases or services to FHIR?
- Who hosts the FHIR server or client? Which entity has more capacity (resources and personnel) to maintain FHIR software and underlying databases?
- Is a push exchange appropriate? Data transactions based on a push exchange model (see Section 2.2.2) originate from the FHIR client and upload information to a FHIR server. Consider this mechanism when the data source has less capacity than the data destination.

5.4 Map Data Sources to FHIR APIs

Information sharing partners may not use the same common data model in their source databases.[45] Source databases may use data models that differ from FHIR. In such instances, implementing a FHIR solution requires mapping these differing data models to the FHIR data model (i.e., FHIR resources) expected by your FHIR API.[46] HL7 developed the FHIR mapping language to support implementers.[47] It supports several mapping tasks, including:

- Map FHIR resources between different FHIR versions.
- Map HL7 C-CDA® CCD document sections to multiple FHIR resources.
- Map HL7 Version 2 messages to multiple FHIR resources.

[44] Health Level Seven International. "Extended Operations on the RESTful API." HL7.org. https://www.hl7.org/fhir/operations.html (accessed Jan. 10, 2023).

[45] E. R. Pfaff, et al. "Fast Healthcare Interoperability Resources (FHIR) as a Meta Model to Integrate Common Data Models: Development of a Tool and Quantitative Validation Study." JMIR medical informatics vol. 7,4 e15199. 16 Oct. 2019, doi:10.2196/15199.

[46] K. Kawamoto, et al. "Establishing a Multidisciplinary Initiative for Interoperable Electronic Health Record Innovations at an Academic Medical Center." JAMIA open vol. 4,3 ooab041. 31 Jul. 2021, doi:10.1093/jamiaopen/ooab041.

[47] Health Level Seven International. "Using the FHIR Mapping Language." confluence.hl7.org. https://confluence.hl7.org/display/FHIR/Using+the+FHIR+Mapping+Language (accessed Dec. 30, 2022).

- Map any structured data format to any other structured data format, including to multiple FHIR resources.[48]

Checklist

Identify data sources that you need to map to FHIR resources.
Determine target FHIR resources and format requirements.
Map the data sources to FHIR resources and their data elements.
Convert the source data to FHIR. Consider using existing tools such as CAMP FHIR.[49]
Test exposing and sharing data through your FHIR API.

Key Questions

- What mapping will you implement to convert your local data into the format needed for your FHIR API?
- Do you and your data sharing partners use the same common data model?
- How will you create mappings accurately and efficiently?

5.5 Manage Testing and Deployment

Test-driven development refers to deploying simple, working software solutions that can be improved through early and frequent feedback.[50] The feedback drives the incremental adjustments to achieve efficient, minimally viable solutions. During deployment, testing occurs through monitoring and improving product performance.

Checklist

Develop the initial version of the FHIR software.
Develop a test plan that incorporates early and frequent testing as well as input from your information-sharing partners.
Identify appropriate test data sources.
Conduct pre-deployment testing using validation and testing tools (e.g., Inferno[51]).
Conduct pre-deployment testing with partners for each transaction in the use case.
Develop a deployment plan with input from your information sharing partners.
Develop an onboarding process to add users post-deployment.
Configure the production system to enable the use case connectivity.
Validate connectivity through authentication and sample FHIR resource exchanges.
Collect feedback to improve performance and end-user experience.

[48] Health Level Seven International. "Using the FHIR Mapping Language." confluence.hl7.org. https://confluence.hl7.org/display/FHIR/Using+the+FHIR+Mapping+Language (accessed Dec. 30, 2022).

[49] The Biomedical Data Translator Consortium. "CAMP FHIR." researchsoftwareinstitute.github.io. https://researchsoftwareinstitute.github.io/data-translator/apps/camp-fhir (accessed Dec. 30, 2022).

[50] Agile Alliance. "What is Test Driven Development (TDD)?" agilealliance.org. https://www.agilealliance.org/glossary/tdd (accessed Dec. 30, 2022).

[51] US Department of Health & Human Services. "Inferno." healthit.gov. https://inferno.healthit.gov/ (accessed July 3, 2023).

Key Questions

- What are all of the features that you plan to test?
- What is a minimally viable feature?
- Who will test it?
- What constitutes a successful test?
- How will you capture feedback?
- What schedule and resources can you and your information-sharing partners commit to?
- How will you maintain and improve the implementation after deployment?

5.6 Ensure Data Quality

While FHIR can improve data exchange and create more opportunities for data use, it does not automatically solve data quality issues. Poor data quality adversely affects how data may be used, both by the owner of the source system and by data exchange partners. The SMART on FHIR framework can help address this issue and encourage the delivery of higher quality data. SMART on FHIR refers to efforts by Boston Children's Hospital and Harvard Medical School to develop "substitutable medical applications, reusable technologies" that evolved to support FHIR implementations.[52] This support includes a "limited set of broadly applicable data types, rather than permitting a proliferation of interface-specific definitions."[53] However, steps are necessary at the data source to ensure data quality. That is, organizations exchanging information need to address data quality issues in the underlying system data.[54, 55]

Checklist

Create workflow diagrams depicting real-world use of the data.

Create data flow diagrams detailing data capture, transmission, and mappings from and to source and destination data models respectively.

Develop a data quality assessment plan with quality criteria for data elements.

Use a SMART on FHIR or comparable vocabulary management tools to constrain exchanged data to coded values supporting the use case.

Assess source data for completeness, accuracy, and consistency prior to and during implementation. Use process-based and data-based assessment approaches.

Deploy real-time checks to ensure data quality during operation for both pre-and post-information exchanges.

Key Questions

- What is the source of truth for each data element in your API?

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[52] Computational Health Informatics Program. "SMART." smarthealthit.org. https://smarthealthit.org/ (accessed May 9, 2023).

[53] Computational Health Informatics Program. "SMART on FHIR API." smarthealthit.org. https://smarthealthit.org/smart-on-fhir-api/ (accessed Dec. 30, 2022).

[54] J-P. Stoldt, J. Weber, "Safety improvement for SMART on FHIR apps with data quality by contract," presented at IEEE International Conference on Software Architecture Companion, 2020, 10.1109/ICSA-C50368.2020.00041.

[55] NIH Pragmatic Trials Collaboratory. "Assessing Data Quality for Healthcare Systems Data Used in Clinical Research." dcricollab.dcri.duke.edu. https://dcricollab.dcri.duke.edu/sites/NIHKR/KR/Assessing-data-quality_V1%200.pdf (accessed Dec. 30, 2022).

- Are definitions for data elements consistent with all participants? Do these definitions support the purpose of the information exchange?
- Does the source data map directly to the API (i.e., are data aligned or misaligned)?
- What is the fitness for use of the data from the perspectives of completeness, accuracy, and consistency?

5.7 Manage Security

FHIR "is not a security protocol, nor does it define any security-related functionality."[56] However, a FHIR production implementation needs to run on a system that provides information security, including user authentication, access control, and audit logs. FHIR resources are targets of the security system through FHIR security labels. Security labels applied to a FHIR resource enable the security system to determine if a user has permission to access it.

Checklist

Choose privacy and security protections appropriate for different types of shared data (e.g., not sensitive, business sensitive, individual sensitive, patient sensitive).

Define a mutual trust security framework agreement that all data sharing partners sign.

Use FHIR resource security labels to align FHIR resources and operations to the security framework.

Authenticate and authorize the client and user (consider using SMART App Authorization Guide).[57]

Define access control constraints.

Use the AuditEvent resource to record security-related events.

Use caution when handling attachments to FHIR resources, as they may contain malware.

Validate FHIR resource narratives to ensure no active content or external links leak information.

Consider security risks associated with web-based applications in general.[58]

Key Questions

- Who are your information-sharing partners?
- Is a mutual trust security framework agreement needed between information-sharing partners?
- Where does the security subsystem fit into your deployment architecture?
- What assurances are needed to confirm a party is authorized to receive it?
- Which access control model will you implement (e.g., role-based access control, attribute-based access control)?

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[56] Health Level Seven International. "Security – FHIR v4.3.0." HL7.org. https://www.hl7.org/fhir/security.html (accessed Dec. 30, 2022).

[57] Computational Health Informatics Program. "SMART App Authorization Guide." docs.smarthealthit.org. https://docs.smarthealthit.org/authorization/ (accessed Dec. 30, 2022).

[58] Open Web Application Security Project. "OWASP Top Ten." owasp.org. https://owasp.org/www-project-top-ten/ (accessed Jun. 22, 2023)

6 Conclusion

The purpose of this playbook is to describe FHIR, demonstrate its potential value for public health agencies, and outline the steps needed to ensure a successful implementation. While this playbook cannot include all the details that each health department may need when implementing FHIR, the hope is that this information provides a starting point.

Widespread adoption of FHIR could lead to an unprecedented opportunity for public health to access a growing set of data in EHRs as well as other non-traditional data sources (e.g., claims data) without customizing integrations for each new source.

With the appropriate permissions, public health can consider exchanging data using connections that are scalable across a variety of systems and scenarios (see Figure 8). As FHIR adoption grows, implementations could be simplified and the cost of modernization to public health agencies could decrease. Data exchange with FHIR can be an important aspect of public health data modernization and integration with the broader health information landscape.

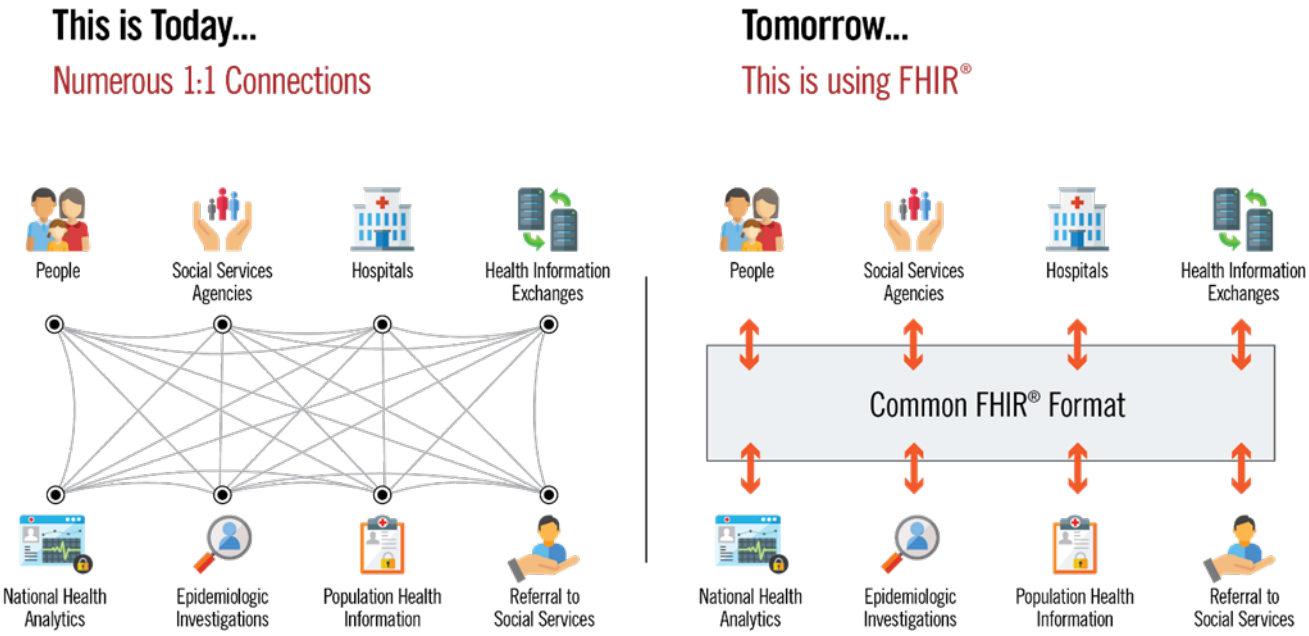

Figure 8: Public Health Vision for FHIR

Appendix A HL7® FHIR® Implementation Guidance Checklist

Purpose

The HL7® FHIR® Implementation Guidance Checklist is intended for CDC programs and partners to assist in navigating available resources for the adoption and use of HL7® FHIR® standards and Application Programming Interface (API) based approaches to interoperability. This checklist was developed by the FHIR Community of Practice and assumes that program efforts are planning to conform to or be aligned with the Cures Act Final Interoperability Rule and to use Health Information Technology (IT) (e.g., Electronic Health Record systems) certified by the Office of the National Coordinator (ONC) Health IT Certification Program. Use of these resources may reduce implementation burden and ensure key questions and considerations are addressed before choosing to develop a new resource or implementation guide.

- Cures Act Final Rule
- Conformance Testing and Certification
- Standards Version Advancement Process (SVAP)
- Interoperability Standards Advisory (ISA)

Implementers should evaluate their data exchange requirements for consistency and alignment with the U.S. Core Data for Interoperability (USCDI) data elements updated by ONC yearly. In addition to FHIR® U.S. Core, FHIR® Accelerator projects have started to develop IGs, profiles, and extensions that may be applicable to future national requirements and certification criteria.

- USCDI Versions
- FHIR® U.S. Core Implementation Guide (current version)
- HL7® FHIR® Accelerator Program

Checklist

The following suggestions for preplanning encourage utilizing pre-existing resources before moving forward in the creation of a new Implementation Guide. CDC's Information Technology and Data Governance (ITDG) and informatics offices, such as The Public Health Informatics Office (PHIO), can aid in identifying potential existing IGs that can be utilized before beginning a new process.

Gathering and Preplanning

During this analysis you may identify specific capabilities that are out-of-scope for your API or intended to be part of future requirements. You may also identify an existing data exchange that can be re-purposed, have a second form of use, or be extended to meet your needs. See http://www.fhir.org/guides/registry/ to search existing FHIR® IGs.

Identify the community of interest (COI): business champions; domain users; interoperability subject matter experts; clinical, administrative, and terminology experts; and other potential partners.

Describe the interoperability challenge and need that will be met by the implementation of the FHIR® IG.

Develop a list of benefits with COI, including ROI, policy barriers, facilitators/enablers, etc., that will accrue to patients and practitioners who use the health IT systems that produce or consume information using APIs.

Note: Do not start an IG without identifying a COI with support from business modeling expertise, and interoperability expertise.

Choose privacy and security protections appropriate for shared data (e.g., not sensitive, business sensitive, individual sensitive, patient sensitive).
Define a mutual trust security framework agreement that all data sharing partners sign.
Use FHIR® resource security labels to align FHIR® resources, bundles, and operations to the security framework.
With the assistance of the COI, define the business and interoperability requirements.
Prepare use cases.
Identify health IT system types and their roles to produce or consume information.
Describe the interoperability scenarios or workflows that define how information exchanges are initiated. These triggers must be consistent with FHIR® Exchange Module.

Note: It is suggested that the FHIR® Release 4.0.1 or later should be used to scope out the project.

Define a mutual trust security framework agreement that all data sharing partners sign.
Use FHIR® resource security labels to align FHIR® resources, bundles, and operations to the security framework.
For each use case, describe the information exchange and acceptance criteria for a successful exchange.
Determine how successful interoperability will be measured.
Identify a project facilitator with expertise in HL7® project initiation, balloting, and reconciliation.
Identify a profile and IG modeler with experience in one or more of the FHIR® IG development tools.
Identify regulations when considering the clinical workflows.
For each information exchange, identify the mandatory data elements used as input or created as an output.
Harmonize data elements with the USCDI to ensure alignment. If alignment is not possible you may identify data issues that need to be addressed by the HL7® FHIR® Core.
Pay attention to any data elements that are mandatory but do not appear in USCDI. For these data elements you need to identify the structure, data type, and terminology, if applicable.
To facilitate planning, review the FHIR® Implementation Guide Process Flow.

Preparation

Choose privacy and security protections appropriate for shared data (e.g., not sensitive, business sensitive, individual sensitive, patient sensitive).
Plan out methods of increasing adoption of this new HL7® FHIR® standard (e.g., incentive policies, cooperative agreement requirements).
Determine the purpose and need for interoperability.
Determine the information to be exchanged.
Develop an evaluation plan to measure interoperability.
Determine the cost to hospitals and providers.
Determine operating costs to maintain.
Verify whether data can be derived from existing workflows and operations rather than a custom data collection.
Verify whether data can be inferred from other activities that are already recorded,
Determine what existing data can be exchanged-purposed or have a second form of use.
Can you extend an existing exchange to meet your needs?
Determine any policy barriers for implementing the HL7® FHIR® standard.
Check for existing specification IGs to help determine if a new IG is needed and how you may use APIs in an architecture.
Verify whether you can utilize existing FHIR® Profiles that electronic health records and other systems may already be producing, e.g., FHIR® U.S. Core. This reduces your barriers to adoption.
Check for content IG's: http://www.fhir.org/guides/registry/

Determine the purpose of data exchange

Once you complete your requirements analysis you may evaluate existing implementations.

Determine whether your project can reuse, expand, or constrain existing FHIR® implementation guides that were balloted and published by HL7® as Standard for Trial Use (STU) or Normative specifications. http://www.fhir.org/guides/registry/

Initiate a new HL7® Project

FHIR® IGs may be balloted using the HL7® development process. A new Project Scope Statement (PSS) is required to start a new FHIR® IG project that will result in a balloted specification.

Identify a HL7® workgroup that focuses on the same domain as the IG or project (e.g. Medications would be addressed by the Pharmacy Workgroup, Transfer of Care would be addressed by Patient Care Workgroup). There is a list of Workgroups and a link to their respective Confluence Pages here: https://confluence.hl7.org/

Note: If your IG is intended to expand FHIR® APIs in the United States, the Cross-Group Projects Workgroup may need to be involved. The U.S. Realm Steering Committee can provide guidance to U.S.-based projects.

Draft a PSS using the HL7®-provided guidance: https://confluence.hl7.org/display/PSS.

Note: Typically, a FHIR® IG is balloted as a "Standard for Trial Use" to ensure the experience of implementers can be added to the IG prior to its Normative status.

If you want to ballot an implementation guide, please follow the HL7® process to create a ballotable FHIR® IG that can be approved.

- https://confluence.hl7.org/display/FHIR/Designers
- https://build.fhir.org/ig/FHIR/ig-guidance/best-practice.html
- https://confluence.hl7.org/display/FHIR
- https://confluence.hl7.org/display/FHIR/Designers

Address terminology gaps by reaching out to HL7® Vocabulary or HL7® Terminology Authority (HTA), Regenstrief, or the National Library of Medicine.

Note: Terminology should be defined and approved through the vocabulary maintenance process with the Vocabulary Workgroup

- https://confluence.hl7.org/display/VOC/
- https://confluence.hl7.org/display/TA

Authoring tools and resources

Visit the Confluence pages listed here:

- https://www.hl7.org/fhir/downloads.html
- https://confluence.hl7.org/display/FHIR/
- https://confluence.hl7.org/display/FHIR/FHIR+Tooling+Ecosystem

Sign up to the FHIR® Committers Zulip chat.

Register on https://chat.fhir.org to be able to ask for help from the FHIR® Community.

Document capabilities of a FHIR® Terminology Server

Available tools:

- FHIR® SUSHI tools for FHIR® IG development using HL7® FHIR® Shorthand (MITRE)
- Forge + Simplifier.NET- Windows application for authoring HL7® FHIR® profiles
- Trifolia-on-FHIR®, is a free, web-based, open-source tool for creating HL7® FHIR® profiles and IGs

Validate your IG with the FHIR® IG validator.

HL7® FHIR® References

- ONC fact sheets
- ONC webinar
- Check for content IG's
- Check for existing specification IGs to help determine if a new IG is needed
- Reference HL7® FHIR® Getting Started Link
- HL7® GitHub Web page
- Examples of balloting

Conformance and Profiling References

Check System Profile, Use-cases Profile, and Check Global Profiles

☐ Identify what other related profiles exist in other IGs

References:

- HL7® Downloads
- HL7® Profiling Link
- Epic HL7® FHIR® Tutorial
- Using Profiles
- Profiling HL7® FHIR®
- Extension Registry

HL7® IG Review

Apply the FHIR® IG Checklist during IG development and prior to formal reviews and publication. Key areas of concern:

Check clarity and appropriateness of purpose, realm, and dependencies

Check notes to balloters and readers, history, and quality report (qa.html)

Check the actors and exchange protocol(s) for alignment with the business needs statements

For all profiles and extensions, check search, conformance, slicing, terminology binding and strength, cardinality, definitions, and comments

Check for valid and comprehensive Capability Statement

Check for a Must Support definition, correct inheritance, and usage within profiles

For all new terminology, ensure the need then check copyright, version, and registration in the HL7® Unified Terminology Gateway

Check for business appropriate Privacy and Security guidance and requirements

Check for relevance and completeness of examples

Submit all gathered work for the proposal of the new or recreated IG to the appropriate parties before submitting for a ballot

Testing references

HL7® Connectathon

IHE Connectathon

How to get involved?

Become an HL7® member

Join the CDC HL7® FHIR® Community of Practice

Join the HL7® FHIR® chat (sometimes referred to as "Zulip")

Build a community through HL7® Work Groups

Subscribe to the HL7® FHIR® Foundation Calendar

Watch #FHIR on twitter

Other Resources

EPIC HL7® FHIR® Tutorial

Cerner SMART on FHIR® Tutorial

Mapping Tutorial

National Academy of Medicine Special Report on Procuring Interoperability

Disclaimer: For informational purposes only.

Appendix B List of Public Health-Related FHIR Implementation Guides

Several public health-related implementation guides are available through the Fast Healthcare Interoperability Resources (FHIR) Implementation Guide (IG) Registry.

Table B-1: Public Health-Related Implementation Guides

Short Name	Description	Link
Bidirectional Services eReferrals (BSeR)	Provides guidance for coordinating a referral from a clinical provider to a typically extra-clinical program service provider, such as a diabetes prevention program, a smoking quitline, or a hypertension management training program.	http://www.hl7.org/fhir/us/bser/history.html
Bulk Data Access	Defines a way to efficiently access large volumes of information on a group of individuals from an electronic health record (EHR).	http://hl7.org/fhir/uv/bulkdata/
Common Data Models Harmonization (CDMH)	Provides the guidance necessary to map four common data models (Sentinel, PCORnet, i2b2, and OMOP) to FHIR resources and profiles.	https://build.fhir.org/ig/HL7/cdmh/
Data Access Framework	Focuses on enabling researchers to access data from multiple organizations.	http://hl7.org/fhir/us/daf/history.html
Electronic Case Reporting (eCR)	Supports reporting, investigation, and management via electronic transmission of clinical data from electronic health records to public health agencies, along with the management and processing of population cases. This IG covers bidirectional information exchange and triggering and decision support.	http://hl7.org/fhir/us/ecr/
Electronic Long-Term Services and Supports (eLTSS)	Support exchange of data generated during the planning and provision of long-term services and supports and is currently scoped to data commonly found on LTSS service plans due to various disabling conditions and chronic illnesses.	http://hl7.org/fhir/us/eltss/
FHIR Clinical Guidelines	Builds shareable and computable representations of the content of clinical care guidelines. The guide focuses on common patterns in clinical guidelines, establishing profiles, conformance requirements, and guidance for the patient-independent, as well as analogous patterns for the patient-specific representation of guideline recommendations.	http://build.fhir.org/ig/HL7/cqf-recommendations/
Genomics Reporting	Enables improved interoperable and computable sharing of genetic testing results.	http://build.fhir.org/ig/HL7/genomics-reporting/

Short Name	Description	Link
Healthcare Associated Infection (HAI) Reports Long Term Care Facilities (LTCF)	Supports reporting to the National Healthcare Safety Network to track HAIs.	http://build.fhir.org/ig/HL7/HAI-LTCF/
Immunization Decision Support Forecast (ImmDS)	Used by health information systems to indicate which vaccinations a patient is due for next.	http://hl7.org/fhir/us/immds/index.html
Integrating the Healthcare Enterprise (IHE) Birth and Fetal Death Reporting - Enhanced	Provides means for pre-populating of data from EHR systems to electronic vital records systems for birth and fetal death reporting.	https://wiki.ihe.net/index.php/Birth_and_Fetal_Death_Reporting_Enhanced_Profile
IHE Quality Outcome Reporting for Emergency Medical Services	Supports transmission of clinical data for use in calculating Emergency Medical Services Quality measures. Focus on Stroke, CPR, and ST-Elevation Myocardial Infarction.	https://wiki.ihe.net/index.php/Quality_Outcome_Reporting_for_EMS
Longitudinal Maternal & Infant Health Information for Research	Defines a framework to enable maternal health researchers to aggregate, calculate, and analyze clinical information of research populations to explore the root causes for maternal and child morbidity and mortality.	http://build.fhir.org/ig/HL7/fhir-mmm-ig/
Making EHR Data More Available to Research and Public Health (MedMorph)	Enables public health and research organizations to access EHR data without increasing provider burden. Examples include Central Cancer Registry Reporting Content IG, Healthcare Surveys Reporting Content IG, and Research Content IG.	http://build.fhir.org/ig/HL7/fhir-medmorph/
Medicolegal Death Investigation (MDI)	Provides guidance on the exchange of information to and from MDI information systems.	http://hl7.org/fhir/us/mdi/
Occupational Data for Health (ODH)	Supports information about a patient's work, including some voluntary work, or a patient's household members' work.	http://hl7.org/fhir/us/odh/
Social Determinants of Health (SDOH) Clinical Care	Defines how to exchange SDOH content defined by the Gravity Project using the HL7 FHIR standard.	https://hl7.org/fhir/us/sdoh-clinicalcare/
Situational Awareness for Novel Epidemic Response (SANER)	Enables transmission of high-level situational awareness information from inpatient facilities to centralized data repositories to support the treatment of novel influenza-like illness.	http://hl7.org/fhir/uv/saner/
Structured Data Capture	Describes use of FHIR to distribute electronic questionnaires and return questionnaire responses.	http://hl7.org/fhir/uv/sdc/
US Core Implementation Guide	Defines the minimum set of constraints on the FHIR profiles supporting U.S. healthcare policies and practices.	https://www.hl7.org/fhir/us/core/
Vital Records Birth and Fetal Death Reporting	Provides guidance on reporting birth and fetal death information based on the current revisions of the US Standard Certificate of Live Birth and US Standard Report of Fetal Death.	https://build.fhir.org/ig/HL7/fhir-bfdr/index.html

Short Name	Description	Link
Vital Records Common Profile Library	Contains a library of profiles used by other Vital Records IGs such as Birth and Fetal Death Reporting and Birth Defects Reporting.	http://build.fhir.org/ig/HL7/vr-common-library/
Vital Records Death Reporting (VRDR)	Provides guidance for the bidirectional exchange of mortality data between state-run vital records offices and National Center for Health Statistics (NCHS).	http://hl7.org/fhir/us/vrdr/
Women's Health Technology Coordinated Registry Network	Provides the necessary guidance to use FHIR to build registries specific to monitoring women's health.	https://confluence.hl7.org/display/BRR/CRN+-+FHIR+Investigation+and+Implementation+Guide

Appendix C Examples of FHIR Initiatives

As of early 2023, several FHIR initiatives are underway in public health. This appendix highlights several. This playbook will be updated as these initiatives evolve and new efforts begin.

CDM and FHIR Harmonization

A National Institutes of Health effort to provide resources and tools for researchers exploring the use of FHIR and common data models (CDMs) used in research. FHIR can be used in conjunction with CDMs to capture, integrate, and exchange clinical data for research purposes and to enhance sharing capabilities of research data.

CDM and FHIR Harmonization resources include tools and educational resources to aid clinical researchers who are interested in harmonizing clinical data and FHIR for research. The resources are focused on harmonizing FHIR with four CDMs used by researchers:

- Informatics for Integrating Biology & the Bedside (i2b2) CDM
- Observational Medical Outcomes Partnership (OMOP)
- Patient-Centered Outcomes Research Network (PCORnet) CDM
- Sentinel CDM

Website: https://datascience.nih.gov/fhir-initiatives/resources/cdmcatalog

Clinical Practice Guidelines

The FHIR Clinical Practice Guidelines Implementation Guide (CPG IG) provides a standard, consistent, and scalable way to convert evidence, guidance, and policies developed through public and population health initiatives into actionable knowledge for patient care, emergency response, and community service. The IG contains several example expressions of clinical guidelines conformant to the IG, including:

- WHO Antenatal Care Guidelines
- Anthrax Post-Exposure Prophylaxis
- VA/DoD Clinical Practice Guideline for Chronic Kidney Disease
- Congestive Heart Failure
- COVID-19 Severity Classification
- Recommendation 5 of the CDC Opioid Prescribing Guideline
- HIV Testing of Adults, Adolescents, and Pregnant Women in Healthcare Settings
- Immunization Forecasting of Hepatitis B Vaccine for Adults

The primary objective of the creators of the CPG IG is to “accelerate the translation and delivery of expert body evidence-based and best practice recommendations to the point of care” (Figure

5).[59] Programs that support CPG IG development include Health eDecisions, Clinical Quality Framework initiative, the CDC's Adapting Clinical Guidelines for the Digital Age initiative, the Object Management Group's BPM+ for Health initiative, IHE's Computable Care Guidelines initiative, and the WHO's Smart Guidelines initiative.

Website: http://build.fhir.org/ig/HL7/cqf-recommendations/

Electronic Case Reporting

The Medicare Promoting Interoperability Program for Eligible Hospitals and Critical Access Hospitals includes an objective for public health and clinical data exchange. [60] A required measure under this objective is electronic case reporting,[61] the automated reporting of case report information between EHRs and public health for infectious conditions that may be reportable. One of the acceptable ways to meet this criterion is to use the electronic case reporting (eCR) Now FHIR application.[62] The eCR Now FHIR app is designed to work with existing eCR infrastructure; namely, the Association of Public Health Laboratories Informatics Messaging Services (AIMS) platform.[63] AIMS supports the delivery of electronic case reports from providers to public health agencies. Public health agencies only have the option of receiving HL7v3 CDA® reports. FHIR allows healthcare organizations to more easily communicate eCR information, and AIMS is looking to support the same FHIR functionality for public health in the future.

Website: https://www.cdc.gov/ecr/index.html

Gravity

The focus of the Gravity FHIR Accelerator project is to use FHIR to improve interoperability and sharing of data on social determinants of health (SDOH).[64] Their goals are to develop SDOH FHIR data exchange use cases, identify and promote data elements to support these use cases, and define data capture and exchange mechanisms for SDOH data. As one example, Gravity developed the SDOH Clinical Care for Multiple Domains FHIR Implementation Guide.[65] This guide's purpose is to facilitate the flow of information between patients, their providers, payers,

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[59] Health Level Seven International. "FHIR Clinical Guidelines." HL7.org. http://hl7.org/fhir/uv/cpg/ (accessed Dec. 30, 2022).

[60] US Department of Health & Human Services. "2022 Medicare Promoting Interoperability Program Requirements." cms.gov. https://www.cms.gov/regulations-guidance/promoting-interoperability/2022-medicare-promoting-interoperability-program-requirements (accessed Dec. 30, 2022).

[61] US Department of Health & Human Services. "2022 Medicare Promoting Interoperability Program for Eligible Hospitals and Critical Access Hospitals: Public Health and Clinical Data Exchange Objective Fact Sheet." cms.gov. https://www.cms.gov/sites/default/files/2022-03/2022%20Public%20Health%20and%20Clinical%20Data%20Exchange%20Objective%20Fact%20Sheet.pdf (accessed Dec. 30, 2022).

[62] US Department of Health & Human Services. "Transmission to public health agencies – electronic case reporting." healthit.gov. https://www.healthit.gov/test-method/transmission-public-health-agencies-electronic-case-reporting (accessed Dec. 30, 2022).

[63] Association of Public Health Laboratories. "eCR Now FHIR App." ecr.aimsplatform.org. https://ecr.aimsplatform.org/ecr-now-fhir-app (accessed Dec. 30, 2022).

[64] Health Level Seven International. "Gravity Project." HL7.org. https://www.hl7.org/gravity/ (accessed Dec. 30, 2022).

[65] Health Level Seven International. "SDOH Clinical Care." HL7.org. http://hl7.org/fhir/us/sdoh-clinicalcare/ (accessed Dec. 30, 2022).

community-based organizations, and public health to assess SDOH risks, establish goals in response to risks, track intervention, and measure outcomes both on individual and population levels.

Website: https://www.hl7.org/gravity/

Helios

Helios works to "ensure data modernization efforts in public health incorporate market-based solutions that incentivize participation and are compatible with nationwide interoperability priorities."[66] Helios focuses on public health data sharing with healthcare, with other sectors and with the public. Finally, the ONC and CDC sponsor Helios' work to advance public health through improved data sharing within and across all levels of public health.[67] The Helios project team identified three high-priority areas in 2022:

1. Make data in public health systems accessible in bulk: Ensure authorized users of immunization systems can access vaccination data in bulk.
2. Deliver aggregate information to public health: Provide critical public health data on healthcare resource capacity during emergencies or other events of public health importance.
3. Align and optimize public health data sharing: Identify commonalities and assess optimal ways for public health to access data in EHRs that would not be easily available under existing data channels.[68]

Website: http://www.hl7.org/helios/

MedMorph

The Making EHR Data More available for Research and Public Health (MedMorph) project addresses use cases in research and public health, and is conducting pilots for hepatitis C surveillance, cancer registry reporting, and healthcare surveys for healthcare utilization. The MedMorph team works closely with the eCR project team to ensure alignment, as their hepatitis C surveillance work overlaps with eCR's more general disease reporting initiatives.

Website: https://hl7.org/fhir/us/medmorph/2021Jan/index.html

Project Vulcan

Project Vulcan aims to accelerate data exchange functionality for translational and clinical research using FHIR.[69] Vulcan has several efforts underway, including the following:

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[66] Health Level Seven International. "Helios." HL7.org. https://www.hl7.org/helios/ (accessed Dec. 30, 2022).

[67] Health Level Seven International. "HL7® Launches Helios FHIR® Accelerator for Public Health." blog.HL7.org. http://blog.hl7.org/hl7-launches-helios-fhir-accelerator-for-public-health (accessed Dec. 30, 2022).

[68] Health Level Seven International. "Helios FHIR Accelerator for Public Health Home." confluence.hl7.org. https://confluence.hl7.org/display/PH/Helios+FHIR+Accelerator+for+Public+Health+Home (accessed Dec. 30, 2022).

[69] https://confluence.hl7.org/display/VA/Vulcan+Projects

- Real World Data – Develop a new IG for retrieving research data from real-world data sources (e.g., electronic health records).
- Adverse Events – Use real-world data to identify unexpected adverse events related to treatment.
- Phenopackets – Define requirements for de-identification to promote the sharing of genomic data.

Website: https://www.hl7.org/vulcan/

Public Health FHIR Implementation Collaborative (PHFIC)

PHFIC is a collaborative established to build a FHIR community for public health. Its objectives are to identify FHIR implementation challenges, provide training, and demonstrate impact through pilot projects.[70] PHFIC focuses on data sharing within and across public health. Its initial focus is data exchange between state and local health departments, piloting surveillance and mortality data. PHFIC's goals with this pilot work will be twofold, to showcase the efficacy and adaptability of FHIR data exchanges and to create scalable software that others in public health can utilize for their purposes.

Website: [URL pending]

Situational Awareness

ONC awarded funding to the Texas Health Services Authority (THSA) to implement Situational Awareness for Novel Epidemic Response (SANER) in Texas.[71] The goal of the SANER project is to use FHIR to simplify public health reporting for hospitals by supporting uniform comparisons of facilities across the state and exchanging real-time facility capacity information, such as the number of cases, available beds, staffing levels, and other critical care resources. This exchange of information allows better insight into where resources are needed for crises, such as natural disasters, pandemics, or mass injury events. The implementation guide for SANER supports the reporting of situational awareness information from inpatient facilities to centralized data repositories used for public health emergencies and responses.[72]

Website: https://build.fhir.org/ig/HL7/fhir-saner/

Sync for Science (S4S)

[70] The MITRE Corporation. "Public Health FHIR® Implementation Collaborative (PHFIC)." https://sites.mitre.org/phfic/ (accessed Dec. 30, 2022).

[71] Texas Health Services Authority. "The Situational Awareness for Novel Epidemic Response Project (SANER PROJECT)." thsa.org. https://thsa.org/hie-texas/saner-project/ (accessed Dec. 30, 2022).

[72] Health Level Seven International. "Situational Awareness for Novel Epidemic Response." HL7.org. http://hl7.org/fhir/uv/saner/ (accessed Dec. 30, 2022).

S4S is a public-private partnership launched to support the Precision Medicine Initiative (PMI).[73] The PMI mission is "to enable a new era of medicine through research, technology, and policies that empower patients, researchers, and providers to work together toward the development of individualized care."[74] S4S uses FHIR and SMART to simplify the sharing of individual health data with the National Institutes of Health's All of Us Research Program.[75]

Website: https://www.healthit.gov/topic/sync-science

Vital Records

CDC's National Vital Statistics System (NVSS) developed the Vital Records Death Reporting (VRDR) IG to facilitate the automated exchange of data between state vital records offices and the National Center for Health Statistics (NCHS). FHIR resources are used to represent death events reported by medical examiners. This work aims to save time and reduce data entry errors by removing duplicate entries for the cause of death information. As part of this project, NVSS worked with the Minnesota Department of Health (MDH) Office of Vital Records, Minnesota IT Services, Southern Minnesota Regional Medical Examiner's Office, and MDILog – a case management vendor to implement the VRDR IG as a real-world example.[76]

Website: http://hl7.org/fhir/us/vrdr/index.html

[73] US Department of Health & Human Services. "Sync for Science." healthit.gov. https://www.healthit.gov/topic/sync-science (accessed Dec. 30, 2022).

[74] The White House. "The Precision Medicine Initiative." obamawhitehouse.archives.gov. https://obamawhitehouse.archives.gov/precision-medicine (accessed Dec. 30, 2022).

[75] M. L. Braunstein, *Health Informatics on FHIR: How HL7's API is Transforming Healthcare, 2nd ed.* Springer Nature Switzerland AG, 2022.

[76] Health Level Seven International. "Vital Records Death Reporting (VRDR) FHIR Implementation Guide." HL7.org. http://hl7.org/fhir/us/vrdr/ (accessed Dec. 30, 2022).

Appendix D Additional FHIR Material

1. **Video introductions to FHIR**

   There are several videos available on Vimeo and YouTube, some more introductory examples are provided below:

   - *HL7 FHIR Connectathon First Time Attendee Video:* https://vimeo.com/542197402/8fb80fea04
   - *A General Intro to FHIR by Smile CDR*: https://www.youtube.com/watch?v=YbQcJj1GqH0

   For a more complete listing of videos, Altarum has provided a consolidated catalog at https://phinterop.org/catalog

2. **Books on FHIR**

   - *Health Informatics on FHIR: How HL7's API is Transforming Healthcare* 2nd ed. 2022 Edition by Mark L. Braunstein
   - *Principles of Health Interoperability: FHIR, HL7 and SNOMED CT (Health Information Technology Standards)* 4th ed. 2021 Edition by Tim Benson and Grahame Grieve

3. **FHIR communities**

   - HL7 welcomes participants to join in discussion in their Zulip community discussion forums located at http://chat.fhir.org.
   - Join PHFIC's weekly office hours every Wednesday from 12:00pm – 1:00pm ET by emailing PHFIC@mitre.org.
   - Join CDC's FHIR Community of Practice monthly meetings by emailing OPHDST-Comms@cdc.gov.

4. **Standards development for public health**

   - STLT public health agencies may provide feedback on the Trusted Exchange Framework and Common Agreement elements and draft QHIN Technical Framework. To learn more visit https://rce.sequoiaproject.org/common-agreement-elements/.
   - ONC's Interoperability Standards Advisory includes standards used to promote interoperability in public health, health research, patient care delivery, and administrative tasks in healthcare. These standards are updated regularly to meet the interoperability needs of a broad range of organizations. The agency holds annual public comment periods that allow providers, developers, and other interested parties to contribute their ideas to the standards community. To learn more visit https://www.healthit.gov/isa/.

- ONC's USCDI and USCDI+ initiatives allow for public comment on proposed data exchange elements on a rolling basis. USCDI's focus is on identifying important data elements across healthcare and public health. To connect with USCDI, please visit https://www.healthit.gov/isa/united-states-core-data-interoperability-uscdi. USCDI+ has similar processes, but its focus is data elements important to public health. To connect with the public health USCDI+ effort visit ONC's USCDI+ website at https://www.healthit.gov/topic/interoperability/uscdi-plus.

- HL7 standards development, including development of the FHIR standard, is open to anyone.[77] To encourage a community approach, HL7 organizes regular working group meetings to encourage face-to-face discussion.[78,79] Readers of this playbook may be particularly interested in the HL7 Public Health Work Group whose work focuses on interoperability in population health monitoring, vital records, disease detection and response, public health registries, and similar public health interests.[80] More information about HL7 workgroups is available at https://www.hl7.org/special/committees/index.cfm.

- HL7 also oversees several FHIR accelerators. These accelerators promote the development and distribution of FHIR services across healthcare within a certain focus area. Examples related to include: HL7 Helios FHIR Accelerator for Public Health, Project Vulcan, and the Gravity FHIR accelerator. More information about FHIR accelerators is available at https://www.hl7.org/about/fhir-accelerator/.

[77] Health Level Seven International. "Participating in HL7." confluence.hl7.org. https://confluence.hl7.org/display/HL7/Participating+in+HL7 (accessed Dec. 30, 2022).

[78] Health Level Seven International. "HL7 Work Groups & Projects." confluence.hl7.org. https://confluence.hl7.org/pages/viewpage.action?pageId=4489802 (accessed Dec. 30, 2022).

[79] Health Level Seven International. "Work Group Meetings." HL7.org. https://www.hl7.org/events/workgroupmeetings.cfm (accessed Dec. 30, 2022).

[80] Health Level Seven International. "Public Health Work Group." confluence.hl7.org. https://confluence.hl7.org/display/PHWG/Public+Health+Work+Group (accessed Dec. 30, 2022).

Appendix E Acronyms & Glossary

Term	Definition
AIMS Platform	APHL Informatics Messaging Platform; acts as an intermediary for public health data exchange
API	Application Programming Interface
BSeR	Bidirectional Services eReferrals
Bulk FHIR	FHIR approach for moving data on a group of individuals
CDA	Clinical Document Architecture
CDC	Centers for Disease Control and Prevention
CDM	Common Data Models
COI	Community of Interest
CPG IG	Clinical Practice Guidelines Implementation Guide
Client (FHIR)	Software application designed to request or send data to a FHIR server
DMI	Data Modernization Initiative
eCR	Electronic Case Reporting
EHR	Electronic Health Record
ELR	Electronic Laboratory Report
eLTSS	Electronic Long-Term Services and Supports
Endpoint	Term often used by developers to reference a FHIR server
FHIR	Fast Healthcare Interoperability Resources
FHIR Pull	Exchange paradigm where FHIR data is retrieved from a source FHIR server by a client system
FHIR Push	Exchange paradigm where FHIR data is sent from a source FHIR server to a destination system
FHIR Query	See FHIR Pull
FHIR Questionnaire	Mechanism to collect information from the user of a system such as an EHR
FHIR Subscription	Mechanism to send update messages from a server to subscribing clients as FHIR resources are created or updated on the server
HAI	Healthcare Associated Infection Reports
HIE	Health Information Exchange
HIN	Health Information Network
HL7	Health Level Seven International

Term	Definition
i2b2	Informatics for Integrating Biology & the Bedside
IG	Implementation Guide
IHE	Integrating the Healthcare Enterprise
IIS	Immunization Information System
ISA	Interoperability Standards Advisory
IT	Information Technology
JSON	JavaScript Object Notation
LTCF	Long-Term Care Facilities
OMOP	Observational Medical Outcomes Partnership
ONC	Office of the National Coordinator for Health Information Technology
PCORnet	Patient-Centered Outcomes Research Network
PHFIC	Public Health FHIR Implementation Collaborative
PMI	Precision Medicine Initiative
PSS	Project Scope Statement
QHIN	Qualified Health Information Networks
RDF	Resource Description Framework
RESTful	Representational State Transfer
S4S	Sync for Science
SANER	Situational Awareness for Novel Epidemic Response
SDO	Standards Development Organization
SDOH	Social Determinants of Health
Server (FHIR)	A computer designed to provide FHIR resources in response to queries from client systems
SMART	Substitutable Medical Applications and Reusable Technologies
STLT	State, Tribal, Local, and Territorial
STU	Standard for Trial Use
TEFCA	Trusted Exchange Framework and Common Agreement describes the approach for nationwide health data exchange per the 21st Century Cures Act
USCDI	United States Core Data for Interoperability
USDS	United States Digital Service
VRDR	Vital Records Death Reporting

Term	Definition
WHO	World Health Organization
XML	Extensible Markup Language